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FEB 14 1986

Mr. O. K. Stender, Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

We have completed our review of your Final Supplemental Environmental Impact Statement (SEIS) for the Kahauale'a Geothermal Project filed with the department on February 6, 1986. The Final SEIS was prepared for the Kahauale'a Geothermal Project located on property described as TMK 1-2-10:3 and within the Kilauea Middle East Rift Geothermal Resource Subzone (GRS), Puna, Hawaii. The department has determined that the Final SEIS has adequately disclosed and described all identifiable environmental impacts. Further, the document has satisfactorily responded to comments received during the review of the statement. Thus, it represents an informational document as required by Chapter 343, Hawaii Revised Statutes and, therefore, is deemed acceptable.

Background

The environmental impact statement has been reviewed according to Section 11-200-23 of the Environmental Impact Rules.

An Environmental Impact Statement as defined in the EIS Regulations is "an informational document prepared in compliance with Chapter 343, Hawaii Revised Statutes, and this chapter and which discloses the environmental effects of a proposed action, effects of a proposed action on the economic and social welfare of the community and state, effects of the economic activities arising out of the proposed action, measures proposed to minimize adverse effects and alternatives to the action and their environmental effects".

Further, the document must satisfy criteria enumerated under Section 11-200-23(b) of the EIS Regulations. These criteria can be categorized as procedural, review process and content-related requirements.

With reference to content requirements, the document must satisfactorily comply with provisions specified under Sections 11-200-18 and 11-200-28 of the EIS Regulations for a supplemental EIS.

Analysis

Procedural Requirements

1. A Preparation Notice for the Supplemental EIS was issued by the Office of Environmental Quality Control on July 23, 1985.

2. The Draft Supplemental EIS was filed with OEQC on December 23, 1985.

3. The applicant had consulted with agencies at the Federal, State and County levels. Further, the applicant had also consulted with individuals and organizations who had shown an interest in the proposal.

4. The applicant had also held informational meetings with agencies, organizations and individuals on the Island of Hawaii.

5. Comments received during the consultation period were incorporated into the Draft Supplemental EIS.

6. Comments regarding the Draft SEIS were appended to the Final SEIS. Responses were made and incorporated into the FSEIS.

Review Process Requirements

1. Comments submitted during the review period were responded and appended to the FSEIS.

Content Requirements

1. The department finds the Final Supplemental EIS has satisfactorily met the requirements of Sections 11-200-16, 11-200-17, 11-200-18 and 11-200-28 of the EIS Regulations.

2. A section pertaining to the environmental setting had been incorporated. Descriptions of the existing condi- tions including drainage and erosion, flora and fauna,

soil and leaf tissue chemical composition, climatology, air quality, noise quality, geologic setting, historical/ archaeological attributes, socio-economic characteristics and visual factors.

3. Point-by-point discussions of the potential impacts arising from the proposed project and mitigating measures have been adequately discussed.

4. Unavoidable adverse environmental effects, irreversible and irretrievable commitments of resources and possible alternatives have been described.

5. A section delineating the proposed changes from the original EIS has been adequately discussed.

Conclusion

Based on the foregoing, the department finds the Final SEIS for the Kahauale's project met the requirements of an EIS and is an acceptable document.

Very truly yours,

SUSUMU ONO, Chairman

[redacted]

SUSUMU ONO, Chairperson
Board of Land and Natural Resources

cc: OEQC

bcc: DAR
DOFAW
DOWALD
Historic Sites
State Parks
NARS
Land Management

ALS:bq

# FINAL

# SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

TO THE

# REVISED

# ENVIRONMENTAL IMPACT STATEMENT

FOR THE

# KAHAUALE'A GEOTHERMAL PROJECT

FEBRUARY 1986

A TRUE/MID-PACIFIC GEOTHERMAL VENTURE
IN COORDINATION WITH THE ESTATE OF JAMES CAMPBELL

FINAL



# SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

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A TRUE/MID-PACIFIC GEOTHERMAL VENTURE

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## SUMMARY

True/Mid-Pacific Geothermal, Inc. in coordination with the Trustees of The Estate of James Campbell proposes to explore for and develop 100 megawatts (MW) of geothermal resources to produce electrical power in the Kilauea Middle East Rift Zone Geothermal Resource Subzone (GRS), Puna District, Island of Hawaii. This is a Supplemental Environmental Impact Statement (SUP EIS) to the Revised Kahauale'a Environmental Impact Statement [dated June, 1982 and accepted by the Board of Land and Natural Resources (BLNR) on July 20, 1982]. This SUP EIS has been prepared as a result of a land exchange (State land in the Kilauea middle east rift zone for Kahauale'a) proposed by the BLNR and executed on December 20, 1985. (Land exchanges involving State lands are subject to review and veto by the Legislature.)

As a result of the proposal to relocate the project area to adjoining State land encompassing the Kilauea middle east rift zone, a Conservation District Use Permit Appplication (CDUA) was submitted (Aug. 20, 1985) to the BLNR. This SUP EIS has been prepared in support of the revised CDUA. The proposed 100 MW geothermal development project (scaled down from the 250 MW Kahauale'a project) would be located within the designated GRS of 8,500 acres, more or less, within the 26,000 acres, more or less, of Campbell Estate land acquired from the State in

exchange for Kahauale'a. Approximately 245 to 305 acres of a land area of 26,000 acres will be required for drilling sites, roadways, fluid transmission lines, electrical transmission lines, power plants and ancillary facilities. The project will require 35 drilling sites located in up to five exploration/development areas and up to five power plant sites. Power plant capacities will range from 5 MW to 55 MW of electricity. (One megawatt (MW) is equal to 1000 kilowatts).

Electricity generated will be used to satisfy the needs of the island of Hawaii first, and secondly, for export to Oahu via a potential deep water cable between Hawaii and Oahu.

The project area proposed is within the GRS of a Conservation District. Relatively unpopulated residential subdivisions are immediately north, east and south of the project area. The Kahauale'a parcel borders the western boundary and the Kamaili Geothermal Resource subzone borders the eastern boundary.

The topography of the project area is gradually sloping from an elevation of 2,000 feet down to 1,300 feet. Annual average rainfall ranges from 120 to 150 inches and annual average temperatures range from 80°F to mid 50°F. Prevailing winds during the day are northeast tradewinds while northwesterly drainage winds prevail at night.

The project area is in a rural area, mostly forested with vegetation ranging from high quality native vegetation to disturbed vegetation and open areas devastated by recent (1983-1985) lava flows. During recent botanical surveys, four rare or endangered plants were sighted in the project area. A rare fern (Adenophorus periens) has been sighted in the lower central portion of the project area. The endangered Hawaiian Hawk has been sighted in the area.

Ambient noise levels in the area are subjectively judged to be "quiet" to "very quiet." The ambient air quality, as determined by three monitoring programs, has low levels of pollutants except during volcanic eruptions.

The area surrounding the proposed project mirror the existing socioeconomic characteristics of the Puna District with primary employment in agriculture, construction, trade, light manufacturing and service industries.

The archaeological/historical information on the project area suggests that the potential for finding sites of archaelogical significance is limited. The visual attributes of the project and surrounding areas are open, forested areas interrupted by recent or older barren lava flows.

The long-range positive social and economic benefits of developing Hawaii's geothermal resources as proposed by this project are expected to outweigh potential negative environmental impacts and short-term social impacts. Less than 3 percent of the project area and about 1 percent of the State land proposed for exchange will be required for siting of project facilities and roads.

The most environmentally sensitive areas of class 1 ohia forests will be avoided to the maximum extent possible; all areas to be cleared will be inspected by qualified biologists and archaeologists prior to clearing; and all power plant sites will be situated to minimize visual intrusion. Drainage/erosion characteristics of the project area will not be altered; all project exploration, development and operations will be designed and performed to meet all applicable Federal, State and County environmental protection regulations; project employment during construction phases is expected to generate approximately $2,250,000 per year in income.

## Section I

### INTRODUCTION

A. Background

This is a supplemental environmental impact statement (SUP EIS) to the environmental impact statement (EIS) for the Kahauale'a Geothermal Project (dated June, 1982) and accepted by the State Board of Land and Natural Resources (BLNR) on July 30, 1982.

The Kahauale'a Geothermal Project was initiated for the purpose of developing geothermal resources on Campbell Estate lands (Kahauale'a) in the Puna District, Island of Hawaii. Geothermal development activities are now proposed on adjoining lands that formerly belonged to the State in lieu of Kahauale'a, as the result of a land exchange proposed by the State to the Estate of James Campbell and executed on December 20, 1985.

A Conservation District Use Application (CDUA) was submitted in March, 1982 to the BLNR for a permit to conduct geothermal exploration and development activities within the boundaries of Kahauale'a. The EIS was submitted in support of the CDUA.

Subsequent to acceptance of the EIS for the Kahauale'a Geothermal project, the State Legislature enacted two laws dealing with geothermal development (Act 296, Session Laws of Hawaii, 1983 and Act 151, Session Laws of Hawaii, 1984). These two acts provided that "geothermal development activities" could occur in any of the four land use districts in the State within specified boundaries established by the BLNR as a Geothermal Resource Subzone (GRS) in accordance with criteria established in the Acts, but subject to application for and issuance of all required permits on a project-by-project basis. Act 296 defined geothermal development activities as those activities associated with the exploration and development of geothermal resources and the production of those resources to generate electrical energy.

The BLNR proposed three sub-zones on the Kilauea East Rift Zone. Two of the sub-zones were designated by BLNR in November 1984. The proposal for a sub-zone within Kahauale'a was the subject of a contested case hearing by the Volcano Community Association and several individuals, the result of which was that a portion of Kahauale'a was designated by the BLNR as a GRS by BLNR Decision and Order of 28 December 1984.

In the foregoing Decision and Order, the BLNR also proposed that the landowner of Kahauale'a (the Estate of James Campbell) consider a land exchange of Kahauale'a for adjoining State-owned land in the middle east rift zone of Kilauea (the Puna Forest Reserve, the Wao Kele O Puna Natural Area Reserve, and such other adjacent State land as would be appropriate). If such exchange is determined to be feasible and is consummated in conjunction with the designation of a suitable GRS within the exchanged State lands, geothermal development activities would occur in the exchanged lands rather than Kahauale'a. Upon the designation of a GRS within the lands to be exchanged and upon issuance of the proper permits for geothermal development in the State lands to be exchanged, including acceptance and approval of this SUP EIS, the land exchange would be considered irreversible and the presently designated GRS for Kahauale'a would be terminated. Subsequently, a Natural Area Reserve would be established within Kahauale'a.

Following the proposal by the BLNR, the landowners (Campbell Estate and the State) agreed in principle to the proposed land exchange consisting of approximately 25,000 acres, more or less, from each land area as shown in Figures 1 and 2. The Legislature, during the 1985 session, unanimously passed a joint resolution requesting the BLNR to expedite the proposed land exchange. Steps were initiated between the parties to undertake the actions required to appraise the separate values of the affected lands and consummate the land exchange (the exchange was executed on December 20, 1985). In the interim, a revised CDUA for a permit to conduct geothermal development activities on the State lands to be exchanged in lieu of Kahauale'a was submitted to the BLNR. In addition, action was initiated by the State to propose additional portions of the Kilauea east rift zone as a GRS, which would include a portion of the State lands to be exchanged. Following a contested hearing, a GRS was designated by the BLNR on December 20, 1985. See Figure 3. The proposed project lies entirely within the newly designated Kilauea Middle East Rift Zone GRS.

B. REQUIREMENT FOR SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Under Chapter 343, Hawaii Revised Statutes (HRS), a Supplemental Environmental Impact Statement (SUP EIS) is required if there is any major change in the action proposed in the EIS, including especially the size, scope, location and timing, which could in turn result in new or different environmental impacts than originally predicted. The "accepting authority" for the EIS, the BLNR, has determined that as a result of relocating proposed geothermal development activities to the adjoining State lands, a SUP EIS is required to describe and document the changes in the environmental setting of the proposed action and any changes in the environmental impacts predicted in the EIS, or in the mitigation measures described in the EIS to reduce or prevent these impacts.

This SUP EIS is prepared on the assumption that a conservation district use permit to conduct geothermal development activities in the GRS will be issued by the BLNR.

If the CDU permit has not been issued before the adjournment of the 1986 Legislative Session, or if the Legislature vetoes the land exchange, all permit applications and this SUP EIS will be withdrawn. In such event, actions will be resumed towards obtaining final authority to conduct geothermal development activities within the designated GRS for Kahauale'a.

## C. SCOPE OF SUPPLEMENTAL EIS

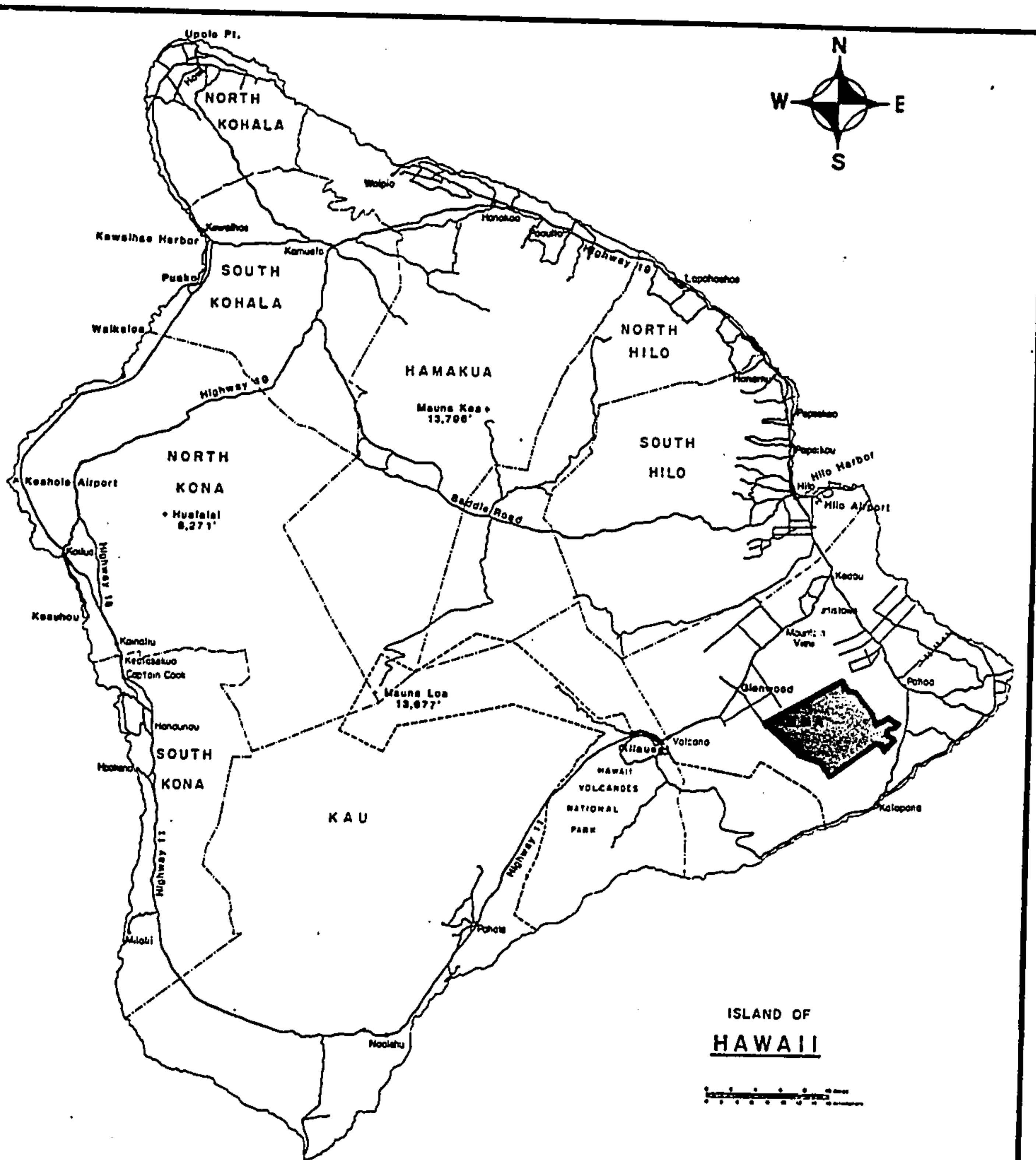
The scope of this SUP EIS is limited primarily to presenting information on:

(1) changes in the environmental setting described in the EIS that are the result of relocating the project activities to the adjoining land areas;

(2) additional baseline data collected in the area since preparation of the EIS;

(3) the effects, if any, of changed environmental baseline data and the relocation of the project site on both the environmental impacts predicted for the project and the measures planned to reduce or prevent those impacts as described in the EIS; and

(4) information on revised development plans for the proposed project.




LEGEND:

Location of Project Area

Source:

Project Location

FIGURE

1

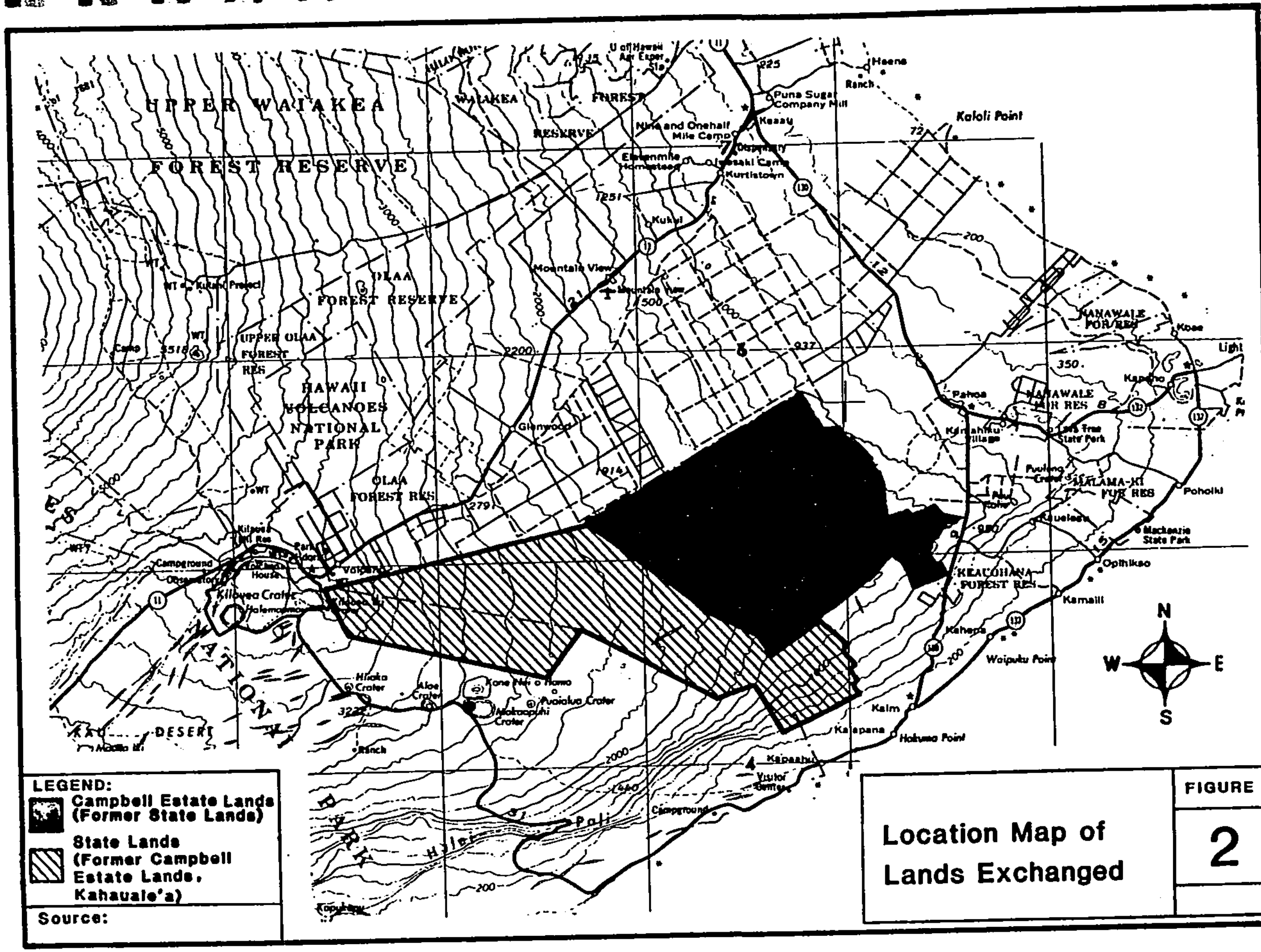
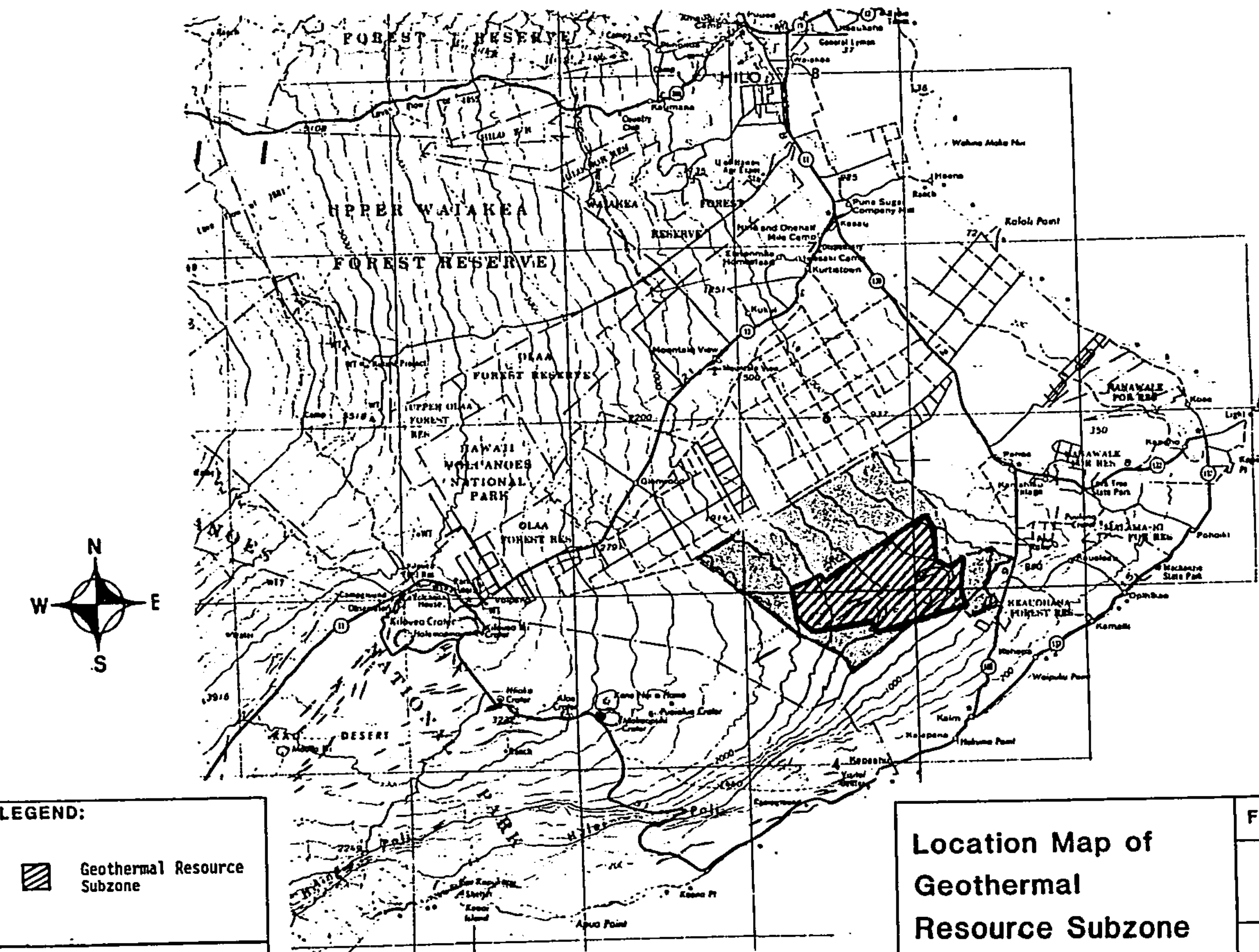



FIGURE 2

Location Map of Lands Exchanged




LEGEND:

Geothermal Resource Subzone

Source:

Location Map of Geothermal Resource Subzone

FIGURE 3

All information in the EIS that is not directly affected by this planned shift of the project site to adjacent land remains valid, is applicable to the SUP EIS and is incorporated in this SUP EIS by reference by authority of the BLNR and Chapter 343, HRS.

For the convenience of the reviewer, an overview of the EIS for the Kahauale'a Geothermal Project is provided below. Other information from the EIS that is considered relevant to an understanding of information presented in this SUP EIS is also included in summary form in applicable sections.

## D. OVERVIEW OF THE ENVIRONMENTAL IMPACT STATEMENT FOR KAHAUALE'A

The EIS for the Kahauale'a Geothermal Project, Puna District, Island of Hawaii, was prepared pursuant to Chapter 343, HRS. The EIS described the proposed action that would occur within Kahauale'a which consists of two parcels of land owned by the Estate of James Campbell, TMK No. 1-1-01 Parcel 1 and TMK No. 1-2-08 Parcel 1. These parcels constitute a total of 25,461 acres of which 21,943 acres lie within the conservation district boundary and 3,518 acres within an agricultural boundary. The Hawaii Volcanoes National Park borders the western boundary of Kahauale'a and the Wao Kele O Puna Natural Area Reserve is on the eastern boundary (see Figure 2, Lands to Be Exchanged).

As to the environmental setting, the Kahauale'a lands consist largely of relatively undisturbed 'ohi'a forest lands with dense 80% canopy (created by the uppermost spreading branch layers of the forest) in the eastern portion to 40% canopy in the southern and western sections. Baseline environmental surveys revealed the presence of rare/endangered and new plant species in the northeastern section of Kahauale'a: The Cyrtandra, Cyanea, Clermontia and the Adenophorous periens which was also present in other areas of the parcel.

The Hawaiian Hawk ('Io) and Hawaiian Honeycreeper ('O'u) have been sighted in Kahauale'a. The hawk is a wide ranging raptor that frequents woody forest areas. Its population count has risen in recent years and its rare/endangered status may be appropriate for reevaluation. The honeycreeper has been sighted once previously in Kahauale'a but it is not known if this bird nests in this area. A single sighting of the Hawaiian Bat, the only known native mammal in Hawaii on the Rare/Endangered Species List, was made in a shallow cave in an exposed lava area during the baseline assessment survey. It, too, is a wide ranging creature.

Documentary literature searches were conducted for evidence of sites which may have archaeological interest within the project area. While there is no record of archaeological sites with the State Historic Preservation Office, the literature search did reveal indications of early Hawaiian activity in the mauka regions of Kahauale'a.

The proposed action in the EIS is to develop geothermal resources that may be present in this portion of the east rift zone of Kilauea Volcano and to convert those resources into electrical energy. The development of one of Hawaii's major natural energy resources would contribute significantly towards reducing the State's near total dependence on imported oil for its electrical power, an objective of State and County governments and a delineated goal in the State's energy plan.

In the project area for Kahauale'a, it is estimated that up to 250 MW of electrical power could be produced for a period of at least 30 years.

Development plans provide for a gradual achievement of this potential over a period of 14 to 20 years subject to continuous monitoring by BLNR and the issuance of separate permits by the State Department of Health and BLNR for authority to construct each power plant and drill each well, as applicable. Development is planned to encompass exploration and development drilling from up to 35 drilling sites. Directional (slant) drilling, when possible, would allow up to six wells to be drilled from each site. Power plants to convert the geothermal energy into electrical energy are planned in units with capacities from 12.5 MW to 110 MW.

The development plan identifies five potential sites for locating geothermal power plants. The total surface area needed for the project, if fully developed, is estimated to be between 400 and 600 acres, approximately 3% of the total acreage (25,461 acres) of the two parcels combined. The surface area would be adequate for drilling sites, power plant sites, access road, power transmission lines, maintenance roads between drilling sites and power plant sites and geothermal fluid transmission lines which would be placed adjacent to the maintenance roads.

The actual and potential environmental impacts for the proposed action in Kahauale'a are described in the EIS in relation to the environmental setting within and adjacent to Kahauale'a. These impacts could be caused as a result of land clearing and construction activities for roads and facilities, drilling operations, well testing, and power plant operations. The extent of the impacts that could or would occur from these development activities depends on the specific measures taken to mitigate or prevent the impacts from such operations.

The comments received during the consultation periods for the EIS for

Kahauale'a pertained to concerns that the proposed project activity could result in various impacts summarized as follows: damage or destruction of rare or unique plants and superior quality 'ohi'a forests; the invasion of exotic plants into areas cleared for operations and the possible resultant adverse effects on the forest area and wildlife; the creation of noise levels that would disturb nearby residents or National Park visitors and wildlife in the near vicinity of the noise source; the emission of particles, fluids or gases (especially hydrogen sulfide - $H_2S$) during well drilling, well testing and power plant operations that may exceed levels above which there could be a nuisance odor of hydrogen sulfide, or health problems, or damage to plants and wildlife; visual impacts of a drilling rig or power plants in a natural forest area close to the Hawaii Volcanoes National Park; and the concerns that cultural values or significant archaeological remains, if present, could be adversely impacted by the proposed project activity.

Procedures and measures are described in the EIS to avoid or lessen to acceptable degrees the impacts associated with geothermal development activities in the environmental setting of Kahauale'a. In addition, the EIS refers to existing and pending regulatory policies and standards by which project operations wil be monitored by government agencies and which will result in additional measures being taken to assure that impacts would be or remain within acceptable ranges.

In response to the concerns described above which were voiced during the consultation periods, additional information was included in the final EIS on those mitigation measures that are applicable to those expressed concerns.

## SECTION II

## PROJECT DESCRIPTION

### A. OVERVIEW

The overall revised geothermal resource development project as described in this SUP EIS, has been designed to explore for, develop and produce geothermal resources sufficient to generate 100 MW of electricity to satisfy the needs of the Island of Hawaii (Big Island) first, and secondly, for export purposes via a potential deepwater electrical transmission cable between the Big Island and Oahu. In order for the County of Hawaii to become energy self-sufficient by 1995 without use of oil, in excess of 100 MW of alternate energy derived power would be needed.

Inherent in this development plan is an exploration strategy designed to fully define the extent and characteristics of any geothermal reservoir in the middle East Rift Zone GRS. The information on the production potential of the project area, together with that for other areas from other developers, is necessary to demonstrate to State agencies and private developers of a deepwater cable that sufficient geothermal resources are present on the Big Island to justify proceeding with a costly commercial deepwater cable program. The resource exploration and development plan as described herein has been designed to accomodate environmental, market and technological considerations.

## B. GEOTHERMAL RESOURCE POTENTIAL OF PROJECT AREA

The geothermal resource potential of the Kahauale'a area is described in detail in the EIS (Appendix D). Analyses completed subsequent to the publication of the EIS confirm the resource potential not only for the Kahauale'a area, but also for the present project area and entire Kilauea east rift zone (Niimi, 1985 and DLNR, 1985). As indicated by DLNR (1985) "Currently available geotechnical data indicated the presence of a geothermal resource along the entire Kilauea East Rift Zone. The assesment of geothermal resource potential was based on a qualitative interpretation of regional surveys based on the following types of data: groundwater temperature, geologic age, geochemistry, resistivity, infrared, seismic, magnetics, gravity, self-potential and exploratory drilling. The evaluation of these data indicated that the potential for a geothermal resource on this rift zone was greater than 90 percent through its entire length." Further, DLNR (1985) concluded that "...no single geothermal exploration technique, except for exploratory drilling, is capable of positively identifying a subsurface geothermal system...".

The continued successful operation and generation of electricity by the HGP-A plant further confirms the resource potential of the east rift zone. Similarly, based on the numerous geophysical, geological, and geochemical studies of the east rift zone that have been performed over the past 10 years (see References to EIS, Appendix D of EIS, Niimi, 1985 and DLNR, 1985), plus the fact that vast amounts of heat energy are available from an active volcano as demonstrated by the prolonged activity and eruptions of Pu'u O'o, further demonstrate the resource potential of the project area. Figure 4 delineates the estimated percent probability of geothermal resource potential in the middle east rift zone GRS. (The designated GRS was reduced by approximately 2500 acres from the proposed GRS, but is within the boundary of the proposed GRS except on the north side where the GRS extends to the former Puna Forest Reserve boundary, an area of less than 100 acres). High rainfall amounts on the eastern portion of the island of Hawaii, and possibly seawater intrusion below the project area, provide a large source of water to supply the geothermal system.

Studies conducted (Holcomb, 1980) have shown that the surface volcanic expressions of the entire east rift zone indicate little, if any, change in the geologic character of the rift zone from upper to lower elevations. From these studies it is presumed that the subsurface character will not be much different between the upper and lower portions of the rift zone (Niimi, 1985).

The studies conducted to date, as well as the exploratory and production wells that have been drilled in the lower east rift zone by Thermal Power Company and the HGP-A group, provide a preponderance of evidence that geothermal resources exist in the GRS (Figure 3). The exact location of those resources within the project area can only be determined through exploratory drilling as indicated above and described in Paragraph C below.

C. EXPLORATION AND DEVELOPMENT CONCEPT

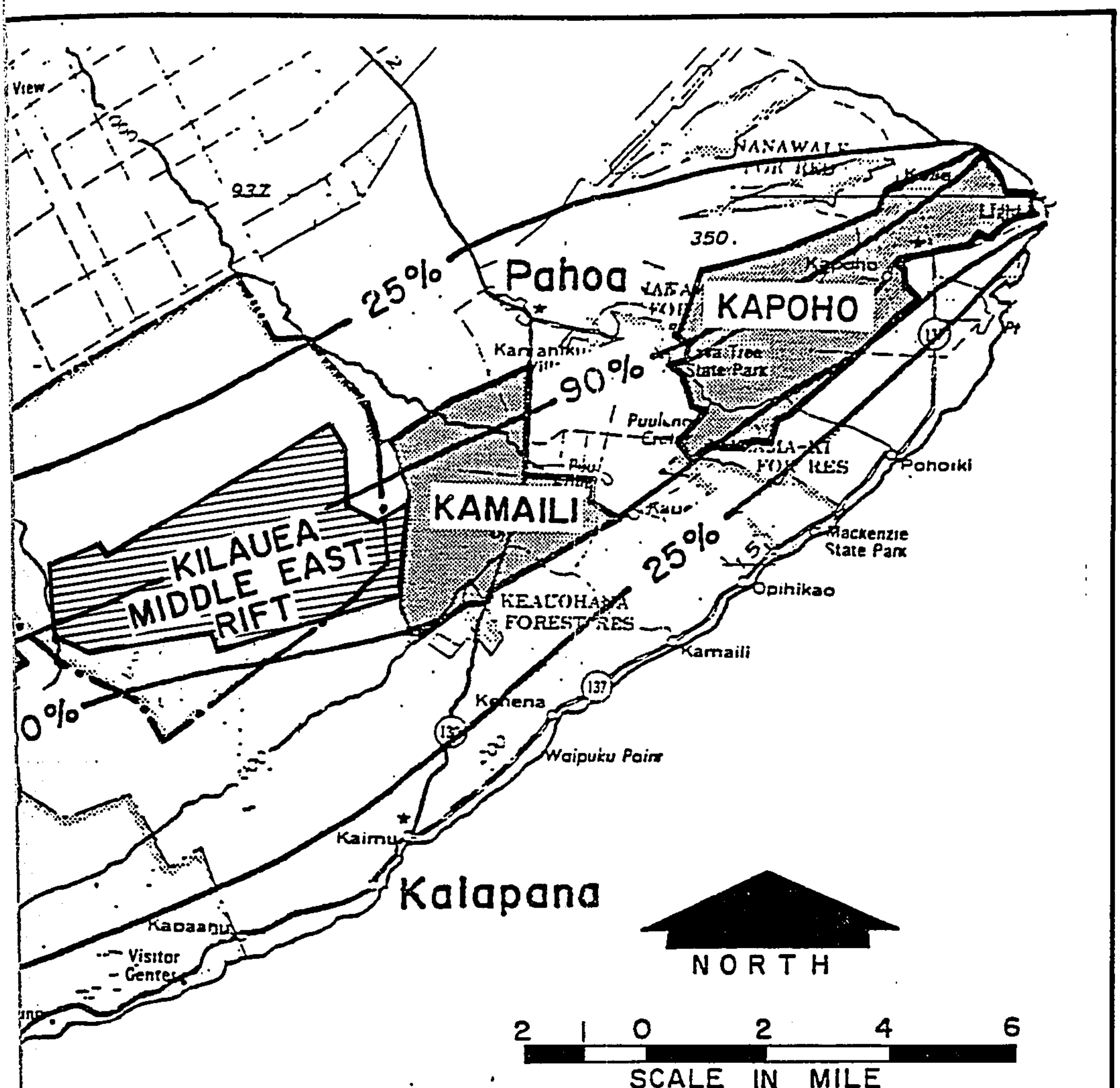
Figure 5 identifies the locations of surface areas within the project area that are expected to be used for geothermal development activities. Table 1 indicates the estimated acreage required for the

TABLE 1

ESTIMATED SURFACE ACREAGE REQUIRED FOR PROJECT USE

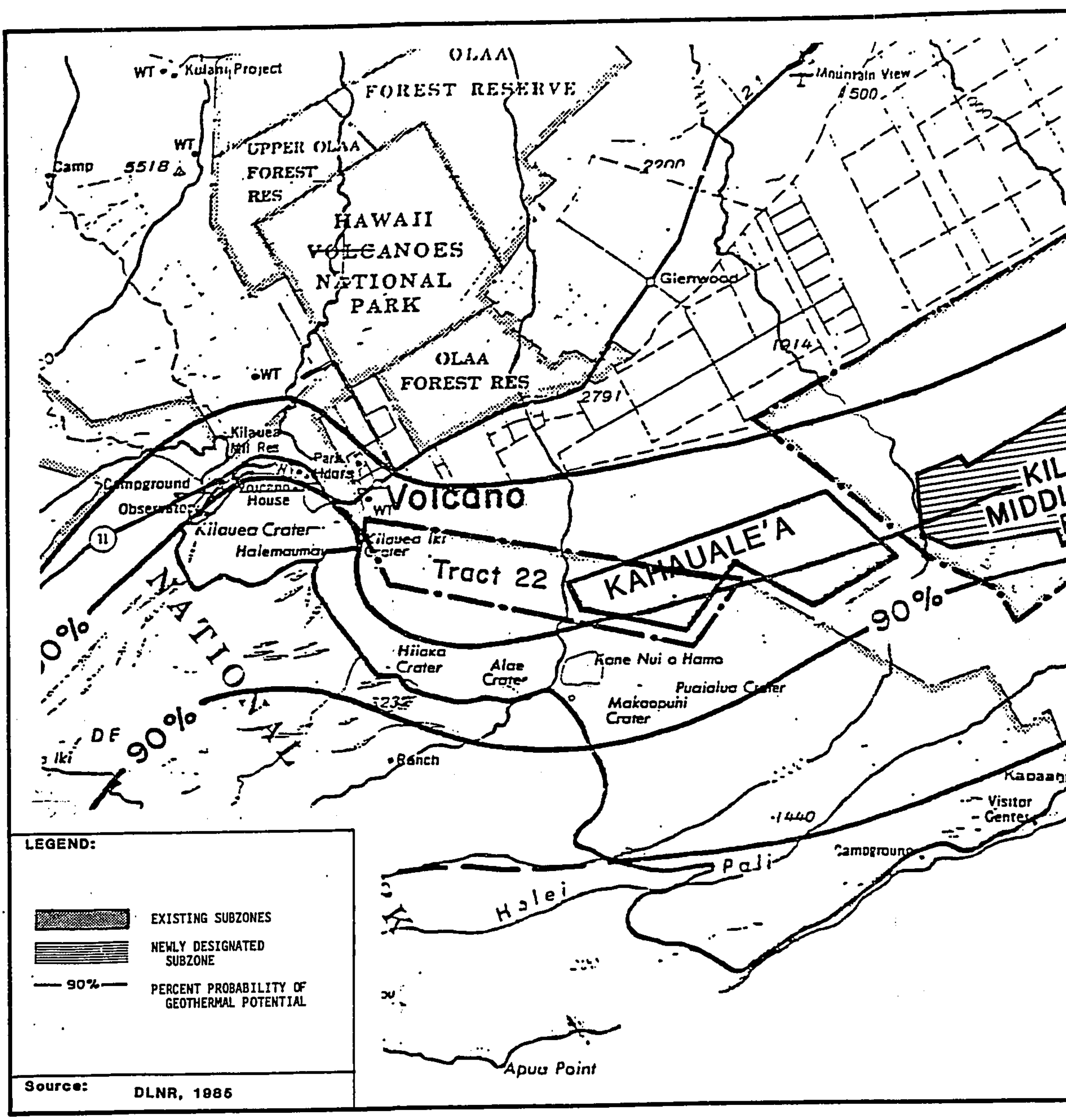
| LAND USE | LENGTH | WIDTH | AREA | TOTAL ACRES |
|---|---|---|---|---|
| Primary Access Roads | 3.8 miles | 30 ft | | 13.8 |
| Service/Maintenance Roads | 17 miles | 20 ft | | 41.2 |
| Electrical Transmission Lines | 12 miles | 44 ft | | 64.0 |
| Fluid Transmission Lines | 17 miles | 10 ft | | 20.6 |
| Drilling Sites (35) | | | 2- 3 acres each | 70 -105 |
| Permanent Power Plant Sites (3-5) | | | 5- 8 acres each | 15 - 40 |
| Miscellaneous Use | | | 20 acres | 20 |
| | TOTAL | | | 244.6-304.6 |

Percentage of Acreage Required based on:
Approx. 26,000 Acres in Parcel = 0.94 - 1.2
Approx. 8,500 Acres in GRS = 2.87 - 3.58

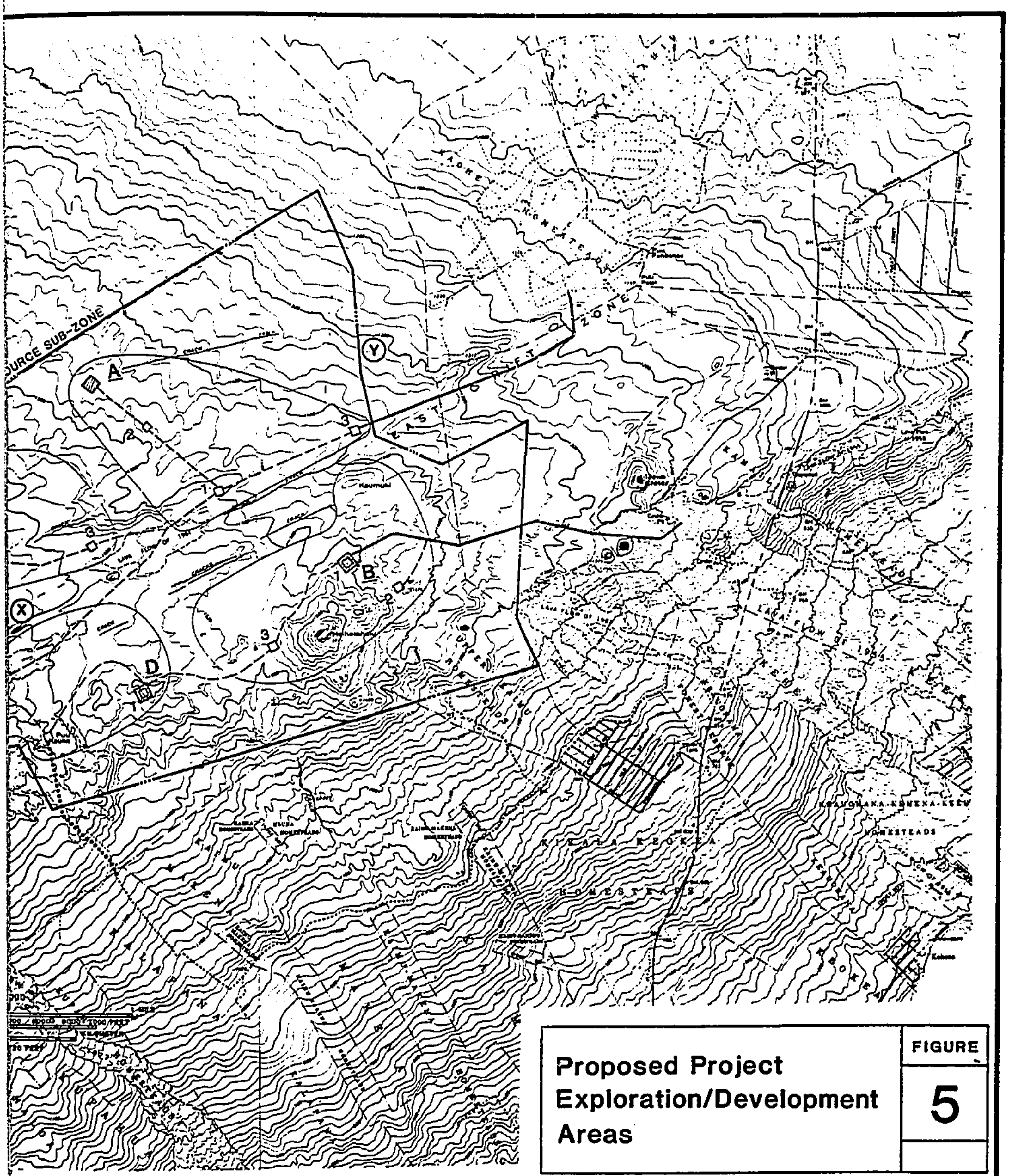



Kilauea Middle East Rift
Potential Geothermal
Resource Area

FIGURE
4

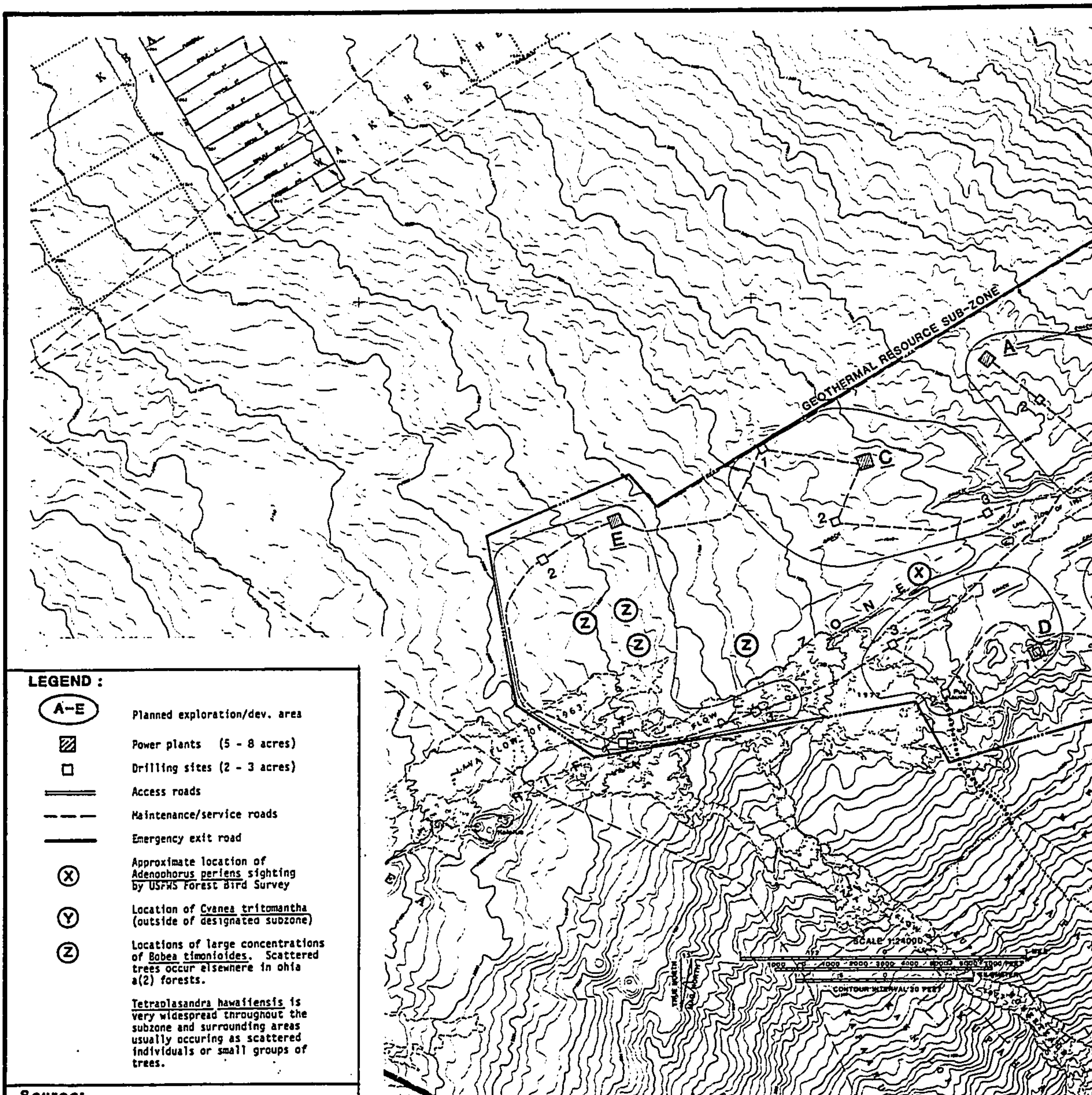


WT Kulani Project
OLAA
FOREST RESERVE
UPPER OLAA FOREST RES
HAWAII VOLCANOES NATIONAL PARK
Camp
5518
Mountain View
500
2200
Glenwood
1914
OLAA FOREST RES
2791
WT
Kilauea Mil Res
Park Hdqrs
Campground
Volcano House
Observatory
Volcano
11
Kilauea Crater
Halemaumau
Kilauea Iki Crater
Tract 22
KAHAUALE'A
MIDDL
90%
Hiiaka Crater
Alae Crater
Kane Nui o Hamo
Puaialua Crater
Makaopuhi Crater
Bench
1440
Kapaa
Visitor Center
Campground
Pali
Halei
Apua Point
LEGEND:
EXISTING SUBZONES
NEWLY DESIGNATED SUBZONE
90%
PERCENT PROBABILITY OF GEOTHERMAL POTENTIAL
Source: DLNR, 1985




Proposed Project Exploration/Development Areas

FIGURE 5




Source: KFC AIRPORT, INC.

total 100MW project use.

Within the project area GRS, surface areas for geothermal development activities were selected on the basis of the geological analyses of the rift zone, surface expressions that are indicative of earlier volcanic activity, minimizing potential environmental impacts and the slope of the surrounding terrain. Those sections of the active rift zone with significant faults and cracks were avoided, as were the more environmentally sensitive 'ohi'a class 1 forests. Due consideration was given to surface features along the rift zone that would tend to minimize the potential for lava flows into a planned exploration development (E/D) site.

These considerations dictated that exploration and development within the GRS be planned to occur on either side of the rift zone including along transects trending northerly from the rift zone in order to locate and develop the northern boundary of the reservoirs expected to exist in this area.

Prospective drilling sites were evaluated in consideration of (1) the physical characteristics of the sites, especially the slope of surrounding land; (2) the objective to avoid, to the extent feasible, areas indicated to have the highest quality forest; (3) the need to locate wells at sufficient distance from other wells to assure the maximum effective exploration/development effort over the area with the minimum amount of drilling; and (4) the objective that development would occur with the most appropriate spacing to enhance the production life of discovered reservoirs.

Inasmuch as the location of geothermal reservoirs must be determined by deep drilling and since the economic producibility of the resource from each discovered reservoir can only be determined by testing each successful well, the drilling sites selected, as shown in Figure 5, are tentative. Depending upon drilling results and testing, the final surveyed location of each proposed well will be identified in each application for a drilling permit for each well (see Section VI). For planning purposes, five exploration/development (E/D) areas have been selected. Each area has three primary drilling sites planned (for a total of 15 sites) connected by access/service roads. Allowing for estimates of non-producible wells, a total of 35 individual drilling sites within the 5 E/D areas may ultimately be required to produce 100 MW of electricity. The drilling sites will occupy from 2-3 acres. If directional drilling is technically and economically feasible, up to 6 exploration/development wells may be drilled from one or more drilling sites.

The first drilling site (see Figure 5) is planned near the eastern area of the proposed sub-zone, north of the rift zone center in E/D area "A". The general sequence of exploration drilling is as follows:

1) If the first exploration well in E/D area "A" <u>is successful</u>, the second well site in this E/D area (Site 2) will be drilled to obtain indications of the northern boundary of the discovered reservoir. (A "successful" well is one from which geothermal resources can be produced economically.)

Regardless of the results of this well the next exploration well would be drilled in E/D area "B", at one of the three planned sites.

2) If the first exploration well in E/D area "A" is not successful, the second well will be drilled at one of the three sites in E/D area "B" on the south side of the rift zone center near Pu'u Heiheiahulu.

3) If the first well in E/D area "B" is successful, another exploration well would be drilled at one of the other planned locations within E/D area "B". If the first well in this E/D area is unsuccessful, the next well would be drilled at one of the three sites in E/D area "C", on the north side of the rift zone center.

4) If the first two wells are unsuccessful in E/D area "A" and E/D area "B", a decision would be made to move to E/D area "E", in the western portion of the GRS near the more active section of the rift zone, or to terminate or suspend the project. If a well drilled at this site is also unsuccessful, the project would be terminated.

5) If a successful well is drilled in E/D area "C", the next wells would be drilled in E/D area "D" and then "E".

Power plant sites will be located at a drilling site or within 2 miles of the furthest well site supplying steam to the plant. Pending successful well field development, five tentative power plant locations are shown in Figure 5. Power plants will vary in size from 5 MW to 55 MW. The area needed for a power plant will vary from 5 to

8 acres depending on the size/capacity of the plant.

It is noted that prior to the construction and/or operation of power plants, Authority to Construct (ATC) and a Permit to Operate permits must be obtained from the State Department of Health. The ATC permit application must detail the specific equipment and procedures that will be used to ensure maintenance of applicable air quality standards in addition to other environmental protection measures that will be used to ensure that the power plant construction and operation will meet all other applicable environmental protection regulations.

Service roads (20 ft. width) and transmission pipelines (adjacent to service roads in a 10-ft. corridor) will be constructed between wells and power plants.

Successful exploration wells would be shut-in after completion and testing if there is no immediate market for the resource.

Drilling of development wells will occur concurrently with the ability of the electric utilities to replace oil generated electricity with geothermal generated electricity. As a general rule, each development well will be drilled within 2000 feet of wells that have intersected reservoirs with economically producible resources.

The primary access road into the GRS and project area will be via State Road 130 to Pahoa By-Pass, North of Pahoa, to South Road and then to Middle Road in the Kaohe Homesteads (Figure 5). From the boundary of the State land, the access road would proceed to E/D "A" to the first drill site north of the center line of the rift zone.

A secondary access road planned via State Road 130 to a county road approximately 3 miles south of Pahoa leading to the cinder pit south of Iilewa Crater. From the end of the county road, the access road into the State agricultural parcel (TMK 1-2-10:1) would proceed through AMFAC land (TMK 1-3-01:07), subject to granting of an easement to E/D area "B" on the south of the center line of the rift zone. An emergency exit road to the south from the center of the GRS (E/D Area "D") is planned for the route shown connecting with the western end of the county road leading to Route 130.

D. PROJECT SCHEDULE

The preceding development plan is presently planned to be accomplished over an eight to ten-year period as shown in Figure 6. Figure 6A shows the most optimistic geothermal development schedule for Hawaii County. For planning purposes it has been assumed that initial drilling operations in E/D area "A" will begin on July 1, 1986. Assuming that all permits are obtained in a timely manner, that drilling operations proceed in an orderly fashion and that one out of four wells is not producible, all drilling and well testing operations will be complete around July 30, 1993. The first 12.5 MW of power should be on-line around March 1, 1989 and the final 75 MW should be on-line during 1995.

The development schedule (Figure 6) is based on the following assumptions:

1) A land use permit is issued to authorize the development of up to 100 MW of geothermal generated electrical power.

2) The initial exploration and development drilling will supply

base load power to the Big Island utility (HELCO) to the extent its system can replace oil generated electricity (assumed to be 25 MW to 50 MW during the 1988-1995 period).

3) The subsequent exploration and development drilling will be accomplished to prove the presence and production readiness of resources capable of supplying a major portion of the capacity of the first increment of the planned deepwater cable to Oahu (first cable increment assumed to be 250 MW and completed by 1994-1995).

4) Power plant "authority to construct" permits will be issued as the demand for the electrical power develops to the level of production authorized in the CDU permits. Power plants will be in units ranging from 5 MW to 55 MW.

5) Power demands for base-load alternate energy generated electricity are estimated to be as follows:

   (a) Base load on Big Island - 25 MW by 1990 and 50 MW by 1995.

   (b) Base load for Oahu - 250 MW by 1995
   - 500 MW by 1997

6) Time requirements for exploration/development activities are as follows:

   (a) Mobilization/Drilling/Demobilization - 75 days per well

   (b) Well testing and completion - 45 days per well

   (c) Power plant design/construction/testing - 18 months

## FIGURE 6
## DEVELOPMENT SCHEDULE
(Geothermal Development Project for 100 MW)

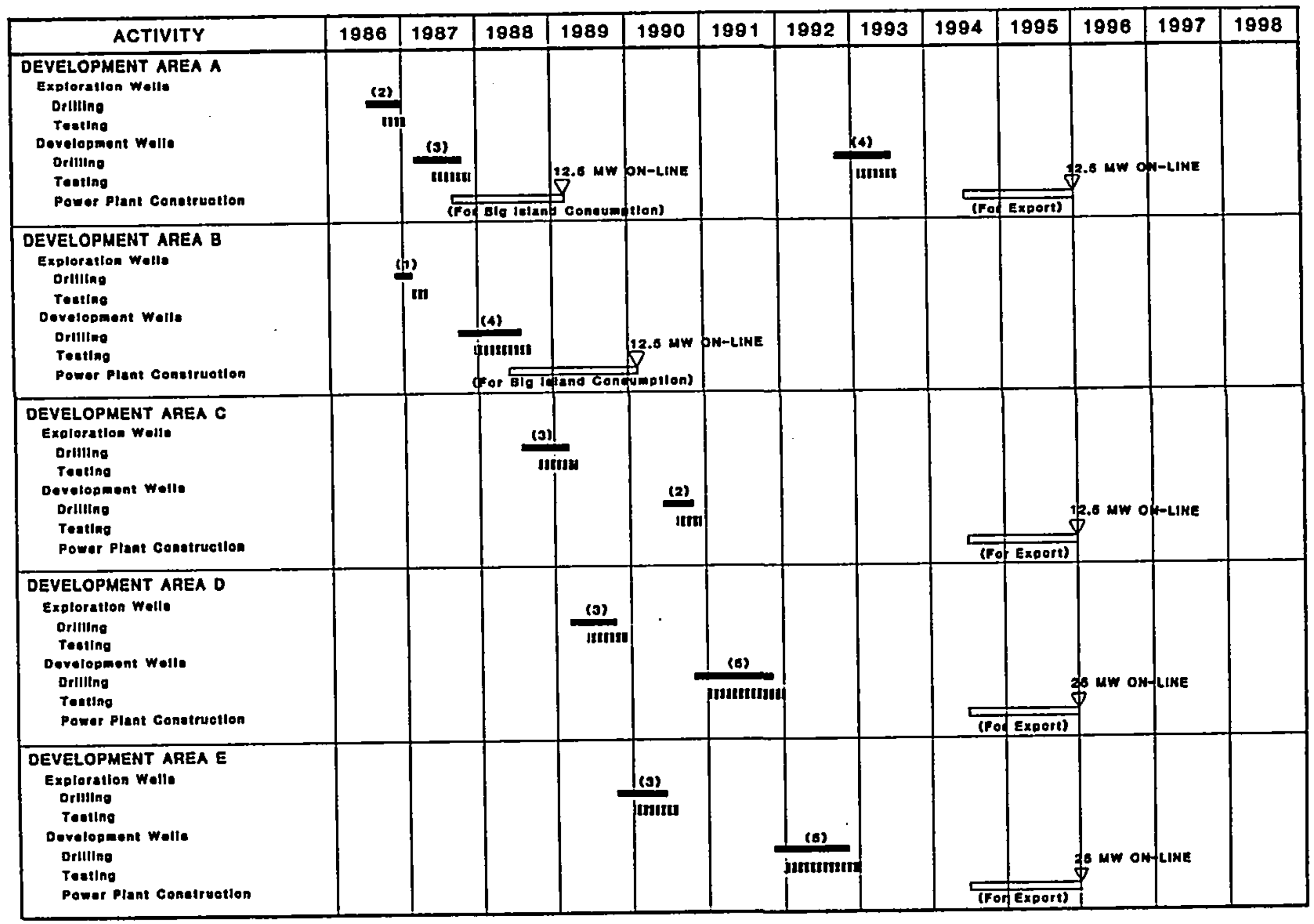
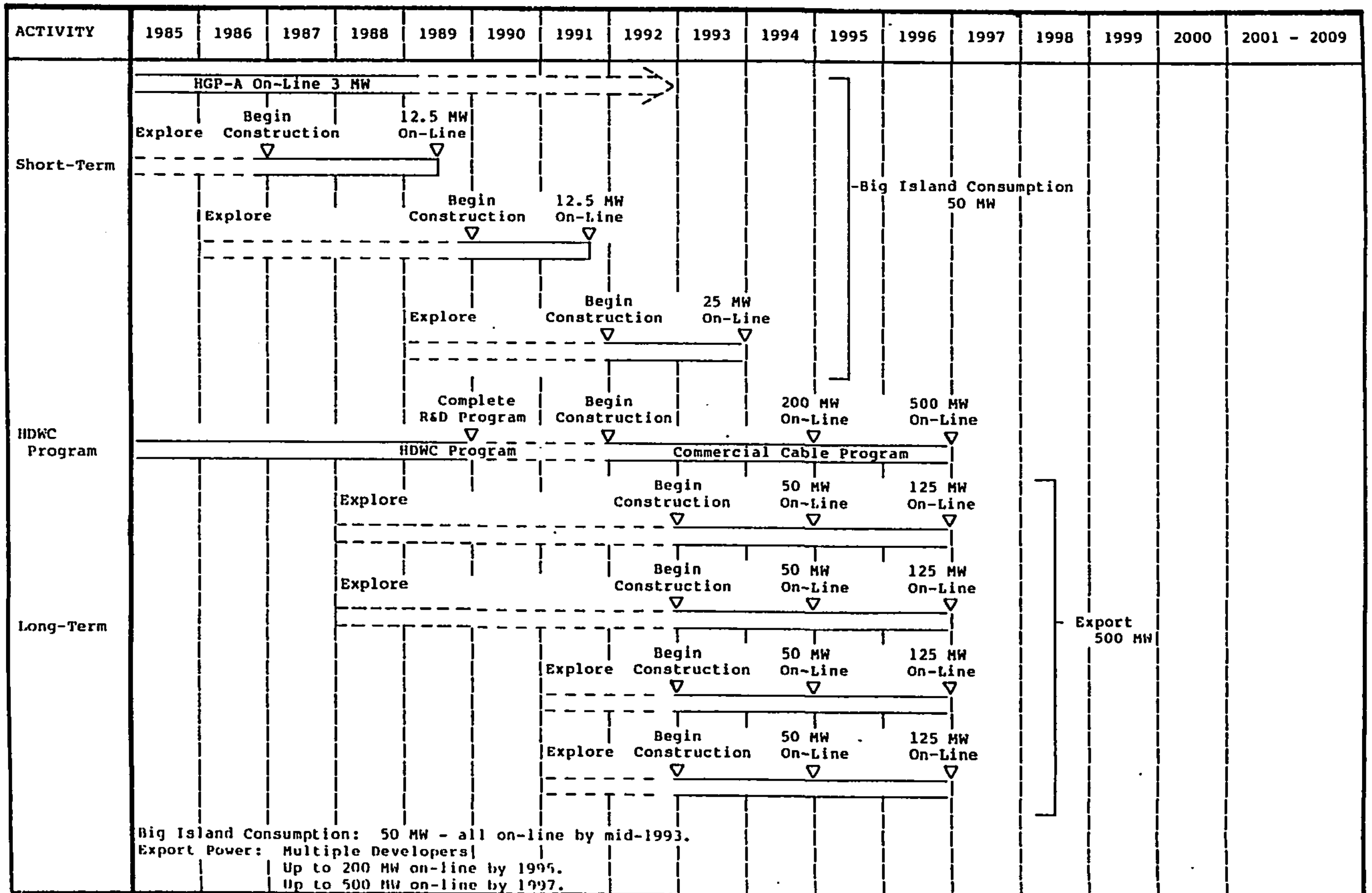


Figure 6A

MOST OPTIMISTIC GEOTHERMAL DEVELOPMENT PLAN AND SCHEDULE

HAWAII COUNTY




(Source: DPED 1985. Report To The Thirteenth State Legislature in Response To Senate Resolution No. 140.)

7) Each successful well will produce 3.5 MW of electricity.

## E. Project Construction, Major Equipment and Facilities

The EIS describes construction procedures and the dimensions, designs and details of typical project facilities and major equipments including drill site lay out, road design, well profile, gathering and injection system, drilling rig, power plants and power transmission line design. (The potential impacts of these facilities and activities are also described in the EIS). These data remain valid for the SUP EIS even though recent developments in technology have resulted in new designs and operating features and improved efficiencies in some equipment and systems required in the development and utilization of geothermal resources with certain resource characteristics.

### 1. Geothermal Power Plants

The detailed design, dimensions and operating features of power plants currently in use with capacities of 25 MW and 55 MW are described in the EIS. Power plant technology developments have resulted in more efficient utilization of steam and therefore higher annual levels of production, improved operating features in critical systems and better materials including corrosion protection of turbine parts.

Centrifugal compressors are being used to improve the efficiency of non-condensible gas removal processes under some operating conditions. In those cases where such compressors are determined suitable, there would be a reduction in cooling water requirements and start-up time and increased flexibility in handling varying quantities of non-condensible gases.

A recently installed power plant at the Geysers has design features that allow steam flow by-pass directly to the condenser at full or partial flow without direct atmospheric emission of $H_2S$ during outages.

In addition, smaller, modular power plant units are now being used in some developments, particularly as well-head generators and for initial production operations as a pilot plant for a larger plant to be installed in the future.

There are now 188 power plants in 17 countries of the world which generate electricity from geothermal resources with an annual world-wide growth rate in production predicted at 16.5% (DiPippo 1985). Capacities of operating power plants vary from less than 1 MW to 140 MW.

2. $H_2S$ Abatement Systems

In addition to the $H_2S$ abatement systems described in Appendix E to the EIS, developments in new technology and processes have resulted in new and modified systems. As an example, one system using GAS/SPEC RT-2 technology (DOW Chemical) converts the $H_2S$ in the geothermal fluid (steam) into soluble sulfur compounds for ready reinjection without residues of sulfur or waste by-products. This system is now being tested at the HGP-A plant.

A second technology that has been developed for effective $H_2S$ removal uses chelated iron as an element of the chemical process.

This system does not use any toxic chemicals which could be an improvement over existing technology. Other technology for chemical abatement processes is under development and is expected to result in further improvements to $H_2S$ abatement systems for geothermal power plants in the future.

The selection of the best available $H_2S$ control technology for each power plant is deferred by geothermal developers until the geothermal fluid from each successful well intended to supply the plant can be tested and analyzed for its chemical composition and characteristics. At that time the most appropriate match between the resource and control system is made to assure that air quality standards can be met.

In addition to abatement systems that remove $H_2S$ from steam prior to steam discharge to the atmosphere, new automatic systems have been developed to expeditiously reduce the amount of steam allowed to enter the pipeline delivery system from each well when required to meet environmental regulations on $H_2S$ emissions during plant outages.

3. Road Alignment and Facility Sites

A ground reconnaissance was made along the proposed primary access road of approximately 2.5 miles into the planned first drilling site of exploration/development area "A" (See Figure 5). Observed surface features and conditions indicated that roads or facility sites could be constructed without encountering unusual or unique engineering construction problems. Further, based on the previous reconnaissance of the access route into Kahauale'a, it appears that the surface expressions of the project area and GRS are similar to much of the Kilauea east rift zone.

The size of the GRS allows facility siting flexibility based on the location of discovered resources. Therefore, road alignments and facility sites can be selected generally in the most practical and economical locations based on detailed engineering surveys and environmental considerations.

## F. PROJECT CHANGES FROM EIS

The scope of the proposed actions on which this SUP EIS is based is reduced from the scope of action proposed in the EIS. The changes in the scope of action are as follows:

1) The construction of a primary and secondary access road into the eastern portion of the GRS and project area. (See Figure 5).
   Change: Location of access roads is in areas less environmentaly sensitive than in Kahauale'a; length of access roads reduced from 8.3 to 3.8 miles.

2) The deep drilling of up to 12 exploration wells in the GRS and project area .
   Change: A reduced number of exploration wells to be drilled during this increment as compared to 20 exploration wells planned for Kahauale'a.

3) The drilling of up to 23 development wells.

<u>Change</u>: A reduced number of development wells to be drilled in this increment as compared to 72 wells for Kahauale'a.

4) The drilling of up to 8 reinjection wells to return resource effluent to appropriate underground levels.

<u>Change</u>: A reduced number of planned injection wells during this increment as compared to seventeen injection wells planned for Kahauale'a, reflecting the reduction in the number of production wells.

5) The construction of electrical generating facilities capable of generating a total of 100 MW of electricity. The size and configuration of power plants will vary from 5 MW to 55 MW. The maximum generating capacity at a single site will not exceed 55 MW.

<u>Change</u>: A limit to the upper level of production to 100 MW this increment as compared to 250 MW proposed for Kahauale'a; planned use of smaller, portable generating units (5 MW); no unit larger than 55 MW to be constructed at one site as compared to 110 MW plants proposed for Kahauale'a.

6) Project service/maintenance roads between drilling sites and power plant sites.

<u>Change</u>: The surface area potentially required for this 100MW increment (42 acres) is approximately the same as for

project area include Upper Kaimu Homesteads, Kaimu Makena Homesteads, Kauka Homesteads, Kikala-Keonea Homesteads and Kupahua Homesteads. All of these subdivisions are sparsely populated at present. The Kamaili Geothermal Resource Subzone (Figure 4) borders the eastern boundary and Kahauale'a borders the western boundary of the project area. At present, access to the proposed project area is via foot trails or helicopter as there are no roads into the project area.

The topography of the project area is generally gradually sloping with elevations ranging from 2,000 feet down to 1,300 feet. Slopes in the project area vary from about 6 to 12 percent, with some localized areas having slopes as great as 20 percent. The major topographic contours of the project and surrounding areas are shown in Figure 7. Average annual rainfall in the project area ranges from approximately 120 inches to 150 inches. Annual average temperatures range from the mid-80's (Fahrenheit) to the mid-50's. It can be expected that the maximum high temperature in the project area may reach 90°F and the maximum low may be around 40°F.

Prevailing winds during the day are northeast tradewinds while northwesterly drainage winds prevail during the night (Figures 8, 9 and 10). Average daytime wind speeds are 7.5 mph at 50 feet and average nighttime wind speeds are 5.2 mph at 50 feet. Only 1 percent of the wind speeds are between 15 and 19 mph (Hariguchi, 1985).

a proposed 250 MW development at Kahauale'a.

7) Geothermal fluid transmission lines to transmit the resource from well heads to power plant.

Change: The surface area potentially required for this increment (64 acres) is approximately the same as for Kahaule'a.

SECTION III

## ENVIRONMENTAL IMPACTS AND MITIGATING MEASURES

### A. INTRODUCTION

Both primary (direct) and secondary (indirect or induced) environmental impacts may be generated by the proposed project. These impacts can be either positive or negative, short- or long-term. Direct impacts are those that are related to the exploration, development and production of geothermal resources including construction of roads and facilities, drilling and testing of wells and operation of power plants to generate electricity. Indirect or induced impacts are those that may occur in other areas of the region (Puna District or the Big Island) as a result of related on-going or planned geothermal resource activities.

The potential environmental impacts of the proposed project and the mitigation measures that will be taken to minimize those impacts are discussed below. The discussion assesses the potential impacts of the exploration and development of geothermal resources and the long-term operation of geothermal resource facilities in the proposed project area in relation to the following:

- Drainage and Erosion
- Flora and Fauna (including endangered or threatened species)

In the project area, the cool drainage air flow plus the radiational cooling of the land at night are both expected to contribute to the formation of a ground temperature inversion on most nights with light winds. The temperature inversion may not exist during nights with strong winds or heavy rain. Based on the drainage wind height of 180 feet at Mauna Loa Observatory (Mendonca and Iwaoka, 1969), maximum drainage wind heights of 160 to 650 feet (Ekern and Garrett, 1979), and the average height of the top of the ground temperature inversion at about 450 feet at Hilo Airport, the height of the top of the temperature inversion at the project area is estimated to range from 200 to 500 feet. Its strength (temperature difference between the ground and top of inversion) is estimated to range from 0°F to 4°F with an average strength of 2°F occurring on most nights. The wind speed of the drainage wind is estimated to be 1 to 4 mph (Hariguchi, 1985).

The proposed project area is situated on an active volcano (Kilauea) and lies astride a rift zone (the east rift zone) in which much of the eruptive activity of Kilauea is concentrated. The anticipated geothermal resources exist because of the dynamic geologic setting.

Lava eruptions have occurred in historic times in the east rift zone at intervals ranging from about 4 years (based on the period 1950 to present) to about 40 years (based on the period from 1790 to 1950). The 1983-1985 activity at Pu'u O'o has

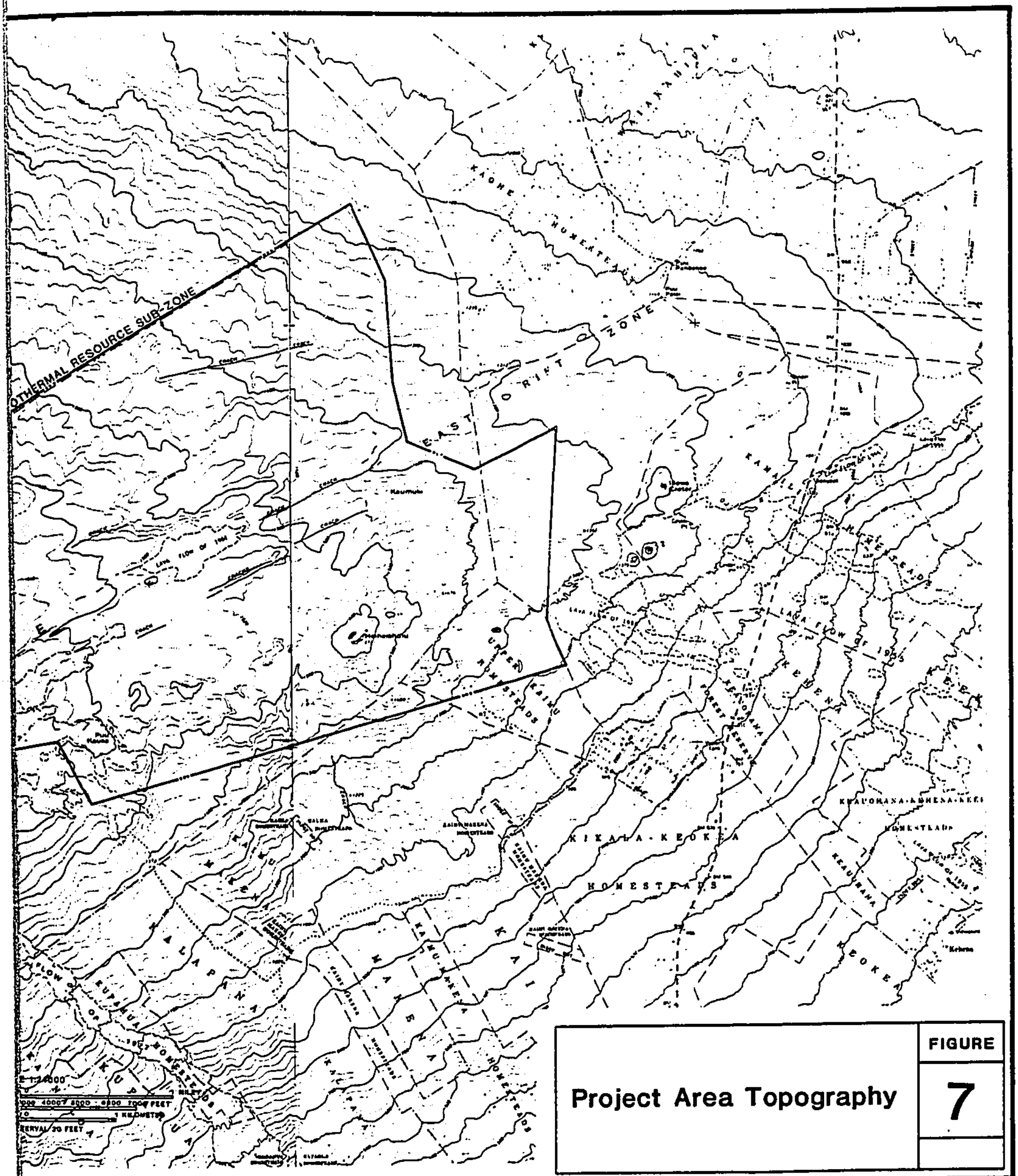
- Soil and Leaf Tissue Chemical Composition
- Climatology
- Air Quality (Including air dispersion modeling)
- Noise Quality
- Geologic Setting/Hazards
- Historical/Archaeological Attributes
- Socioeconomic Characteristics
- Visual Appearance

This SUP EIS has been prepared for the full 100 MW development project. As such, the environmental impacts described represent the "worst case" or "maximum impact" conditions.

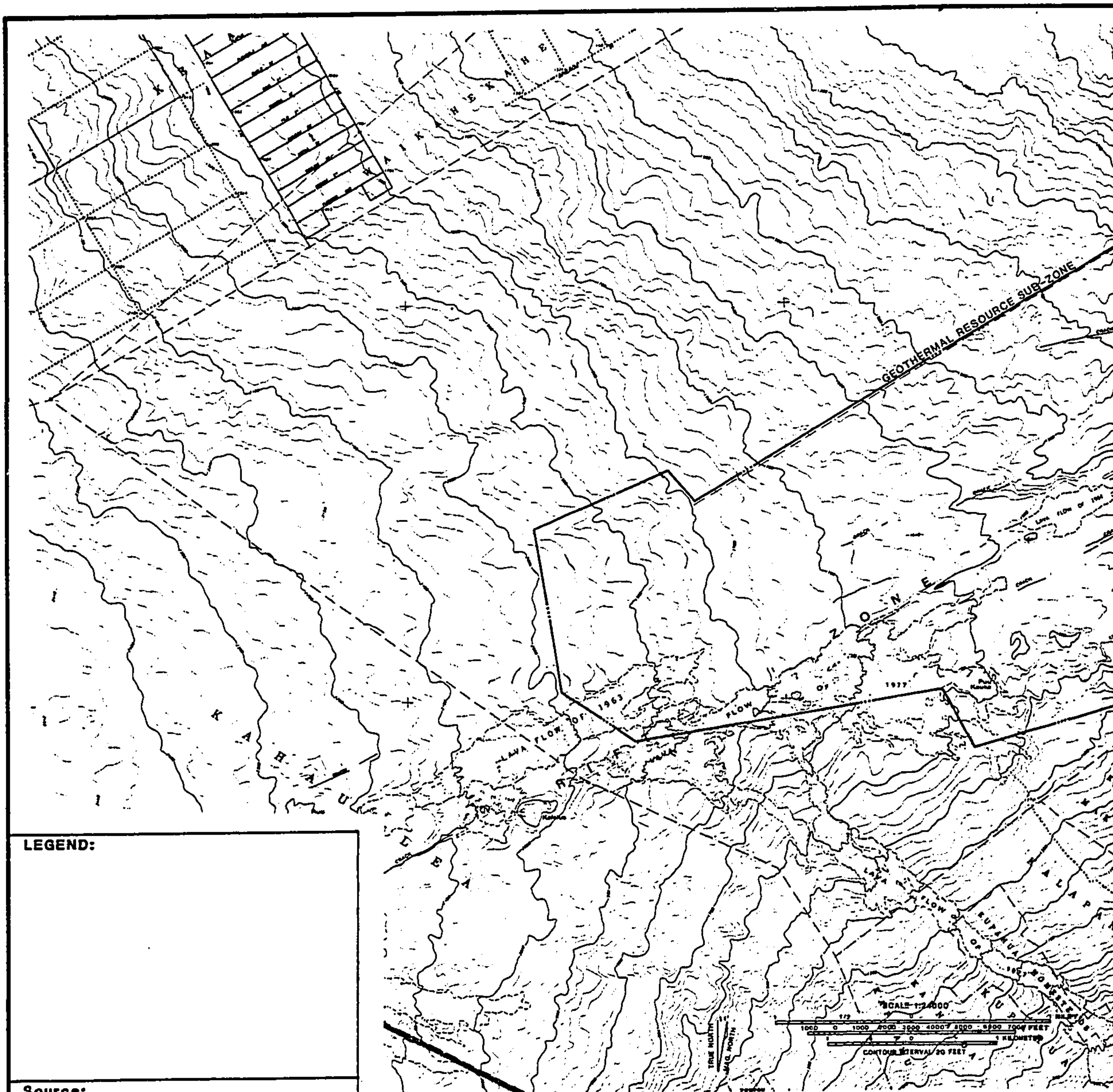
## B. ENVIRONMENTAL SETTING OF THE PROJECT AREA (EXISTING CONDITIONS)

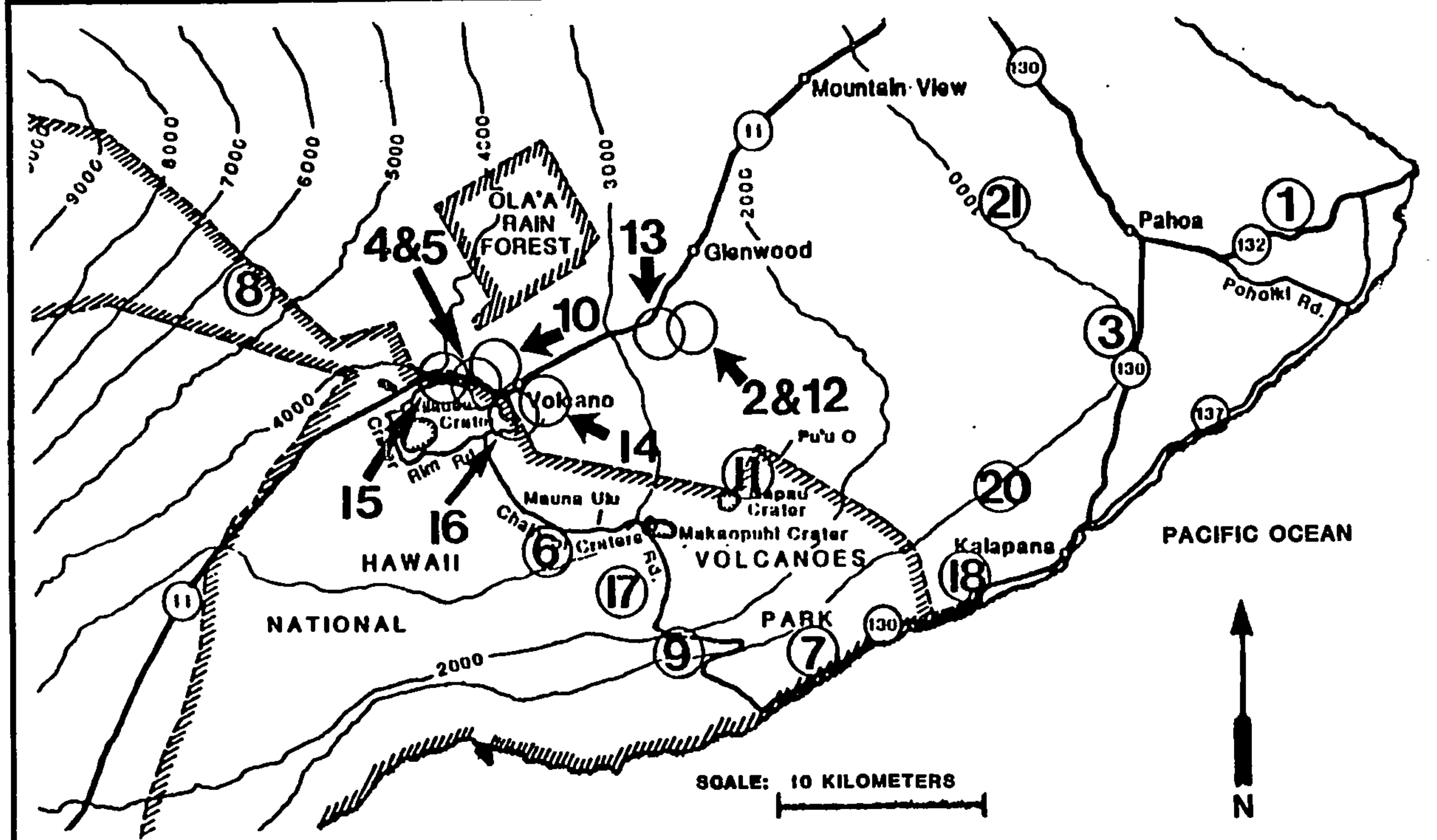
(Note: Detailed botanical, soil and leaf tissue, birds and mammals, wind climatology, air quality, air diffusion modeling, noise, geologic setting/hazards, social analyses and reports have been developed during the preparation of this SUP EIS and are included here by reference. The following paragraphs describing existing conditions, expected impacts and mitigating measures are excerpted from those reports.

The proposed project area is located within the Puna District, Island of Hawaii, approximately 16 miles from Hilo and approximately 7 miles from Pahoa (Figure 1). Residential subdivisions immediately north and east of the project area include Fern Forest Vacation Estates, Hawaiian Acres, Ainaloa Estates and Kaohe Homesteads. Subdivisions south of the




| Project Area Topography | FIGURE |
|---|---|
| | 7 |


GEOTHERMAL RESOURCE SUB-ZONE
LAVA FLOW OF 1963
LAVA FLOW OF 1977
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
TRUE NORTH
MAG. NORTH
LEGEND:
Source: U.S.G.S., QUADS.

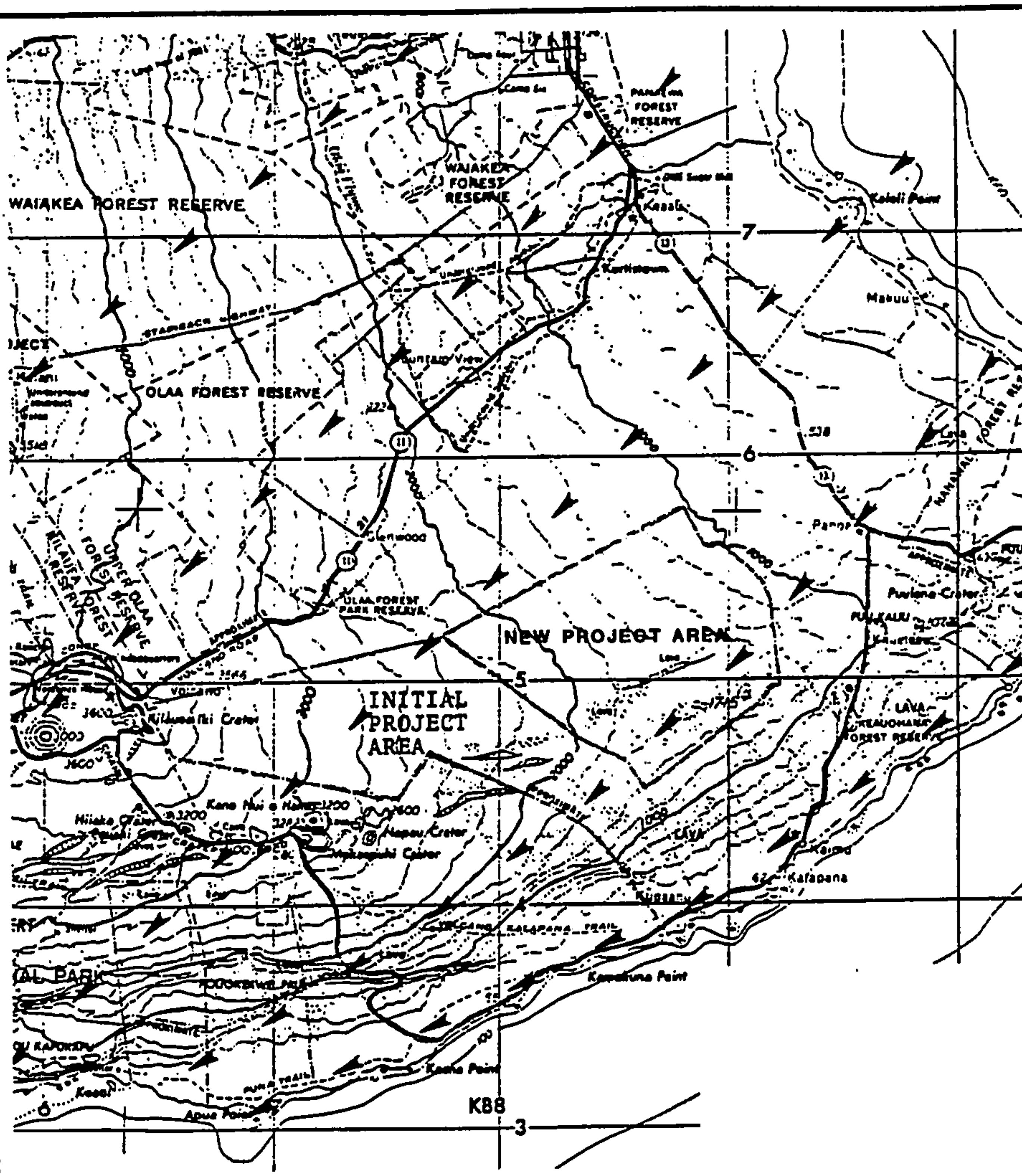



LEGEND:

Source: Houck, et. al., 1985

Meteorological Stations

FIGURE 8

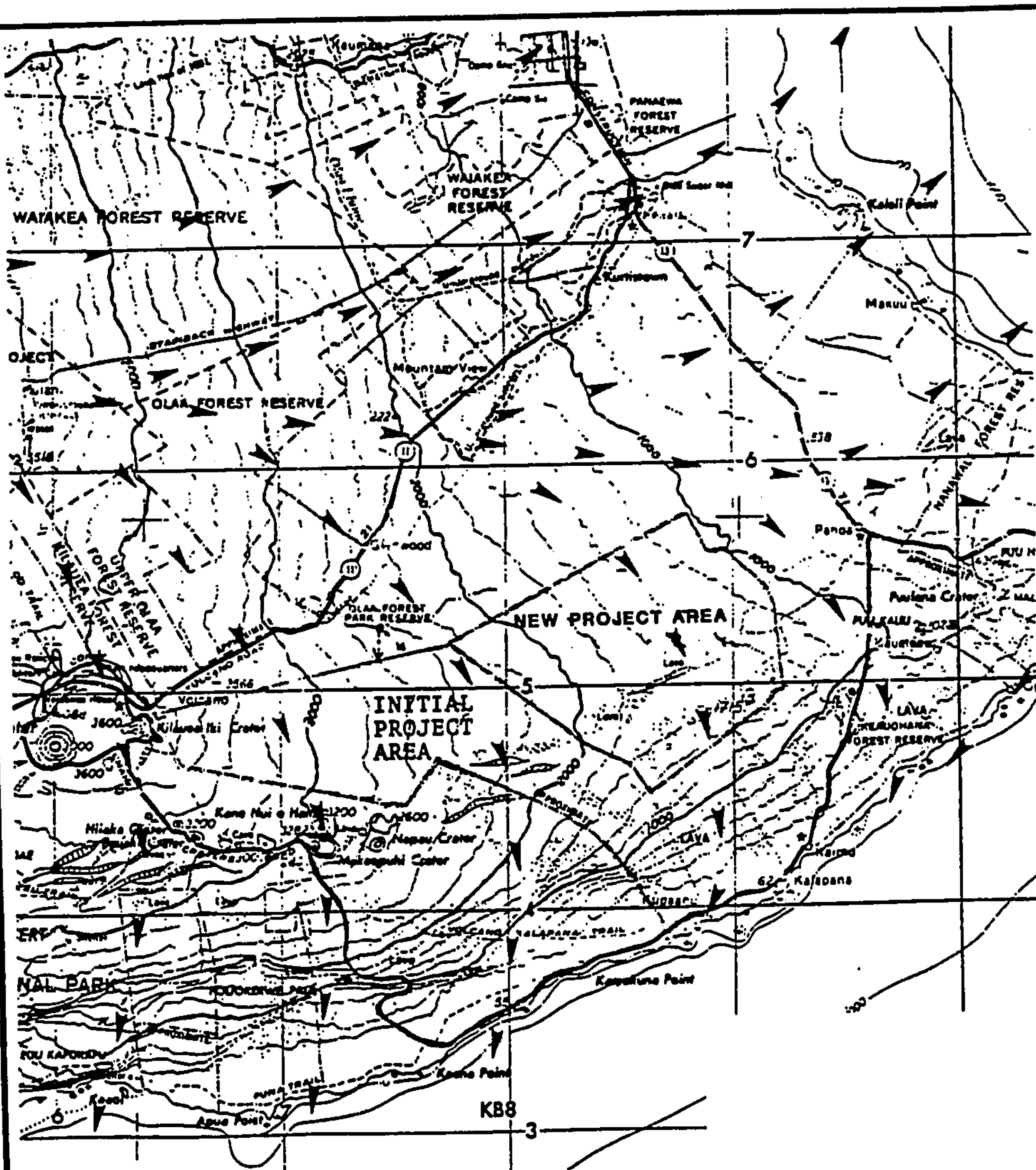



LEGEND:

Source: Hariguchi, 1985

Updated Day-Time Tradewind Flow

FIGURE 9




LEGEND:

Source: Hariguchi, 1985

Updated Night-Time Drainage Wind Flow

FIGURE 10

included 41 eruptive phases (as of February 1, 1986) spaced at intervals of a few weeks and is one of the longer eruptive series. Activity in the past 30 years has been concentrated in the upper and lower east rift zones, and several times lava has overrun parts of the proposed project area. From the perspective of the period 1790 to 1985, volcanic activity has been rather uniformly distributed along almost the entire length of the east rift zone. Lava eruptions have caused the burial, at one time or another, of nearly 11 percent of the project area. Based on historical records there is roughly a 0.5 probability that any given plot of ground within the east rift zone will be buried within a century (Walker, 1985).

The water supply and distribution system in Puna District is composed of a county operated and maintained public system and private distribution and catchment systems. The hydrology and groundwater resources of Puna District and the project area are not well established. However, it is known that there are no known springs, wells or potable water supplies in or adjacent to the project area. Water supply wells are located downslope from the project area. The underground injection and disposal of geothermal effluent will not affect or impact ground water supplies in the project area because they are expected to be brackish, warm or hot. Similarly, the discharge of geothermal fluids upon the land surface during limited well testing operations will not produce a detectable effect on groundwater resources in the project area due to high recharge rate by meteoric water.

The area within and surrounding the GRS or project area is rural, mostly forested with vegetation ranging from high quality native vegetation, with wet 'ohi'a forest with dense, 80% canopy, to lower quality vegetation and open areas devastated by lava flows in and below the rift zone. Exotic plant species are found generally in all areas except the highest quality, closed canopy, native 'ohi'a forest. There is evidence that portions of the 'ohi'a forest in the northeast sector of the project area have been disturbed by human activity. Adenophorus periens, a rare fern, was sighted on one of the transects of the U.S. Fish and Wildlife Service's survey of the area in the Class 1 'ohi'a forest near the middle of the proposed GRS. The major population center of the Adenophorus periens is in the Kahauale'a forests. Other rare or candidate endangered plant species found in the project area include 'ahakea (Bobea timonioides), 'aku'aku (Cyanea tritomantha), 'ohe (Tetraplasandra hawaiiensis), lo'ulu (Pritchardia beccariana), maua (Xylosma hawaiiense Var. hillibrandii), nanu (Gardenia remyi) and kilioe (Embelia pacifica).

Soil and leaf tissue analyses for mercury (Hg), arsenic (As) and boron (B) performed on samples taken from the project area indicate naturally occurring low levels of Hg and As contamination. The plant tissues (Uluhe fern) tended to concentrate Hg while the soils tended to concentrate As. Also, there appears to be a random, low level of Hg in the soils collected.

The avifauna of the project area includes numerous introduced species and 6 endemic species. No indigenous species have been sighted in the project area. Two species presently classified as endangered [the Hawaiian Hawk or 'I'o (Buteo solitarius) and Hawaiian Honeycreeper or O'u (Psittirostra psittacea)] may be found in the area.

Mammals known to inhabit the project area include feral pigs (Sus scrofa), feral goats (Capra hircus), the small indian mongoose (Herpestes auropunctatus), roof or black rat (Rattus rattus), Norway rat (Rattus norvegicus), Polynesian rat (Rattus exulans), house mouse (Mus musculus), feral cat (Felis catus) and feral dog (Canis familiaris). All of these introduced species are predators on birds and their eggs or young (Berger, 1972 and 1981).

The only endemic land mammal in Hawaii is the Hawaiian Bat (Lasiurus cinereus semotus), a subspecies of the American hoary bat. There is no evidence of the occurence of this bat in the project area (Tomich, 1969). However, residents of nearby subdivisions have reported seeing bats (unidentified species) in or near the northeastern corner of the project area.

Ambient air quality along the Kilauea east rift zone has been determined through three air quality monitoring programs.

Six environmental pollutant categories, that are of primary interest in establishing baseline levels in areas where geothermal development operations are expected to occur, were measured. In general, after two and one-half-year's monitoring in areas along the Kilauea east rift zone, it has been determined that in the project area all pollutant categories are low and below mainland U.S. and/or existing or proposed U.S. EPA standards.

Air diffusion modeling for the project area using "worst-case" meteorological conditions in relation to the size and location of power plant sites has indicated that the proposed facilities can operate within proposed State ambient air quality standards for hydrogen sulfide ($H_2S$).

Ambient noise (or background noise) refers to the noise levels which exist in the environs of the project site at locations where people reside, play, or work. Typical ambient noise sources are the wind in foliage, motor vehicle traffic, aircraft, lawn mowers, televisions and radios, and home generators.

In the EIS, the impact of noise from geothermal operations was addressed. The noise sources associated with initial construction operations, well drilling and testing, power plant operations and reservoir maintenance will be the same in the project area as those described for Kahauale'a. The major difference for the proposed project is that the noise sources would be located at a greater distance from the national park. Distances to residential areas are similar for the two project areas, except in the eastern portion where project development activity (drilling) could occur up to one-half mile of a residential boundary (Kaohe Homesteads). Except for Kaohe Homesteads, the closest residential subdivision on the south is more than one mile from planned project activities. All residential subdivisions north of the project area are approximately 2 miles from planned project activities.

Observations in the project area indicate that daytime residual noise levels are in the 30-40 dBA range and that nighttime residual levels are 25 to 35 dBA, which would be subjectively judged to be "quiet" to "very quiet". These conditions are expected to change as the population of the subdivisions near the project area increases.

The historical/archaeological information on the project area is limited. It is known that the ancient Hawaiians probably used the area for bird feather collecting and logging for canoes, but no known archaeological sites are listed by the State Historic Preservation office for the area, nor was there any evidence of such sites from the historical and literature study conducted for this SUP EIS. A limited field survey indicated the presence of Hawaiian cultigens which are believed to be indicative of prior native occupancy and/or exploitation in the vicinity. However, searches of the immediate areas did not reveal any archaeological features. Probable archaeological remains consisting of five to six cairns and mounds were encountered in an area of fumarole activity on the southeast summit of Heiheiahulu.

The existing socioeconomic characteristics of the Puna District and project area mirror the socioeconomic characteristics of the island of Hawaii. The primary employment occupations for area residents are agriculture, construction, retail/wholesale trade, manufacturing and service industries including government service. The estimated population of the area (Puna District) is about 16,500 persons, an increase of about 220 percent over the 1970 population and an increase of over 40 percent over the 1980 population. Puna District serves as a "bedroom" community for Hilo. The population of the district is predominantly Caucasian. It is expected that as over 54,000 vacant subdivision lots, in the subdivisions near the project area, are developed, the population of the District will continue to increase. The mean annual income for the area is approximately $17,500. Unemployment in the Puna District is approximately 12 percent.

The visual attributes of the project and surrounding areas are open forested areas interrupted by recent or older barren to sparsely vegetated lava flows, clearly delineated subdivision streets and lots and clearly delineated papaya and macadamia nut orchards. Potential view corridors into the project area within a 3-6 mile range are available from areas along the eastern edge of the National Park and the Hawaii Belt Road upslope from the project area; the Volcanoes National Park Visitors' Center (Kalapana and Chain of Craters Road) and the Kaimu Beach Park in Kalapana downslope from the project area.

## C. EXISTING USES OF PUNA DISTRICT AND THE PROJECT AREA

As indicated in Table 2, the State Land Use Commission has classified 3,628 acres for Urban District and 135 acres for Rural District in Puna. Almost all of these areas are zoned by the County for various urban use categories (Table 3), but the majority of those planned urban use areas are undeveloped at present.

Subdivisions developed prior to enactment of Hawaii County Ordinance No. 62 in 1967, created approximately 59,600 lots (Agriculture and Urban) in the Puna District. Of these, approximately 54,000 lots are presently vacant and are considered by the County Planning Department to be "substandard" in that roads providing access to most of these lots do not meet County dedicable standards.

TABLE 2

PUNA DISTRICT LAND AREA
BY STATE LAND USE DISTRICT

| | | |
|---|---|---|
| Urban | 3,628 Acres | ( 1.1%) |
| Rural | 135 | ( 0.1%) |
| Agricultural | 175,832 | (55.5%) |
| Conservation | 137,025 | (43.3%) |
| Total | 316,620 Acres | (100.0%) |

Source: Planning Department, County of Hawaii.

TABLE 3

PUNA DISTRICT LAND AREA
BY COUNTY ZONING CATEGORIES

| | | |
|---|---|---|
| Single-Family Residential | 2,666 Acres | |
| Multi-Family Residential | 4 | |
| Resort | 1 | ( 1.1%) |
| Commercial | 58 | |
| Industrial | 21 | |
| Residential-Agriculture | 621 | |
| Agriculture | 197,899 | (62.5%) |
| Open Space | 5,044 | ( 1.6%) |
| Unplanned/Forest | 110,306 | (34.8%) |
| Total | 316,620 Acres | (100.0%) |

Source: Planning Department, County of Hawaii.

For the most part, as note previously, the lots are "substantial" in that they are not serviced by water, sewer or electric utilities and do not meet County road standards. Of those "substandard" subdivisions created in Puna District, the nearest to the project area is the Kaohe Homesteads. The Kaohe Homesteads is an agricultural subdivision with a minimum lot size of 5 acres. The area's principal land use character is agricultural. The uses permissible in an agricultural district include: the cultivation of crops; game and fish propagation; economic development of bees; fish, livestock and aquatic life; day camps, picnic grounds and riding stables; solid waste transfer stations and pumping stations; roadside stands; and mills, processing and maintenance facilities.

At present there are a total of 49 parcels in Kaohe Homesteads. Of these, 15 lots are residential dwelling units. Overall, there are 9 cattle ranches, 7 anthurium farms, 8 fruit orchards, 1 banana farm, 1 chicken farm and 9 diversified homesteads with intensified agricultural activities, but not necessarily on a commercial basis.

The proposed project area consists of approximately 8,500 acres within a conservation district. As a former forest and natural area reserve, the project area served as the relatively undisturbed habitat for plants and animals, as described previously. Surrounding areas include the Hawaii Volcanoes National Park and various subdivisions on the north, east and southern boundaries. Except for the National Park, all lands surrounding the project area are zoned agriculture, in which a relatively high intensity use is permitted. Therefore, geothermal development is not considered incompatible with an agricultural area.

The Kamaili GRS, in which a portion of the Kaohe Homesteads are located, is adjacent to and on the eastern boundary of the proposed project area GRS. Table 1 indicates the proposed project land use categories and acreage required for each.

## D. <u>ENVIRONMENTAL IMPACT ANALYSIS</u>

### 1. Drainage and Erosion

#### a. Existing Conditions

Ground slopes in the project area generally vary from about 6 to 12 percent (Figure 7). In general, the potential for erosion or drainage hazards due to the proposed project is minimal due to the relatively high permeability of the soils (mostly a'a' and pahoehoe lavas), relatively complete and established ground cover where it exists and the lack of development in the project area. Flooding has been known to occur in Puna District during heavy, intense rain showers.

#### b. Impacts and Mitigating Measures

Drainage and erosion of the project area are not expected to be impacted by the proposed project.

However, to ensure that existing drainage patterns are maintained, well sites, roads, power plants and other facilities will be designed with drainage swales, catchment basins, seepage pits or drainlines as appropriate. Other mitigation measures to be taken to minimize dust and potential erosion will include minimal disturbance of ground areas, water spraying where practicable, and strict adherence to county grading and excavation regulations.

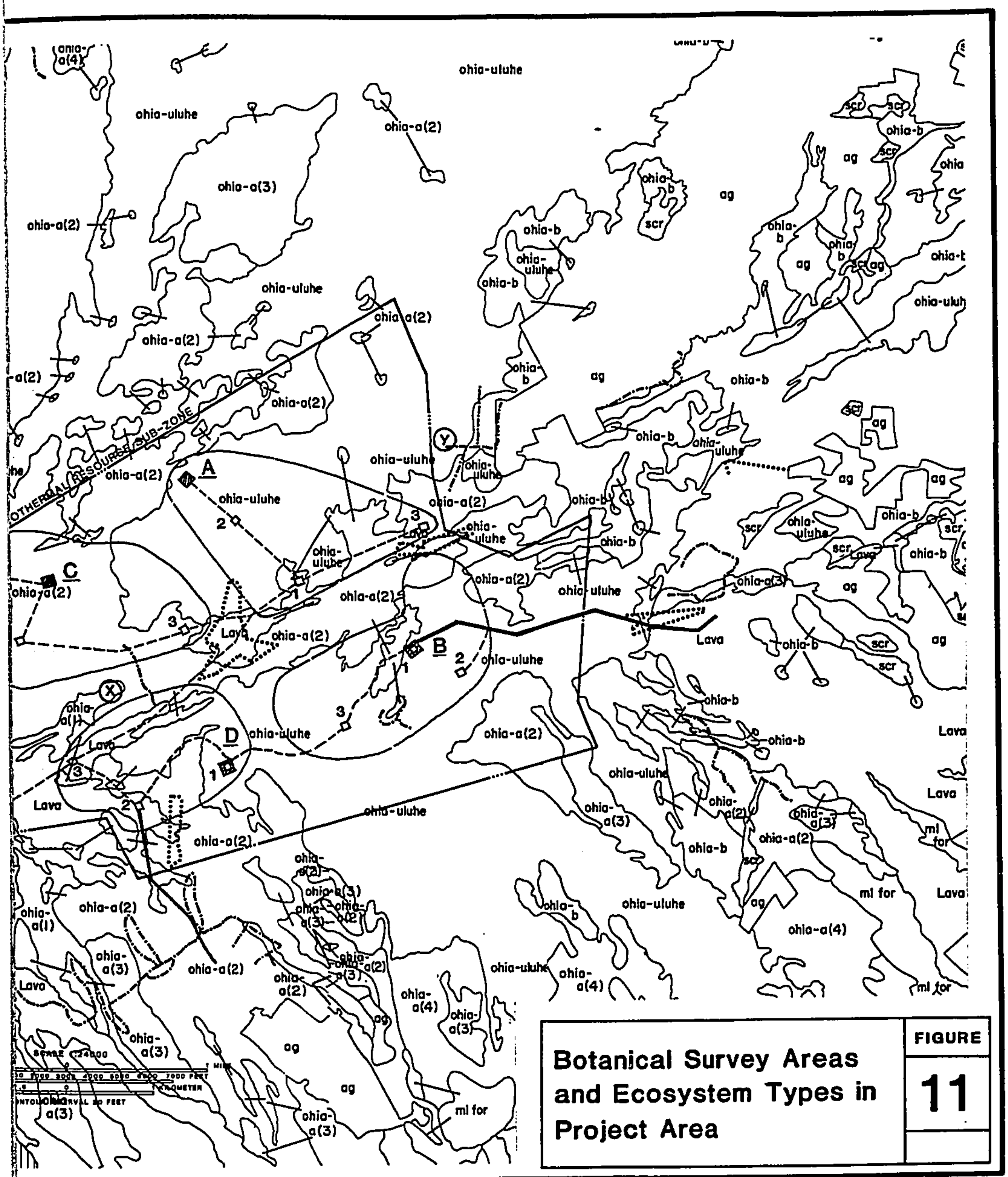
2. Flora

a. Existing Conditions

Results of three recent botanical surveys of Puna and the project area in particular (Jacobi 1985, and Char and Lamoureaux 1985a and 1985b), show that the area consists of a mosaic of different ecosystem types fragmented by recent lava flows (Figure 11). (Note: See Appendix A for detailed description of ecosystem types found in project area and identified on Figure 11.) Much of these lands are covered by a wet, pioneer community composed of scattered 'ohi'a trees and a dense tangle of uluhe ferns; rare or endangered species are usually not found in this vegetation type. 'Ohi'a (Metrosideros collina) forests of varying quality are found in the project area. Some of the existing forests on these lands have been affected by exotic plant species, feral pigs and cattle, and by human disturbances. Char and Lamoureaux (1985b) note that the ohia-a(1) and ohia-a(2) ecosystem types, which contain few exotic (introduced) plants, are the habitat for many rare and/or sensitive-to-disturbance plants as well as bird species. These two ecosystem types are generally found in the western half of the project area. The ohia-a(1) forests in the GRS are limited to three small stands primarily on the western border of the GRS and they are isolated by past lava flows. On the eastern end of the project area are lower quality 'ohi'a forests (ohia-b) with an understory layer dominated largely by exotic species such as Malabar melastome (Melastoma malabathricum), strawberry guava (Psidium cattleianum) and the introduced swordfern (Nephrolepis multiflora).

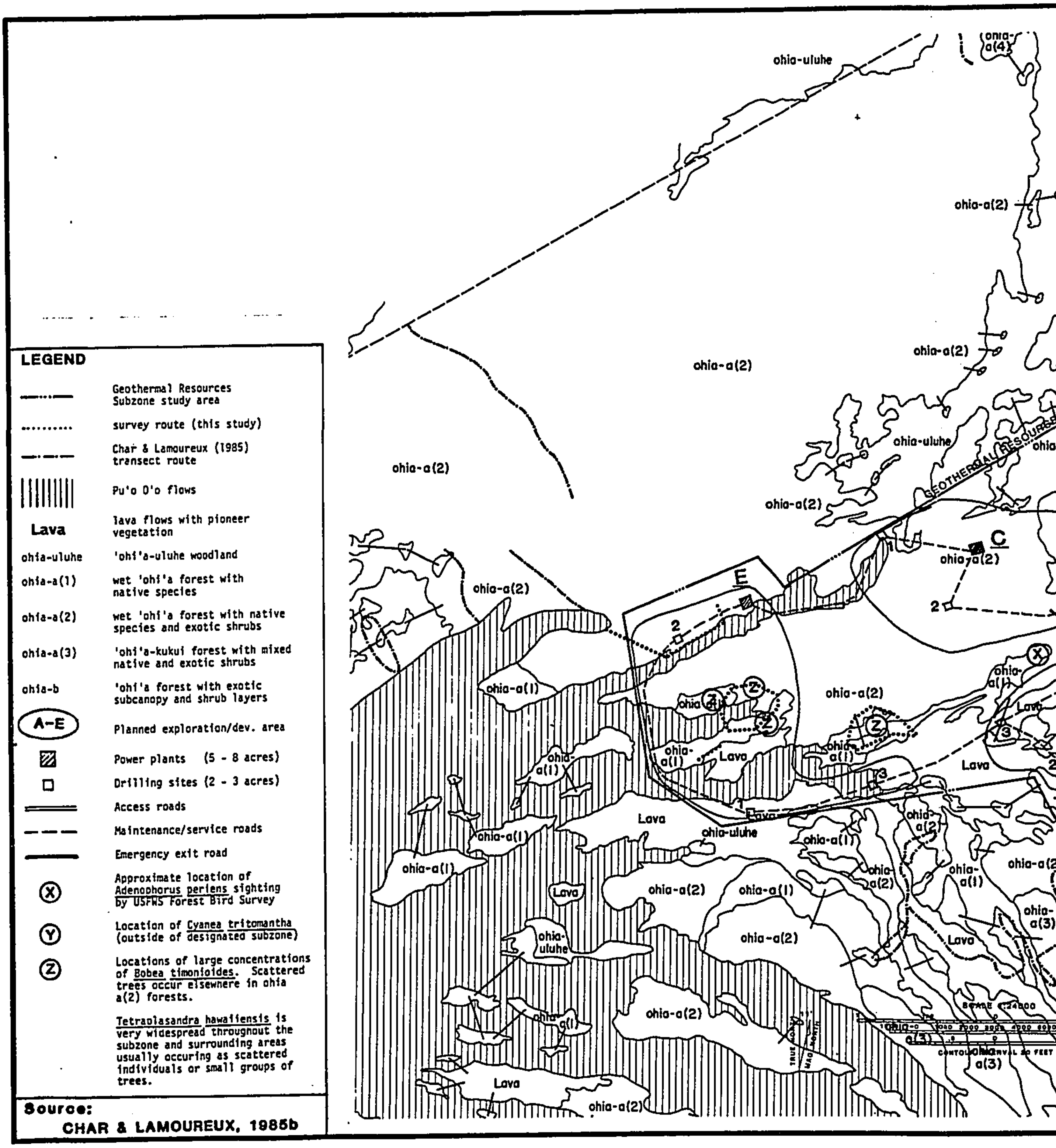
The high quality 'ohi'a forests [ohia-a(1)] were ground checked and correlated with Char and Lamoureux's (1985a) vegetation maps and orthophotoquads. A walk-through survey method was used to identify the structure and composition of the plant communities. Species identifications were made in the field. Plants which could not be positively identified were collected for later determination in the laboratory and herbarium.

The 'ohi'a forests of the project area can be divided into four different types based on structure,




Botanical Survey Areas and Ecosystem Types in Project Area

FIGURE 11


LEGEND
Geothermal Resources Subzone study area
survey route (this study)
Char & Lamoureux (1985) transect route
Pu'o 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)
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:
CHAR & LAMOUREUX, 1985b
ohia-uluhe
ohia-a(4)
ohia-a(2)
ohia-a(1)
ohia-a(3)
Lava
GEOTHERMAL RESOURCE
C
E
TRUE NORTH
MAG NORTH
SCALE 1:24000
CONTOUR INTERVAL 40 FEET

associated plant species, past and present disturbance, and the presence of exotic species (Figure 11). The 'ohi'a forest that are less disturbed support a number of rare, threatened or endangered plant species.

The area occupied by the geothermal resource subzone contains a number of different ecosystem types in a number of successional stages which occur in a mosaic pattern. This pattern is the result of the many lava flows of varying ages which cover the area. Such a pattern is typical of any active rift zone in which new lava flows occur periodically. Such a mosaic of habitat types is of interest to evolutionary biologists because it provides for the continued isolation of small patches of more mature communities in older kipukas separated by newer lava flows. This isolation of small populations allows evolution of new types of plants and animals to proceed more rapidly than in larger, more uniform communities.

Biological succession is the phenomenon by which a new, or newly exposed, part of the earth's surface becomes occupied by a series of communities of plants and animals. When a new surface, such as a new lava flow, or a newly exposed surface, such as one exposed after a fire or a land clearing operation, is present, it is first occupied by a group of organisms, called pioneers, which are able to colonize such new surfaces. Over time these organisms modify the surface, e.g., by contributing to the breakdown of rock into fine particles, by adding organic matter to the substrate, and by providing shade, such that other organisms are able to grow there -- to succeed the pioneers. After a series of communities have succeeded one another, a climax community develops; a stable community which will occupy the site until another lava flow occurs or until there is a climatic change.

In Puna District and in the project area, the first organisms to become established on new lava flows are usually blue-green algae. These microscopic organisms are able to fix nitrogen, which enables other kinds of plants to grow there, including lichens (which may also fix nitrogen), ferns, and shrubby 'ohi'a-lehua plants. More and more plants and animals gradually move in and eventually the climax vegetation, usually an ohia-a (1) or ohia-a (2) forest, develops. The time required for the whole process to occur is greatly dependent on such factors as rainfall, elevation, and initial substrate type -- 'a'a lava, pahoehoe lava, or volcanic ash. It may range from perhaps a few decades to several centuries. In the middle east rift-zone of Kilauea it probably takes from about 100 to perhaps 500 years. The middle east rift zone is presently occupied by a series of lava flows of varying ages which support communities in all stages of succession.

A total of 197 vascular plant species were found during the course of the survey. Of these 82 (42%) are endemic, 32 (16%) indigenous, 76 (39%) exotic (or introduced) species, and 7 (3%) of Polynesian origin (See Appendix A).

A number of rare or candidate endangered plant species are known to occur within the GRS (Char & Lamoureaux 1985a and b). Of these species, four were found during the course of the survey conducted for this SUP EIS and are discussed below.

Adenophorus periens (Bishop)

Although Adenophorus periens was not encountered during the survey, it has been found and does occur northwest of the proposed sub-zone (Char & Lamoureaux 1985a; Jacobi 1985). A sighting of this fern in the class 1 ohia strand of forest in the center of the GRS was made on one of the transects during the U.S. Fish & Wildlife Service survey of the project area (J. Jacobi Testimony in Contested Case Hearing).

*Adenophorus periens* was included by the U.S. Fish and Wildlife Service (1980) as a Category 1 candidate for listing as an endangered species. A Category 1 species definition is: "Taxa for which the Service currently has on file substantial information on biological vulnerability and threat(s) to support the appropriateness of proposing to list them as endangered or threatened species" and "Also included in category 1 are taxa whose status in the recent past is known but that they may already have become extinct".

In the nineteenth century this species was apparently common in rainforests on the six largest Hawaiian islands. For the past 60 years only two populations have been known; a small population (probably less than 100 plants) on Molokai, while the major population occurs entirely within the Puna District. This population exists largely within Kahauale'a, and extends a short distance eastward into the adjoining property.

*Adenophorus periens* is an epiphytic fern that grows in the layer of mosses, liverworts and small ferns that form a mat up to 2 inches thick on the lower trunks of 'ohi'a-lehua trees in areas where the tree canopy is well-developed and where a sub-canopy of hapu'u ferns (Cibotium) provides heavy enough shade to permit the development of the thick moss/fern mat on the lower parts of the tree trunks. This habitat type occurs only in the ohia-a(1) forest type.

Bobea timonioides (Hook. f.)Hillebr.

Bobea timonioides or 'ahakea is presently under review (Category 1) by the U. S. Fish and Wildlife Service (1980). The 'ahakea is found in the project area, principally in the ohia-a(1) and a(2) forests. It is usually uncommon in these areas; however, a large population of 'ahakea trees, 26 to 33 feet tall, was found in the northeastern portion of the project area. Other rare or uncommon species, also in the same area, include lo'ulu (Pritchardia beccariana), maua (Xylosma hawaiiense var. hillebrandii), nanu (Gardenia remyi), and kilioe (Embelia pacifica).

Cyanea tritomantha Gray var. tritomantha

Cyanea tritomantha or 'aku'aku has been placed in Category 1 by the U. S. Fish and Wildlife Service (1980) and is currently under review. Char and Lamoureux (1985a) found this species to be very rare in the Puna area and probably restricted to the ohia-a(1) and a(2) forests. Within the proposed project area, it has been found only on ash-free areas--

rough 'a'a substrates--within ohia-a(1) and a(2) forests. In these localities the populations are small, rarely more than half a dozen plants, and occupy a small area.

Tetraplasandra hawaiiensis Gray var. hawaiiensis

Tetraplasandra hawaiiensis or 'ohe is placed in Category 2 by the U. S. Fish and Wildlife Service (1980). Category 2 species are those "for which information now in possession of the Service indicates the probable appropriateness of listing as endangered or threatened, but for which sufficient information is not presently available to biologically support a proposed rule." The 'ohe occurs throughout the Puna area as scattered individuals or small groups of trees. It can be found over a wide range of elevations (from 100 to 3100 ft. elevation) and ecosystem types (Char & Lamoureux 1985a).

b. Soil and Leave Tissue Analysis

To better understand existing biological and chemical characteristics of the project area prior to initiation of project activities, soil (ash) and plant (uluhe fern) samples were taken from those sites shown in Figure 12. The elemental contaminants selected for measurement were arsenic (As), mercury (Hg) and boron (B). These elements are well documented and commonly

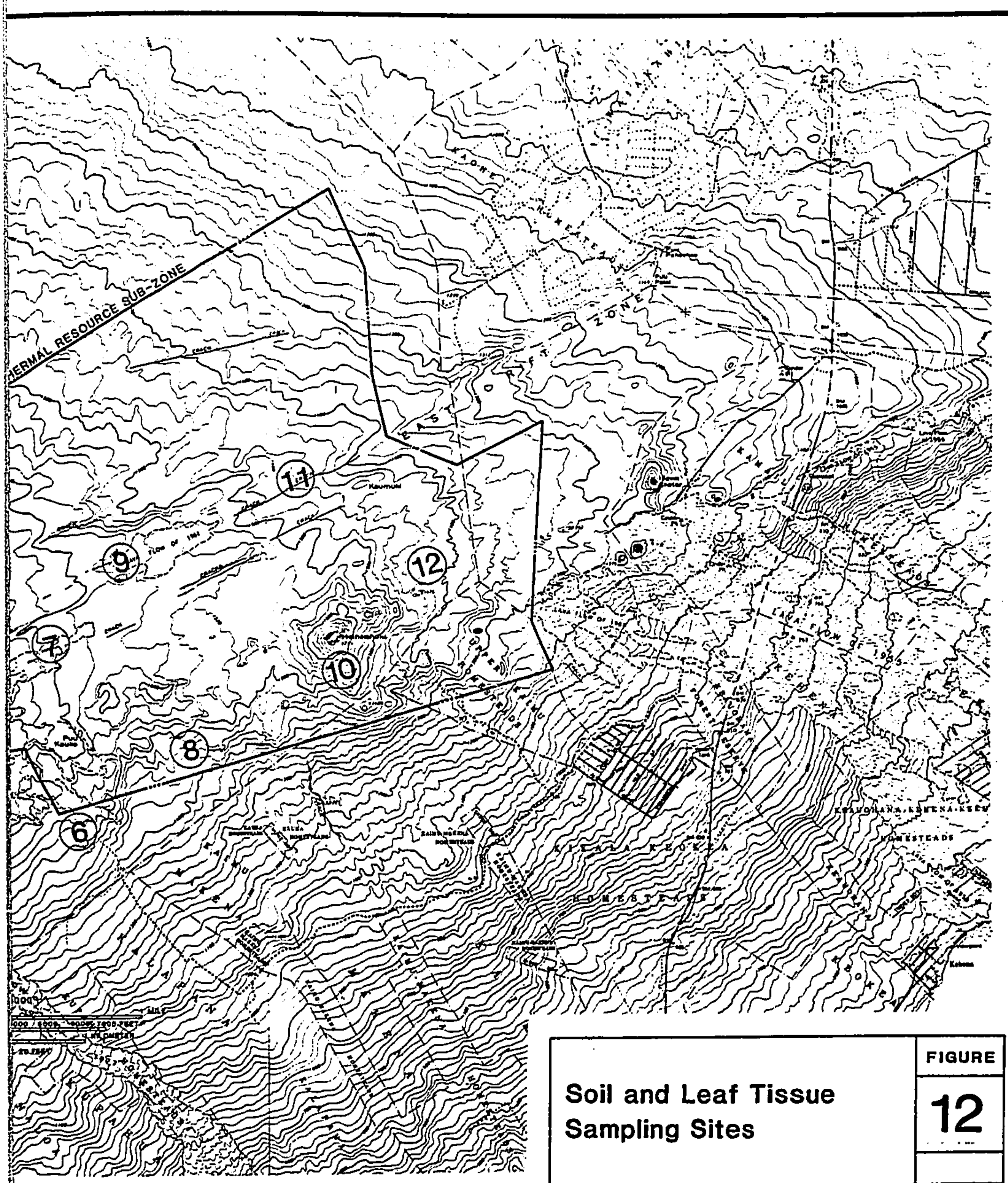
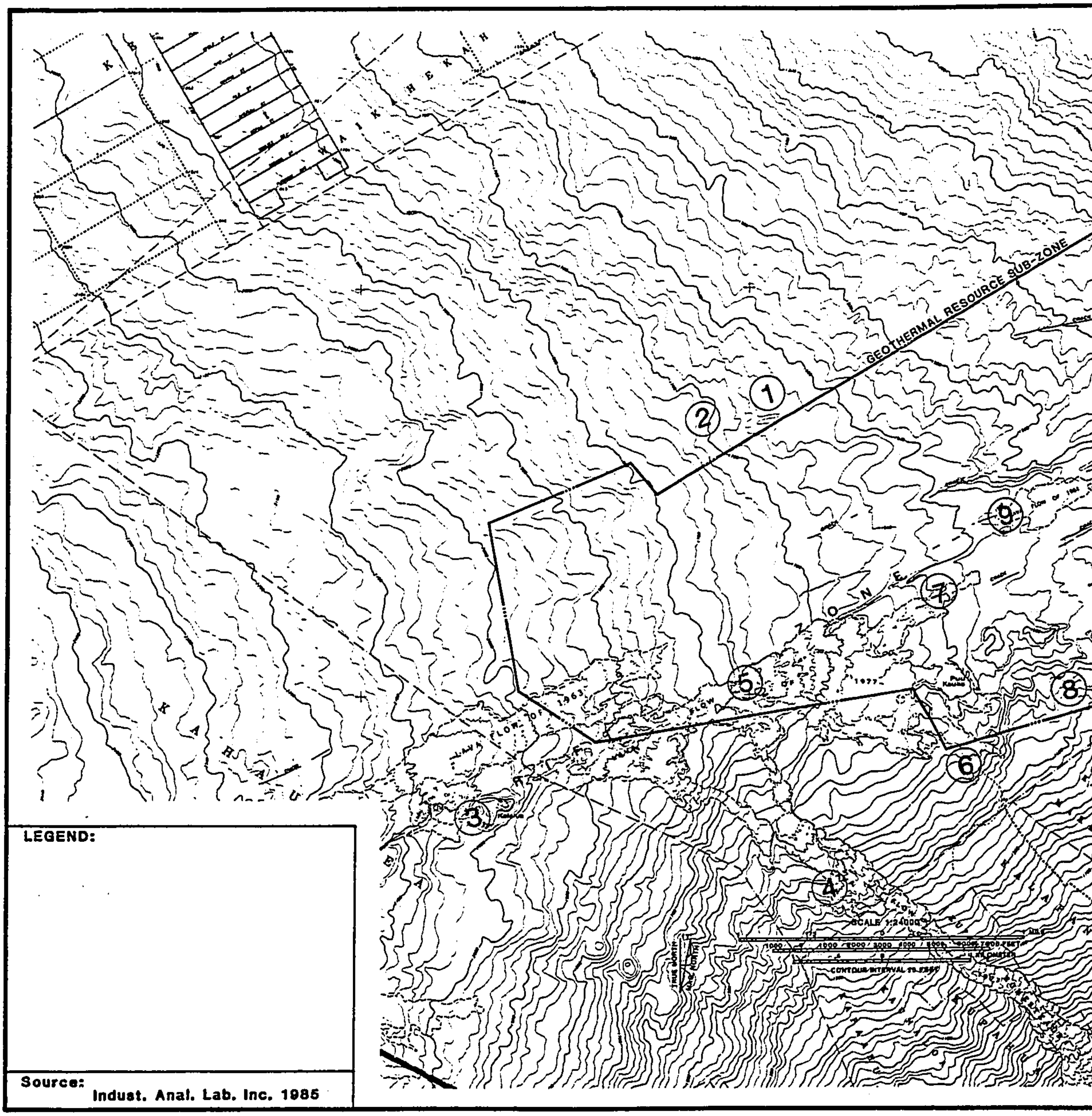



FIGURE 12

**Soil and Leaf Tissue Sampling Sites**


GEOTHERMAL RESOURCE SUB-ZONE
1
2
3
4
5
6
7
8
9
ZONE
FLOW OF 1963
1977
SCALE 1:24000
CONTOUR INTERVAL 20 FEET
LEGEND:
Source:
Indust. Anal. Lab. Inc. 1985

associated with natural geothermal occurences.

The sampling locations were selected on the basis of three significant considerations: (1) meteorology (prevailing upwind and downwind sites were selected); (2) the geological scope of the project area; and (3) accessibility (current and future).

A total of 12 soil and 12 plant samples were taken at each sampling site and standard procedures were used during the analyses.

The analyses performed indicate that both the soils and plant tissues located in the project area possess low levels of Hg and As contamination while only the soils contain extremely low levels of boron [(Industrial Analytical Laboratory, Inc. 1985).] Figure 13 displays the absolute concentration of As and Hg in the soils as a function of sampling location. Figure 14 displays the absolute concentration of As and Hg in plant tissues as a function of sampling location. Average values for the analyses determined are shown in Table 4.

From the analyses conducted it appears that the plant tissues tend to concentrate Hg while the soils tend to concentrate As. Also, there appears to be a random, low level scattering of Hg in the soils collected, but a maximum occurs in plant tissue on or about Site 4. Soil pH (Figure 15) is relatively low with minimas at Sites 6 and 11.

TABLE 4

AVERAGE VALUES FOR SOIL AND

PLANT TISSUE ANALYSES 1/

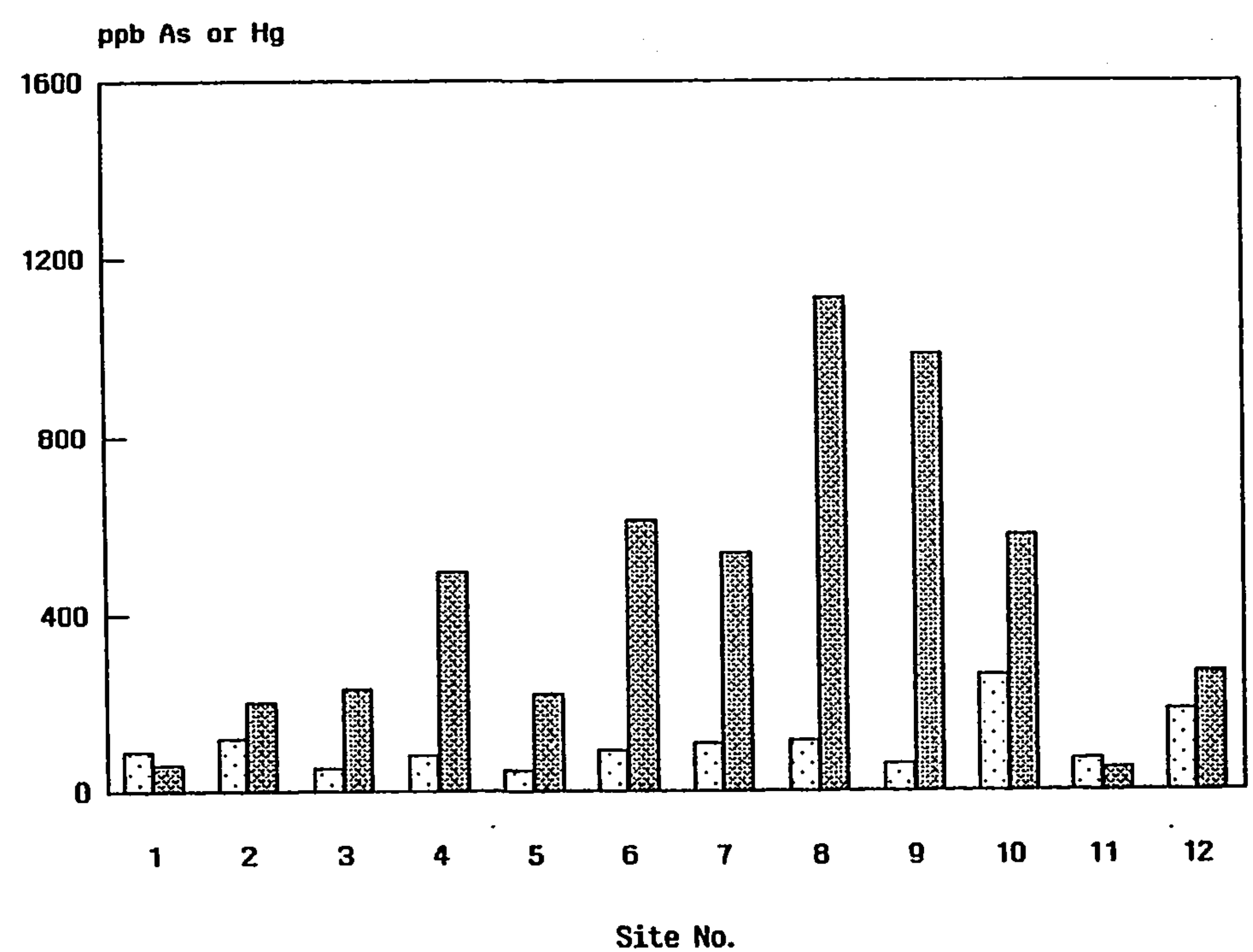
| Analyte | Average ± single standard deviation. |
|---|---|
| Soils: | |
| Mercury | 113.0 ± 62 ppb w/w 2/ |
| Arsenic | 482.0 ± 333 ppb w/w |
| Boron | 12.0 ± 2 ppm w/w Note that detection limit for boron was 88 ppm w/w. |
| Moisture content | 64.4 ± 8 % w/w |
| pH | 5.5 ± 0.2 units |
| Plant Tissue: | |
| Mercury | 490.0 ± 357 ppb w/w |
| Arsenic | 239.0 ± 153 ppb w/w |

1/ Source: Industrial Analytical Laboratory, Inc., 1985.

2/ w/w = wet weight

c. Impacts and Mitigating Measures

Potential impacts to the flora of the project area include possible disturbance or destruction of mosaic patterns of ecosystems and

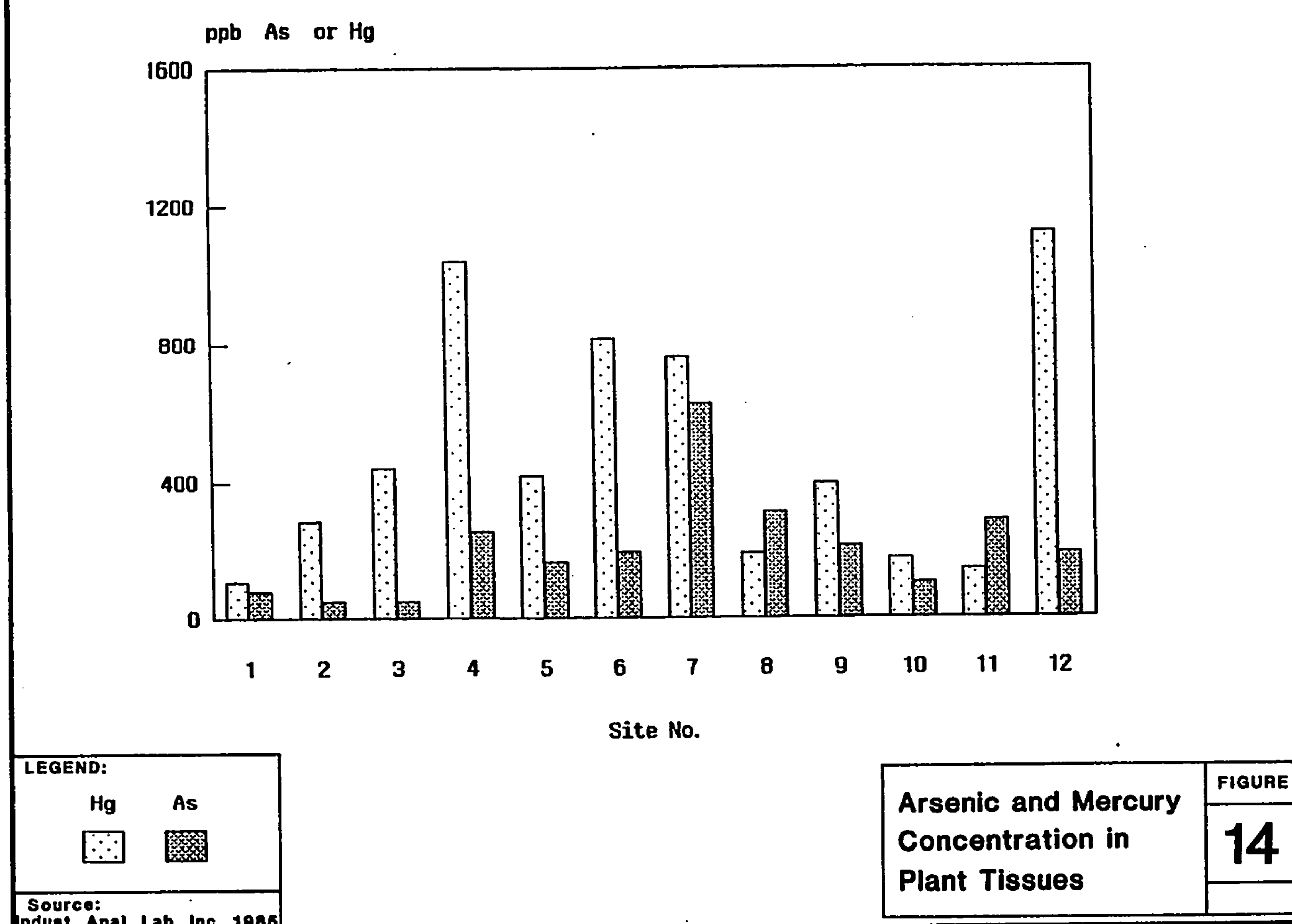



LEGEND:
Hg
AS

Source:
Indust. Anal. Lab. Inc. 1985

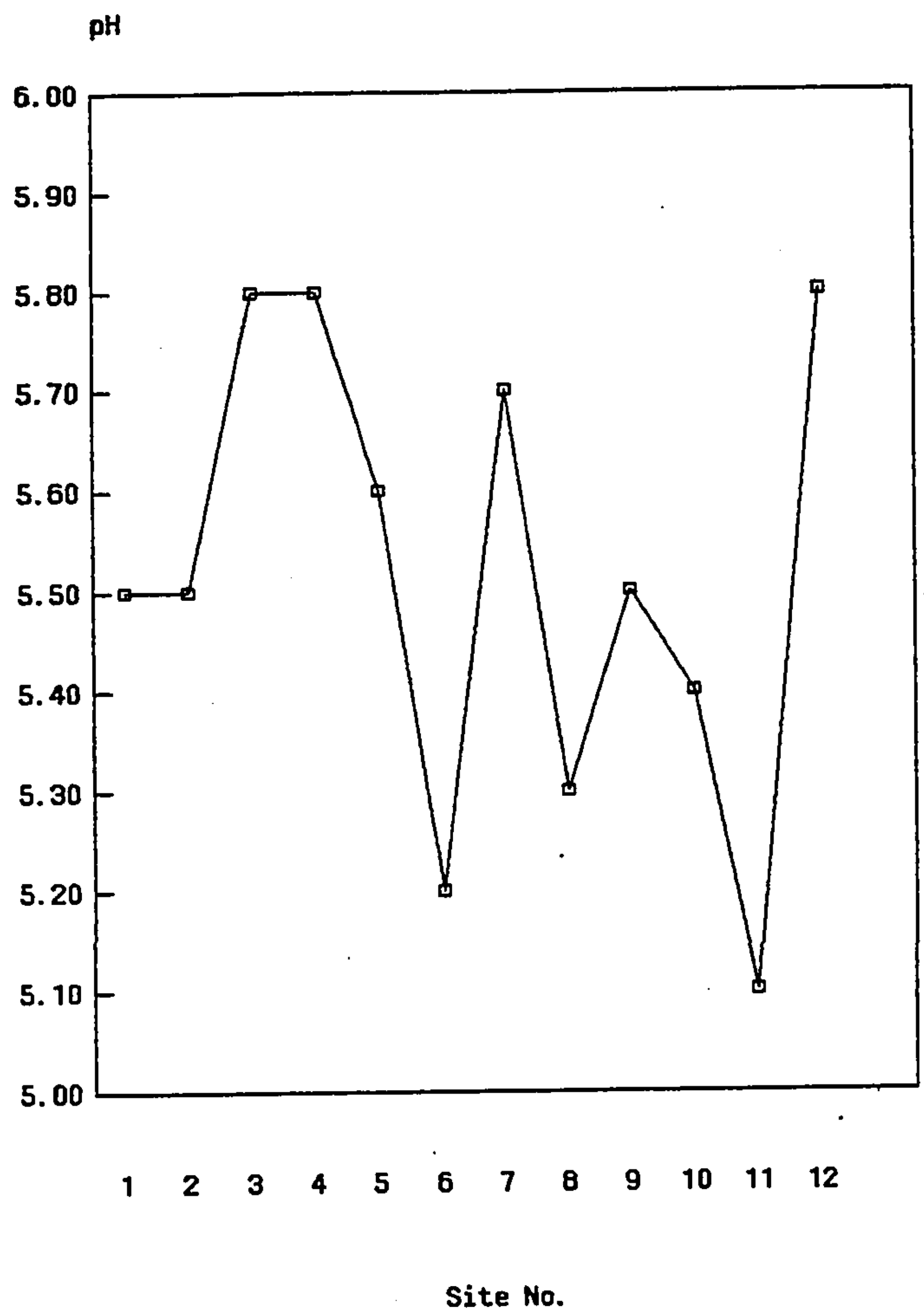
Arsenic and Mercury Concentrations in Soils

FIGURE 13




Arsenic and Mercury Concentration in Plant Tissues

FIGURE 14




LEGEND:

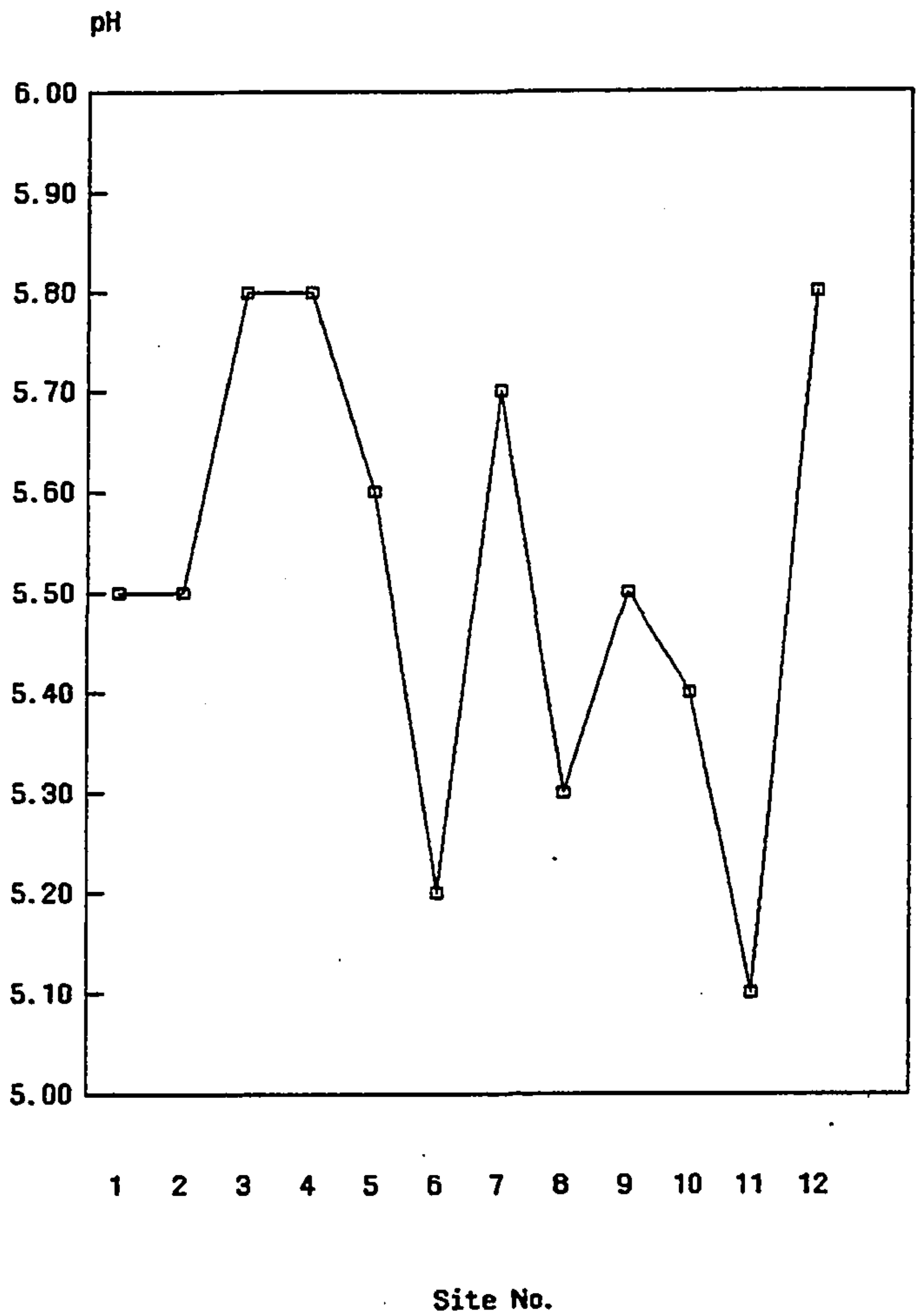
Source:
Indust. Anal. Lab. Inc. 1985

FIGURE 15

Soil pH

# CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING




LEGEND:

Source:
Indust. Anal. Lab. Inc. 1985

Soil pH

FIGURE 15

natural succession in the area, the introduction of exotic and pest plant species and generally increased human activity in the area.

It is highly unlikely that geothermal development in the project area will interfere significantly with the mosaic pattern of ecosystem types or the evolutionary process occurring in those ecosystem types due to the relatively small part of the geothermal resource subzone which will be disturbed during geothermal development, and the avoidance, as far as possible, of especially sensitive areas. It is the mosaic pattern of ecosystems which permits development of geothermal resources in the area to take place in those parts of the subzone which are not of great evolutionary importance, and to avoid those which are. Therefore, it appears that the project will have very little, if any, effect on plant or wildlife evolution in the project or surrounding areas.

There are two ways in which a development project could influence natural succession in this area. One would involve such extensive land clearing that significant portions of some one successional stage were removed from the system. The other would involve the introduction of weed species, as a consequence of development, in such numbers to disrupt the successional process.

The total land area to be cleared in construction of roads, drill sites, power plants, and transmission lines will be about 300 acres, approximately 1 percent of the total area of the land parcel in which the proposed project is planned. Development will not be concentrated in one site or in one flora community type, and will avoid, as far as possible, those areas of mature forest which are the most important sources of plants and animals for completion of the successional process. The dispersed nature of the development will mean that no single successional stage will be disturbed in more than a small percentage of the total area it occupies. The matter of the introduction of weeds has been discussed elsewhere in this SUP EIS, as well as possible mitigation measures. Again, the area involved in relation to the total area in the subzone is so small that no significant interruption of natural successional processes is likely to occur.

To ensure that potential impacts on the vegetation and biological succession and mosaic pattern of that vegetation are minimized to the greatest extent practicable, well sites and power plants will <u>not</u> be located in the limited stands of ohia-a(1) forest. It is possible, however, that geothermal fluid pipelines and associated service roads may traverse ohia-a(1) areas. If this is required, botanical surveys will be conducted prior to construction to limit disturbances as much as practicable. In general, most well sites, power plants, service roads, etc. will be constructed in the ohia-a(2), ohia-b, ohia-uluhe and lava areas. For facilities sited in ohia-a(2) areas, botanical surveys will also be conducted prior to construction to avoid, whenever possible, the more sensitive portions of the forests. It is expected that it will be possible to avoid the more sensitive portions of the 'ohi'a forests based on the total land area of the GRS and the areas required by the project for various uses (See Table 1). Similarly, the following recommendations provided by Char & Lamoureaux (1985b) will also be followed:

-- Vegetation removal will be minimized and carefully limited only to that which is essential. Sensitive areas will be inspected by qualified biologists before construction.

-- If areas in the Conservation zone need to be revegetated, then only native species found in the area will be used. No exotic species will be brought into the area.

-- If additional surface or fill material is required, it will come from a nearby area, such as 'I'ilewa cinder pit, and be as weedfree as possible.

-- The areas around the facilities and along roadsides will be kept in as near a natural condition as possible. All equipment and material brought into the area will be removed if no longer needed. Additionally, all sites will be monitored regularly to assure that drainage remains unimpeded.

-- The vegetation around the developed areas will be monitored regularly for emission damage.

-- An environmentally compatible method of weed control will be initiated around the facilities and along the roads.

3. Fauna

a. Existing Conditions

The invertebrate species inhabiting the project and surrounding areas are not well known. It is known that insects do make up part of the forest bird's diet and it is likely that insects also constitute part of the mongoose diet. Also, it is known that mosquitos (Culex quinquefasciatus) exist in the project area and that they could transmit avian diseases, such as bird malaria.

It is also likely that the endemic Hawaiian Drosophila exists in the project area and that species differentiation between kipukas and the various ecosystem types may have occurred.

The avifauna of the Kahauale'a project area is described in the EIS. Additional analyses have been performed to identify any additional bird species that may be present or any previously cited species that may not inhabit the project area and to assess the potential impacts of the project in the new and adjoining area.

A thorough forest bird survey (Hawaii Forest Bird Survey) has been conducted by personnel of the U.S. Fish and Wildlife Service (Scott, et al., in press) in the project area. The Hawaii Forest Bird Survey (HFBS) was begun in 1976 and was completed in 1979 for the Island of Hawaii. At least one half of the area covered by the HFBS had never been explored by ornithologists. The results of this unique bird survey make it possible, for the first time, to understand the distribution and the status of both the endemic birds and the alien or introduced bird species that occur in Hawaii.

In the EIS, 12 endemic, 2 indigenous, and 11 introduced bird species that could be present in the Kahauale'a project area are described. For the new project area, at lower elevations, it is estimated that no more than 6 endemic, no indigenous and probably 10 introduced or alien species would be present. Table 5 lists the endemic forest birds that could be impacted by geothermal operations in the project area.

TABLE 5

Endemic Birds in the Puna Forest Reserve Below 2,100 Feet 1/

| Species | Status |
|---|---|
| I'o, *Buteo solitarius* | Endangered |
| Elepaio, *Chasiempis sanwichensis* | Not endangered |
| Omao, *Phaeornis obscurus* | " " |
| Amakihi, *Hemignathus virens* | " " |
| Apapane, *Himatione sanguinea* | " " |
| Iiwi, *Vestiaria coccinea* | " " |

1/ Source: Berger (1985), based largely on Scott et al., in press.

Only one of these 6 endemic species is now classified as an endangered species: the Hawaiian Hawk or 'I'o (*Buteo solitarius*). Given the abundance, wide distribution, and high reproductive success of this species, it may be appropriate to reevaluate its endangered status (Scott, et al., in press and Griffin, 1984).

Griffin (1985) suggested that the information that he presented "indicates that reclassification to threatened status may be warranted." Regardless of its status (i.e., endangered or threatened), the 'I'o has a very wide home range where it forages for food. It is an adaptable species, feeding on spiders, insects, mammals (especially rats), and both endemic and introduced birds (Berger, 1981). Similarly, it was noted (Scott, et al., in press) that the 'I'o occupies a broad range of habitats from papaya and macadamia orchards through virtually all types of forests including 'ohi'a rainforest and sub-alpine mamane-naio woodland. Moreover, Griffin (1985, Abstract to Thesis) found "no differences...in success of 'I'o nests in habitats dominated by native (77%) versus exotic (65%) vegetation." Griffin (1985) also found the greatest densities of hawks in "a mixed agricultural area" and that the largest home ranges for the hawk in "wet open 'ohi'a forest with exotic understory" and the smallest home ranges in an "agricultural area with papaya and guava orchards".

In addition to the 'I'o, the endangered O'u or Hawaiian Honeycreeper (Psittirostra psittacea) could possibly inhabit the project area. However, in relation to the project area, where elevations range from

2,000 to 1,300 feet (See Figure 7), there are no records of the O'u being found there. Scott (Scott, et al., in press) noted that on the island of Hawaii the O'u is most abundant from 4,260 to 4,900 ft. elevation, but was recorded at 2,100 feet in Puna. Less than 40 'O'u were recorded during 13,500 count periods conducted during the HFBS (Scott, et al., in press).

Another endemic species which may be seen in the project area is the Pueo or Hawaiian Short-eared Owl (Asio Flammeus sandwichensis). The Pueo is a permanent resident on all main islands in the Hawaiian Chain. The birds occur from sea level to at least 8000 feet on Mauna Loa and Mauna Kea, and the birds are tolerant of wide climatic conditions. The Division of Forestry and Wildlife considers the Pueo to be endangered on Oahu but not on Hawaii.

Of the remaining species of endemic forest birds, Scott (Scott, et al., in press), indicated the following estimates of the population size for these species on the island of Hawaii: 1. Hawaiian thrush or Omao, 113,000 in the Hamakua-Puna districts; 2.

Elepiao, 214,989; 3. Amakihi, 870,000; 4. Iiwi, 340,417; 5. Apapane, more than one million.

The non-endangered native birds and introduced birds in the project area are the same as those listed is the EIS. This includes the following: 'Apapane, 'Oma'o, 'Elepaio, 'Amakihi, 'I'iwi, Japanese White Eye, Cardinal, Red-Billed Leiothrix, Spotted Munia, House Finch, doves, Barn Owl, and mynah. As noted previously, large populations of the preceding species exist in the project area and island of Hawaii.

All of the mammals known to inhabit the project area are introduced species that are predators on birds and their eggs or young (Berger, 1972 and 1981). As noted previously, the Hawaiian Bat is not known to inhabit the project area.

b. Impacts and Mitigating Measures

Potential impacts to the fauna of the project area include those caused by the disturbance or removal of habitat, increased human activity, facilities construction/operation noise, transmission lines, night lighting and possible impacts of emissions.

Clearing and habitat removal due to geothermal development activity for the proposed project is expected to be limited to about 1 percent of the parcel of land in which development would occur, an area of 26,000 acres more or less (See Table 1). Clearing will be severely limited, if required at all, in the small stands of ohia-a(l) forest within the GRS. As a result, the project is expected to have little impact on the relatively large populations of non-endangered and introduced species of birds. Similarly, due to the abundance and wide home range of the Hawaiian Hawk and the lack of evidence indicating the presence of the Hawaiian Honeycreeper in the project area, the proposed geothermal development is expected to have little impact, if any, on these two endangered species that might inhabit the project area.

Impacts to the invertebrate species of the project area are expected to be minimal due to the limited surface area required for project purposes. It is recognized that water ponds used for drilling operations could serve as breeding grounds for mosquitos.

Noise generated during preparation of the project drill sites, roadways, power plant sites, etc., and during operation of the facilities, is expected to have an insignificant impact on the birds inhabiting the project area. Several studies conducted on the mainland U.S. as well as in Hawaii, have shown that normal noise levels in the range expected for the proposed project (i.e., 82dBA within 100 feet of the drilling rig) should have little effect on the birds of the area and that the birds become habituated to noises in the environment that they learn pose no harm to them (Berger, 1985).

Based on the information presented in many mainland studies (Berger, 1985), it has been shown that transmission lines would have minimal impact on any bird species. Turkeys, hawks and Bald Eagles have been observed nesting or roosting on or around powerlines and powerline structures. These birds do not exist in Hawaii. Ducks on the mainland U.S. have been known to collide with powerlines (about 1 in 250,000 birds) when the ducks are migrating. However, it is unlikely that any of the ducks in Hawaii would be migrating through or near the project site.

Night lighting of the operating drill sites or power plants is expected to have little, if any, effect on the endemic forest birds of the project area because none of these species is active at night. Bright, unshielded night lighting could pose a problem to the fledglings of such species as the Manx, Newell's Shearwater and the Dark-rumped Petrel if their routes to nesting or breeding areas passed over or near such lights whether in the project area or a nearby township such as Pohoa. There is no indication that these seabirds nest or breed in the project area.

There is no evidence to indicate that the effects of hydrogen sulfide ($H_2S$) and sulfur dioxide ($SO_2$) on the eyes and respiratory systems of birds would be much different than the effects on mammals. For birds, in general, it can be presumed that if $H_2S$ fumes are of a high enough concentration to affect the birds adversely, the birds would not remain in the area (see Siegel, 1985). For $SO_2$, the research performed indicates that pulmonary function measurements, including tidal volume, respiratory rate, minute volume, dynamic compliance, pulmonary flow resistance and carbon monoxide uptake, showed no detrimental changes that could be attributed to $SO_2$. Hematology and clinical chemistry measurements were normal and body weight, growth and survival were not adversely affected by $SO_2$ (Berger, 1985).

It is considered, therefore, that the emission controls that will be used to protect man will also protect the birds and mammals of the project area and that no significant effects on the birds or mammals will result from the controlled emissions.

Potential impacts on the avifauna of the project area will be mitigated through the following measures:

Noise -- to be controlled by the use of mufflers and other noise abatement methods to comply with county noise guidelines.

Emissions -- to be controlled through the use of approved abatement systems to comply with all air quality standards.

Habitat -- to be protected through minimal disruption and clearing of vegetation and by limiting development whenever possible to the more disturbed forest areas.

The potential impacts of night lighting and transmission lines on the avifauna of the project area appear to be minimal. Light shielding, consistent with proper safety precautions, will be provided.

4. Air Quality and Diffusion Models

a. Existing Conditions

The following general information regarding air quality and regulations pertaining thereto have been provided by the State Department of Health:

"1. The Department is presently in the process of formulating and promulgating geothermal rules for goethermal wells, power plants and other geothermal facilities.

2. Geothermal wells, power plants and other geothermal facilities will be required to submit applications for air pollution control permits. A State Authority to Construct (ATC) permit must be received by the appli-

cant prior to the commencement of construction. Construction activities include the drilling of the geothermal well.

3. Once construction is completed and the facility is operating, a Permit to Operate would be issued by the Department provided that the applicant can meet all State and Federal regulations and has complied with the applicable ATC permit requirements.

4. For all geothermal wells, power plants and other geothermal facilities, the Best Available Control Technologies (BACT) will be required as a minimum to control air emissions."

As previously noted, ambient air quality along the Kilauea east rift zone has been determined through three air quality monitoring programs. The first, conducted by the State Department of Planning and Economic Development, covered the two-year period of December, 1982 to December, 1984, and included monitoring stations from Volcanoes National Park to Pohoiki. The second program, sponsored by the Kahauale'a Geothermal Project, included generally much of the same area and covered the one-year period of February 1984 through March 1985. The third survey, conducted for one year in 1984 by the National Park Service (NPS) in the Hawaii Volcanoes National Park, covered the area generally along the boundary between the Park and Kahauale'a. Six environmental pollutant categories, that are of primary interest in

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Supplemental EIS To the
Revised EIS
Kahauale'a Geothermal Project

NAME Nolan Hirai

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TELEPHONE (B) 543-8200 (H)

8/86

establishing baseline levels in areas where geothermal development operations are expected to occur, were measured:

- Atmospheric Particles (including respirable and inhalable particles)
- Sulfur Dioxide ($SO_2$)
- Hydrogen Sulfide ($H_2S$)
- Rainwater Chemistry
- Radon Activity
- Mercury Vapor

The air pollutants reflected by these categories can be impacted to varying degrees by volcanic activity and as a result of geothermal development activities.

Atmospheric particles are analyzed to determine the compositions of the various elements that are present. By comparing the chemical composition measured in ambient particulate samples and the known chemical composition of particles from specific sources, the contribution that each particulate source makes to atmospheric particulate levels can be calculated. This process is referred to as chemical mass balance (CMB) source apportionment.

The chemical composition of rain water is an important parameter to examine because rain "scrubs" the atmosphere of pollutants and, by doing so, becomes contaminated with those pollutants. Also, acid gases and mists emitted by volcanoes can produce rain that is acidic. [All rainfall in Hawaii has a tendency to be slightly acidic due to long range transport of pollutants from industrialized mainland areas (Houck, et al., 1985)]

In general, the atmospheric concentration of particulate material (including respirable and inhalable particulates), sulfur dioxide gas, hydrogen sulfide gas, mercury vapor, radon, carbon monoxide, nitrous oxides and chlorine gas are low compared to mainland values, U.S. EPA standards or California standards. Episodic high concentrations of sulfur dioxide gas, hydrogen sulfide gas and radon that have been recorded over the past two and one-half years of monitoring have been directly linked to natural volcanic activity.

The highlights of the results of the surveys conducted are extracted from the summary report of the surveys (Houck, et al., 1985) are as follows:

- Atmospheric Particles

  The atmospheric concentration of particulate material is low in the project area as compared to mainland values and U.S. EPA standards. Average total suspended particulate (TSP) values ranged from 8.6 $mg/m^3$ to 29.5 $mg/m^3$ as shown in Table 6. Over 150 high-volume TSP samples were collected along the Kilauea East Rift zone over the course of 2-1/2 years (Figure 16).

Respirable and inhalable particulate concentrations are also low on the Kilauea East Rift as compared to mainland values and the proposed U.S. EPA standards. Data from two monitoring stations (Upper Leilani and Volcano Village) are listed in Table 7. Over fifty respirable and over fifty inhalable samples were collected and analyzed from both sites over a one-year period.

The characteristics of atmospheric particulate material within the project area are not significantly different than any other portion of the Rift Zone and are very well understood. This understanding is based on a sample collection program over a two and one-half year period, detailed chemical analysis of all samples and computer modeling.

- Sulfur Dioxide Gas

Sulfur dioxide ($SO_2$) gas was considered as a high priority pollutant for baseline monitoring since it occurs at relatively high concentrations in volcanic fume and is also produced by a number of industrial activities. Approximately 17,000 hours of continuous $SO_2$ monitoring have been conducted at eleven different locations, and 132 integrated multi-day samples have been collected at ten locations along the Rift Zone (Figure 17).

Measured atmospheric concentrations of $SO_2$ typically ranged between less than 0.4 ppbv to less than 0.5 ppbv (Tables 8 and 9). Frequently, atmospheric concentrations of $SO_2$ exceeded the range of the instruments when such sites were impacted by volcanic fume (Table 8).

The the twenty-four hour $SO_2$ values measured at the National Park Research Center by the State Department of Health illustrate this fact in Table 10.

- Hydrogen Sulfide Gas

Hydrogen sulfide ($H_2S$) gas was considered as a high priority pollutant for baseline monitoring since it is the most problematic pollutant associated with the geothermal industry. It occurs at low concentrations in volcanic fume and it can be produced biologically by anaerobic respiration.

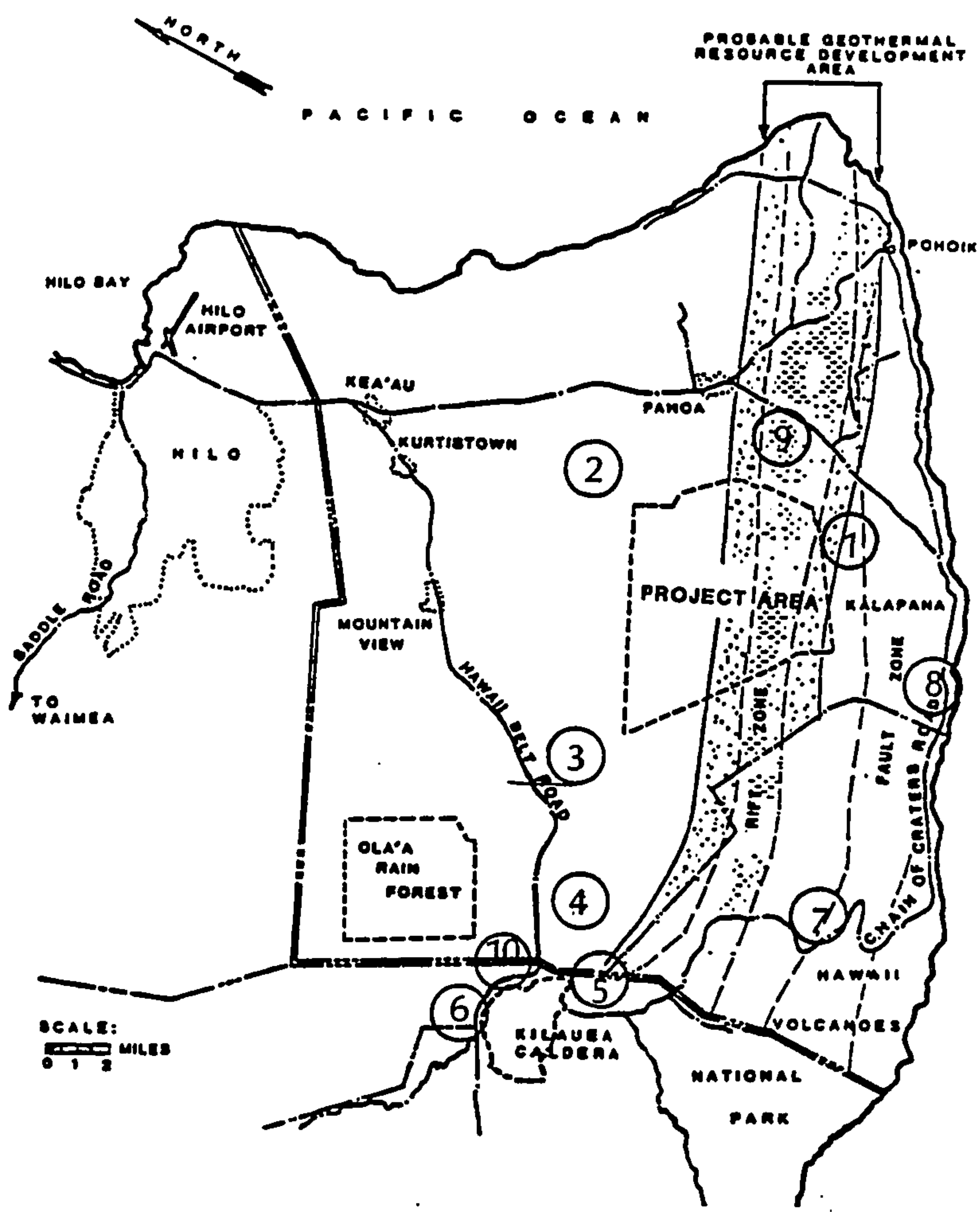
Table 6

Total Suspended Particles

| Study/Description | | Site | Mean TSP ($\mu g/m^3$) |
|---|---|---|---|
| Puna Forest Reserve | 1. | Kaimu-Makena Homestead | 14.7 |
| | 2. | Waikahekahe | 22.4 |
| Kahauale'a Baseline | 3. | Fern Forest Subdivision | 8.6 |
| | 4. | Mauna Loa Estates | 10.0 |
| | 5. | Thurston Lava Tube | 13.3 |
| | 6. | Volcano Golf Course | 17.3 |
| | 7. | Chain of Craters Road | 12.0 |
| | 8. | Royal Gardens Subdivision | 29.5 |
| DPED Baseline | 9. | Upper Leilani | 17.5 |
| | 10. | National Park Headquarters | 12.0 |
| Mainland[a] Means | | | |
| | | Urban - EPA (18) | 80 |
| | | Non-urban - EPA (8) | 50 |
| | | Non-urban - EPRI (9) | 40 |
| U.S. EPA Standards | | | |
| | | Geometric Annual Mean | 75 |
| | | Twenty-four Hour | 260[b] |

[a] Mainland Means - mean of 18 URBAN Sites, U.S. EPA; mean of 8 non-urban sites, U.S. EPA; mean of 9 non-urban sites, Electric Power Research Institute (EPRI)

[b] Not to be exceeded more than once per year




LEGEND:

Source: Houck, et. al., 1985

High Volume TSP Monitoring Sites

FIGURE 16

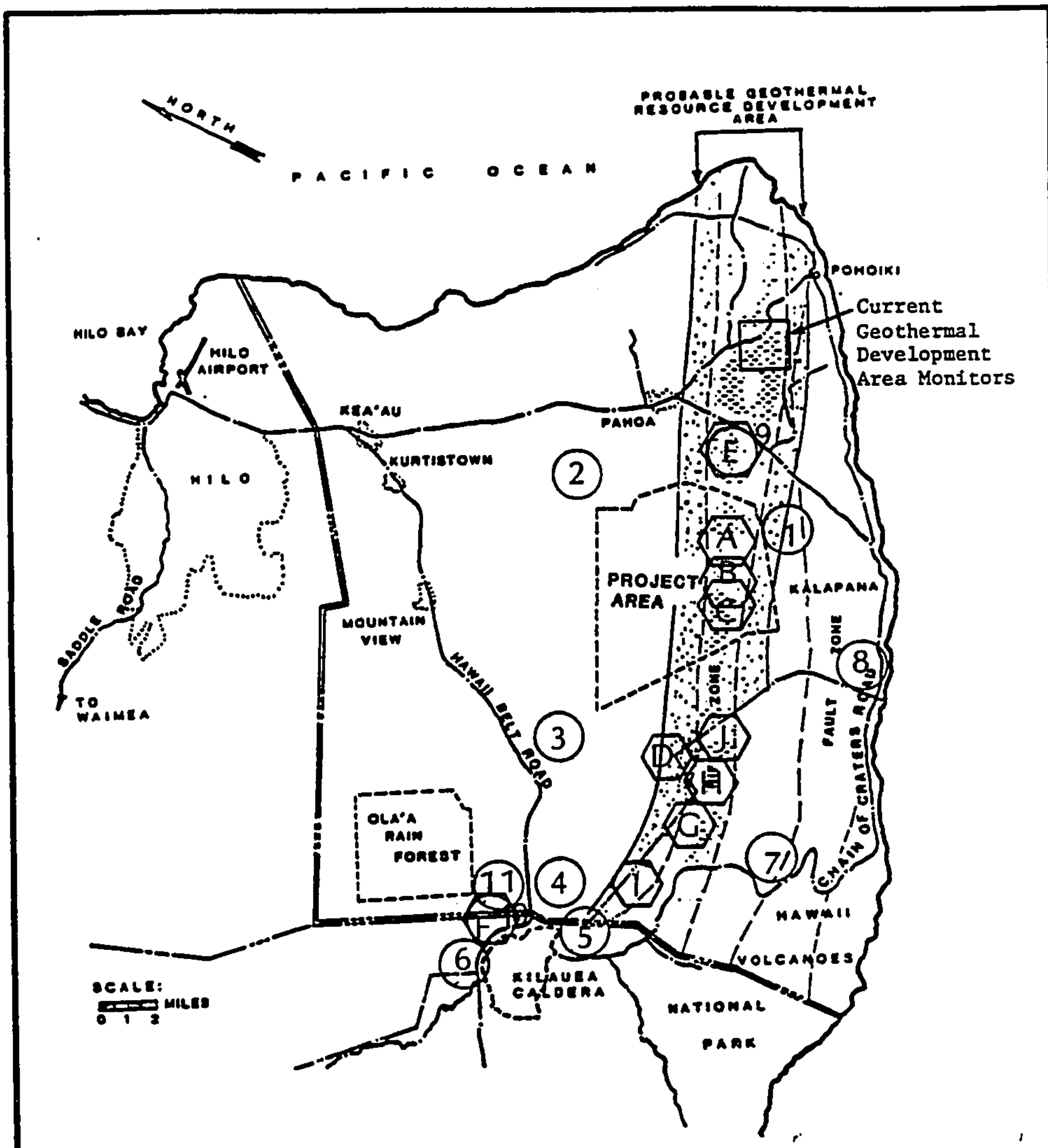
Table 7

Respirable and Inhalable Particles

| Study/Description | Site | Mean Respirable ( < 2.5 μ ) Concentrations (μg/m³) | Mean Inhalable ( < 15 μ ) Concentrations (μg/m³) |
|---|---|---|---|
| DPED Baseline | Upper Leilani | 1.6 | 9.5 |
| | Volcano Village | 1.6 | 5.2 |
| Mainland Means[a] | | | |
| | Urban - EPA (18) | 24 | 46 |
| | Non-Urban - EPA (8) | 15 | 32 |
| | Non-Urban - EPRI (9) | 19 | 28 |
| Proposed U.S. EPA Standard ( < 10 μ ) | | | |
| | Annual Arithmetic Mean | 50 to 60 | |
| | Twenty-four Hour | 150 to 250[b] | |

[a] Mainland Means - mean of 18 Urban Sites, U.S. EPA; mean of 8 non-urban sites, U.S. EPA; mean of 9 non-urban sites, Electric Power Research Institute (EPRI)

[b] Not to be exceeded more than once per year




**LEGEND:**

Circles designate continuous monitoring sites, hexagons designate multi-day integrating sampling sites.

**Source:** Houck, et. al., 1985

**Sulfur Dioxide and Hydrogen Sulfide Monitoring Sites**

**FIGURE 17**

Table 8

Continuous Monitoring - Sulfur Dioxide Gas

| Study/Description | Site | Monitoring Period | Typical Atmospheric Concentration Measured (ppbv) | Maximum Concentration Measured (ppbv)[a] |
|---|---|---|---|---|
| Puna Forest Reserve | 1. Kaimu-Makena Homestead | 2/85-3/85 | < 0.4 | no events above detection limits |
| | 2. Waikahekahe | 3/85 | < 0.4 | |
| Kahauale'a Baseline[b] | 3. Fern Forest Subdivision | 2/84-2/85 | < 0.4 | > 360 |
| | 4. Mauna Loa Estates | 2/84-2/85 | < 0.4 | 148 |
| | 5. Thurston Lava Tube | 2/84-2/85 | < 0.4 | > 345 |
| | 6. Volcano Golf Course (KMC) | 2/84-2/85 | < 0.4 | 484 |
| | 7. Chain of Craters Road | 2/84-2/85 | < 0.4 | 225 |
| | 8. Royal Gardens Subdivision (Park Residences) | 2/84-2/85 | < 0.4 | 10 |
| DPED Baseline | 9. Upper Leilani | 5/83-9/83 | < 0.5 | 1.2 |
| | 10. National Park Headquarters | 12/82-5/83 | < 0.5 | > 160 |
| | 11. Volcano Village | 11/83-4/84, 7/84-9/84 | < 0.4 | ≥ 434 |
| U.S. EPA Standards | Arithmetic Annual Mean | | 30 | |
| | Twenty-four Hour | | 140[c] | |

a When a greater than symbol (>) appears, the maximum range of the monitor was exceeded
b The continuous monitor was operated at each of the six sites used in the Kahauale'a Baseline for one week out of every six
c Not to be exceeded more than once per year.

Table 9

Multi-Day Integrated Sampling - Sulfur Dioxide Gas

| Study/Description | Site | Monitoring Period | Number of Days Sampled | Mean $SO_2$ Concentration (ppbv) |
|---|---|---|---|---|
| Puna Forest Reserve | A. 1977 Lava Flow - Lower Site | 2/85-3/85 | 29 | $\leq$ 0.08 |
| | B. 1977 Lava Flow - Middle Site | 2/85-3/85 | 29 | $\leq$ 0.08 |
| | C. 1977 Lava Flow - Upper Site | 2/85-3/85 | 33 | $\leq$ 0.08 |
| Kahauale'a Baseline | D. Remote Site | 7/84-2/85 | 209 | 0.3 |
| DPED and NPS Baseline | E. Upper Leilani | 1/83-12/83 | 112 | 0.5 |
| | F. National Park Headquarters | 1/83-12/83 | 117 | 4.2 |
| | G. Kane Nui O Hamo | 1/83-1/85 | 225 | 1.1 |
| | H. Napau | 1/83-12/84 | 186 | 0.9 |
| | I. Escape Road | 1/83-10/84 | 205 | 1.0 |
| | J. Pu'u O | 1/84-12/84 | 106 | 1.0 |
| U.S. EPA Standards | | | | |
| | Arithmetic Annual Mean | | 30 | |
| | Twenty-four Hours | | 140[a] | |

[a] Not to be exceeded more than once per year

TABLE 10

Twenty-four Hour Sulfur Dioxide Values Measured
at the National Park Research Center
by the Hawaii Department of Health

| Date | $SO_2$ Concentration (ppbv) |
|---|---|
| 1/8/83 | 170* |
| 1/9/83 | 375* |
| 1/10/83 | 0.7 |
| 1/19/83 | 19 |
| 1/27/83 | 12 |
| 3/4/83 | 14 |
| 3/5/83 | 11 |
| 3/10/83 | 72 |

*Above the U.S. EPA 24 hour standard of 140 ppbv

Approximately 17,000 hours of continuous $H_2S$ monitoring have been conducted at eleven different locations, 132 integrated multi-day samples have been collected at ten locations, and 275 passive $H_2S$ monitors were placed at 36 locations along the Rift Zone (Figures 17 and 18). In addition, $H_2S$ monitoring has been maintained in the vicinity of the geothermal development area along the Pohoiki Road for a number of years.

During the baseline study of the project area, low-level concentrations of $H_2S$, ostensibly from anaerobic respiration, were measured at the site referred to as Waikahekahe which is located on a pahoehoe flat. This area is extensive and is upwind of the project area under normal trade wind conditions. However, hourly mean $H_2S$ values are not likely to exceed the several tenths to several ppbv levels due to natural sources.

The atmospheric concentrations of $H_2S$ measured during the survey are shown in Tables 11 and 12.

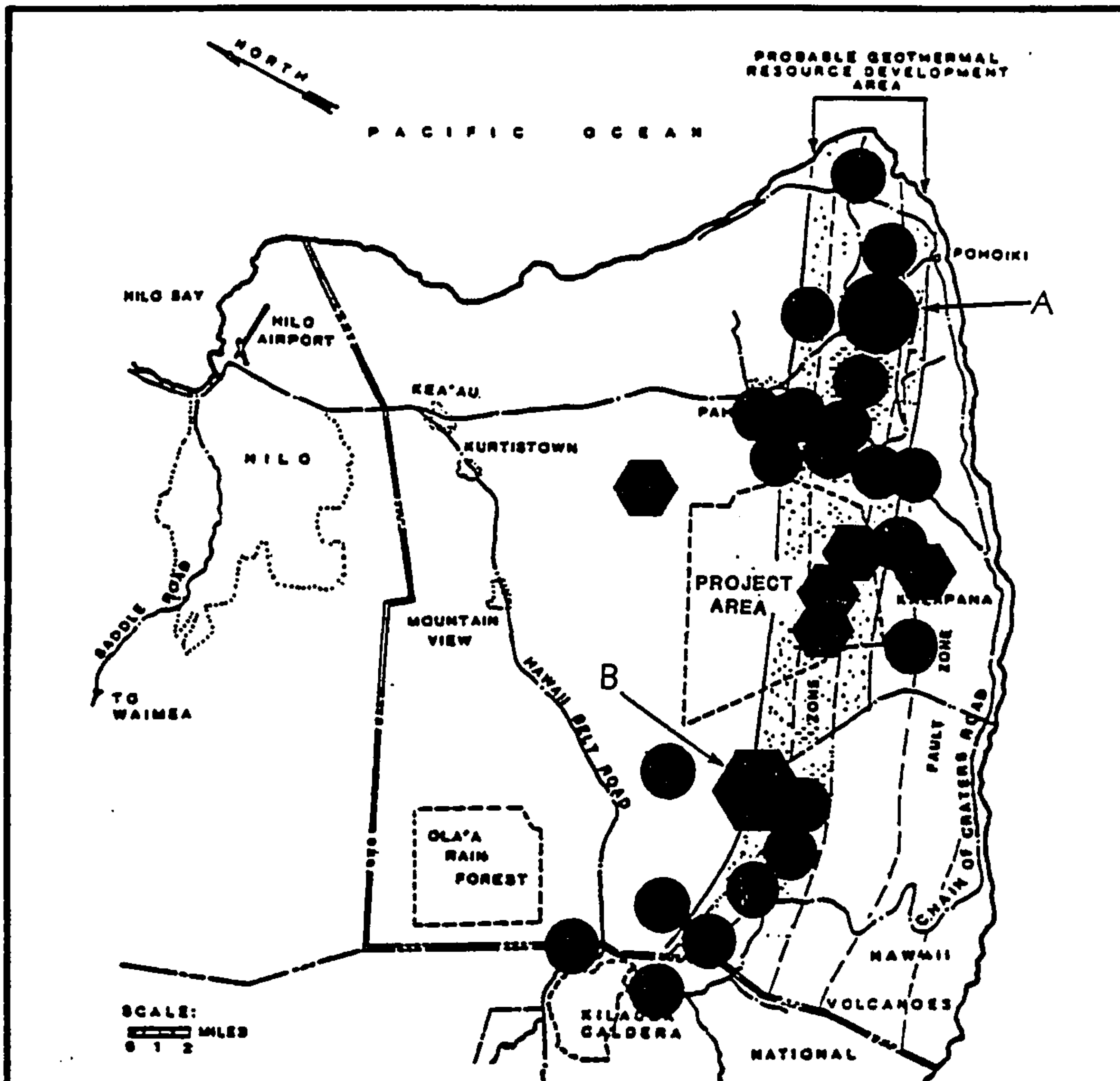
- Rain Water Chemistry

During the period from December, 1982, through March, 1985, some fifty-five rain water samples were collected and analyzed for the various environmental baseline studies which were being conducted (Table 13). In addition, some catchment water in the vicinity of the geothermal development areas along Pohoiki Road has been tested and several scientific studies have examined the rain water chemistry on the island of Hawaii (Houck, et al., 1985).

Table 14 lists the mean chemical composition of rain water samples collected within the project area and the mean chemical composition of samples collected at the Chain of Craters Road site which is heavily impacted by volcanic fume from Pu'u O'o. Sea salt dominates the chemical composition of the rain water collected at the project area (Puna Forest Reserve Site) as shown by the chemical data in Table 14. Similarly, the combined impact of sea salt, volcanic fume, and tephra is apparent in the data from the Chain of Craters Road site.

- Mercury Vapor

Numerous mercury vapor measurements have been made on the Rift Zone. Reported total mercury vapor (elemental, organometallic, and hallide)




**LEGEND:**
The small solid circles (21 sites) are the sites where passive monitors were operated during 1983 for the DPED baseline program. The large solid circle (labeled A) encompasses an area where an extensive $H_2S$ monitoring network has been maintained for a number of years in relation to the geothermal development in the Pohoiki Road area. The small solid hexagons (5 sites) are the sites where passive $H_2S$ monitors were maintained for the True/Mid-Pacific Geothermal Venture Puna Forest Reserve Study. The large solid hexagon (labeled B) encompasses an area where ten passive $H_2S$ monitoring sites were maintained for a year for the True/Mid-Pacific Geothermal Venture Kahauale'a Environmental Study.

**Source:** Houck, et. al., 1986

FIGURE 18

**Locations of Passive $H_2S$ Detectors**

Table 11

Continuous Monitoring - Hydrogen Sulfide Gas

| Study/Description | Site | Monitoring Period | Typical Measured Atmospheric Concentration (ppbv) | Maximum Concentration Measured (ppbv) |
|---|---|---|---|---|
| Puna Forest Reserve | 1. Kaimu-Makena Homestead | 2/85-3/85 | < 0.4 | no events during monitoring period |
| | 2. Waikahekahe | 3/85 | < 0.4 to ≈ 2.0 | 9.1 |
| Kahauale'a Baseline[a] | 3. Fern Forest Subdivision | 2/84-2/85 | < 0.5 | 12.2 |
| | 4. Mauna Loa Estates | 2/84-2/85 | < 0.5 | 6.9 |
| | 5. Thurston Lava Tube | 2/84-2/85 | < 0.5 | 9.1 |
| | 6. Volcano Golf Course (KMC) | 2/84-2/85 | < 0.5 | 7.0 |
| | 7. Chain of Craters Road | 2/84-2/85 | < 0.5 | 10.4 |
| | 8. Royal Gardens Subdivision (Park Residences) | 2/84-2/85 | < 0.5 | 9.2 |
| DPED Baseline | 9. Upper Leilani | 5/83-9/83 | < 0.5 | 1.0 |
| | 10. National Park Headquarters | 12/82-5/83 | < 0.5 | 25.8 |
| | 11. Volcano Village | 9/83-11/83, 4/84-7/84, 9/84-12/84 | < 0.5 | 9.0 |
| California Standard | One Hour Average | | 100 | |

[a] The continuous monitor was operated at each of the six sites used in the Kahauale'a Baseline for one week out of every six

Table 12

Multi-Day Integrated Sampling - Hydrogen Sulfide Gas

| Study/Description | Site | Monitoring Period | Number of Days Sampled | Mean $H_2S$ Concentration (ppbv) |
|---|---|---|---|---|
| Puna Forest Reserve | A. 1977 Lava Flow - Lower Site | 2/85-3/85 | 29 | $\leq$ 0.3 |
| | B. 1977 Lava Flow - Middle Site | 2/85-3/85 | 29 | $\leq$ 0.3 |
| | C. 1977 Lava Flow - Upper Site | 2/85-3/85 | 33 | $\leq$ 0.3 |
| Kahauale'a Baseline | D. Remote Site | 7/84-2/85 | 209 | $\leq$ 0.3 |
| DPED and NPS Baseline | | | | |
| | E. Upper Leilani | 1/83-12/83 | 112 | $\leq$ 0.2 |
| | F. National Park Headquarters | 1/83-12/83 | 117 | $\leq$ 0.3 |
| | G. Kane Nui O Hamo | 1/83-1/85 | 225 | $\leq$ 0.2 |
| | H. Napau | 1/83-12/84 | 186 | $\leq$ 0.3 |
| | I. Escape Road | 1/83-10/84 | 205 | $\leq$ 0.2 |
| | J. Pu'u O | 1/84-12/84 | 106 | $\leq$ 0.2 |
| California Standard | | | | |
| | One Hour Average | | 100 | |

Table 13

Rainfall Collection Sites

| Site | Site Code | Elevation (ft) |
|---|---|---|
| Cape Kumukahi* | CK | 16 |
| Royal Gardens Subdivision | RGS | 20 |
| Waikahekahe | WKK | 920 |
| Kaimu-Makena Homestead | KMH | 1000 |
| Upper Leilani | UL | 1050 |
| 1977 Flow, Puna Forest, Lower Site | 77PL | 1600 |
| 1977 Flow, Puna Forest, Middle Site | 77PM | 1750 |
| Chain of Craters Road | CCR | 2240 |
| Glenwood* | GW | 2296 |
| Drill Site | DS | 2350 |
| Remote Site | RS | 2480 |
| Fern Forest Subdivision | FFS | 2670 |
| Mauna Loa Estates | MLE | 3560 |
| Thurston Lava Tube | TLT | 3880 |
| Volcano Golf Course | VGC | 4000 |
| Hawaii Volcanoes National Park Headquarters | HVNP | 4000 |
| Mauna Loa Observatory* | MLO | 11,148 |

* Cape Kumukahi, Glenwood, and Mauna Loa Observatory data from: Simpson, H.J., 1972, Aerosol Cations at Mauna Loa Observatory, J. Geophy. Res., V. 77, p. 5266-5277.

Table 14

Mean Rain Water Composition

| Element/Ion | Mean Concentration (ppm) Puna Forest Reserve Samples (elevation ≈ 1700') | Mean Concentration (ppm) of Samples Impacted by Pu'u O at Chain of Craters Road (elevation 2240') |
|---|---|---|
| Al | < 0.15 | 0.3 |
| Sb | < 0.15 | < 0.15 |
| As | < 0.3 | < 0.3 |
| Ba | < 0.001 | ≤ 0.001 |
| Be | < 0.003 | ≤ 0.003 |
| Bi | < 0.5 | < 0.5 |
| B | < 0.01 | < 0.01 |
| Cd | < 0.025 | < 0.025 |
| Ca | 0.22 | 0.36 |
| Cr | < 0.03 | < 0.03 |
| Co | < 0.02 | < 0.02 |
| Cu | < 0.015 | < 0.015 |
| Fe | < 0.03 | 0.20 |
| Pb | < 0.08 | < 0.08 |
| Mg | 0.48 | 0.39 |
| Mn | < 0.003 | 0.006 |
| Mo | < 0.04 | < 0.04 |
| Ni | < 0.025 | < 0.025 |
| $PO_4$ | < 0.4 | < 0.4 |
| K | 0.19 | 0.13 |
| $SiO_2$ | ≤ 0.09 | 0.82 |
| Ag | ≤ 0.03 | < 0.03 |
| Na | 3.5 | 2.4 |
| Sr | 0.003 | 0.003 |
| Sn | < 0.03 | < 0.03 |
| Ti | < 0.006 | 0.03 |
| V | < 0.01 | < 0.01 |
| Zn | < 0.015 | 0.02 |
| $Br^-$ | < 0.03 | < 0.03 |
| $Cl^-$ | 7.4 | 5.5 |
| $F^-$ | < 0.01 | 1.2 |
| $PO_4^{3-}$ | < 0.09 | < 0.09 |
| $NO_2^-$ | < 0.16 | < 0.16 |
| $NO_3^-$ | 0.09 | 0.53 |
| $SO_4^{2-}$ | 0.86 | 2.3 |
| $SO_3^{2-1}$ | < 0.05 | < 0.05 |
| pH | 5.4 | 4.0 |

* Underlined values above instrumental detection limits

values typically range from several $ng/m^3$ to several hundred $ng/m^3$ (Houck, et al., 1985). Reported total atmospheric mercury vapor values for the project arae typically ranged from 3 $ng/m^3$ to 7 $ng/m^3$ (Figure 19). Volcanic fume and fumarolic gas, on the other hand, can contain hundreds to tens of thousands of $ng/m^3$ of mercury. (One nanogram is $10^{-9}$ grams, i.e., 1 billion cubic meters of air contains 1 gram of mercury if the atmospheric concentration is 1 $ng/m^3$. Stated another way, 1 $ng/m^3$ is approximately 1 part in a trillion by weight.)

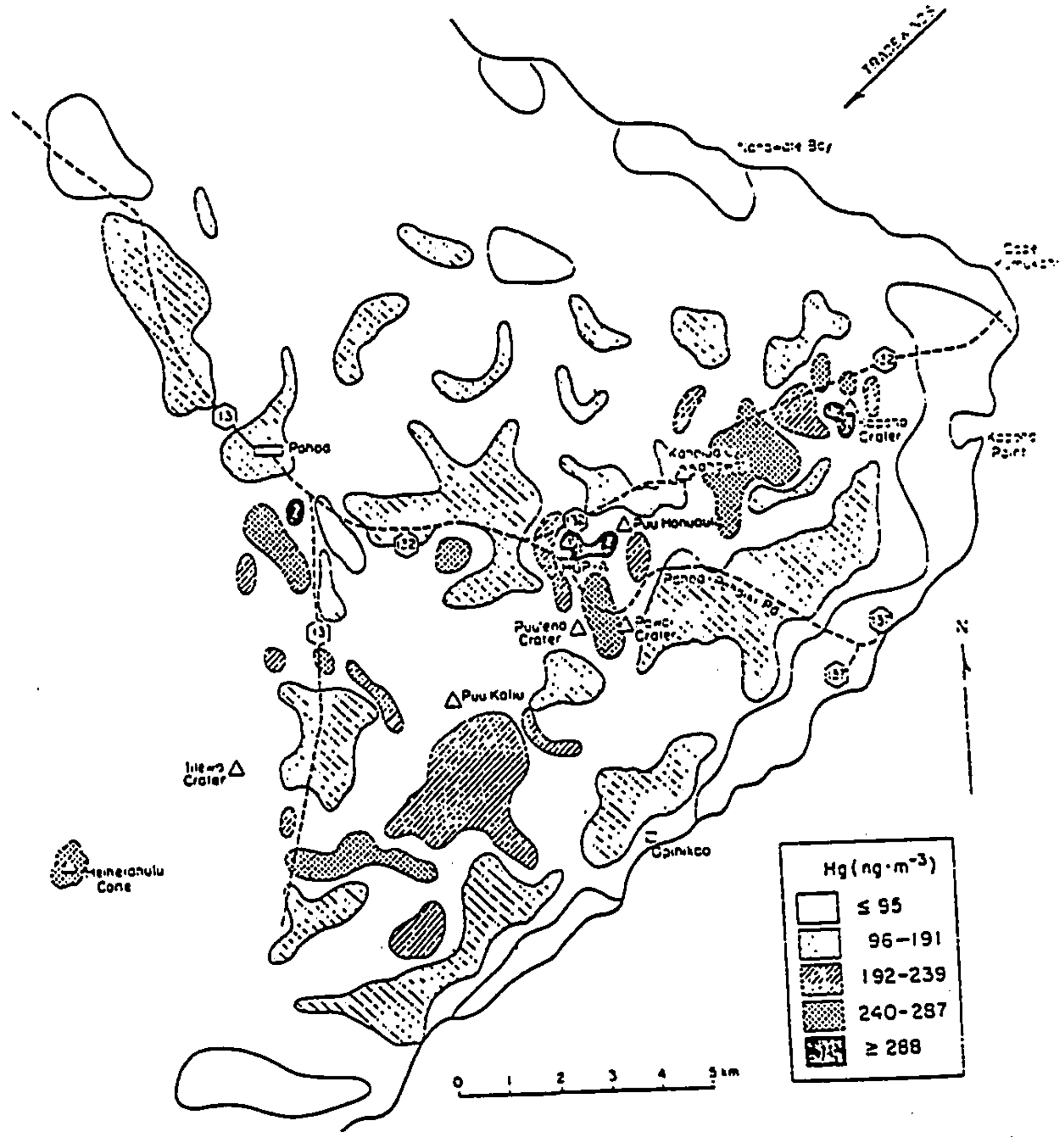
Table 15 lists the mean values for 56 total atmospheric mercury vapor samples collected at nine locations during the environmental baseline studies conducted on the Rift Zone between February, 1984 and March, 1985. Table 16 lists the results of elemental atmospheric mercury vapor samples collected along the Rift Zone.

It is noted that atmospheric mercury samples collected by different investigators may show different results due to temporal, spatial and analytical differences. Based on the surveys conducted, atmospheric mercury concentrations can be expected to be very low above the project area and dramatically below standard values (Houck, et al., 1985 and Houck and Pritchett, 1985).

- Radon Activity

Radon-222 is a radioactive gas naturally formed from the decay of radium contained in geological materials. Radon-222 has a 3.8 day half-life and decays via an energetic alpha particle. Two of its daughter products (Polonium-218 and Polonium-214) also have very short half-lives (3.0 minutes and $1.6 \times 10^{-4}$ seconds respectively), and also decay by energetic alpha particles. High Radon-222 concentrations are injurious to human health. High radon emission rates are associated with volcanic areas and fumaroles.

A total of fifty-seven passive radon monitors were located at sixteen different sites along the rift zone during the two and one-half years of baseline monitoring. Two sites had significantly higher average radon activities than the others: the Napau Crater Site and the Kahauale'a proposed drill site. The high mean listed in Table 17 for the Kahauale'a proposed drill site is due to a single very high value (3430 $pCi/m^3$) obtained when




**LEGEND:**
Figure based on 463 samples collected from 1977 through 1982. Figure and data from: Siegel, B.Z. and Siegel, S.M., 1984, Baseline Mercury Levels in the Puna District Hawaii County, report to the Hawaii Natural Energy Institute, 39 pp plus appendices.

**Source:** Houck, et. al.,1985

**Distribution of Total Atmospheric Mercury Vapor in East Puna**

FIGURE 19

Table 15

Mean Total Atmospheric Mercury Vapor - Kilauea East Rift*

| Study/Description | Site | Mean Value ($ng/m^3$) |
|---|---|---|
| Puna Forest Reserve | 1. Kaimu-Makena Homestead | 7 |
| | 2. Waikahekahe | 3 |
| Kahauale'a Baseline | 3. Fern Forest Subdivision | 3 |
| | 4. Mauna Loa Estates | 4 |
| | 5. Thurston Lava Tube | 3 |
| | 6. Volcano Golf Course (KMC) | 6 |
| | 7. Chain of Craters Road | 4 |
| | 8. Royal Gardens Subdivision | 4 |
| | 11. Kahauale'a Proposed Drill Site | 3 |
| Standards | | |
| American Industrial Hygiene Assoc., maximum recommendation for exposure, 8 hrs. per day, 5 days per week | | 10,000 |
| Occupational Safety and Health Administration, work place maximum level | | 100,000 |

* Data based on 56 samples collected between February, 1984, and March, 1985.

Table 16

Elemental Atmospheric Mercury Vapor - Kilauea East Rift*

| Study/Description | Site | Data Base | Concentration ($ng/m^3$) |
|---|---|---|---|
| DPED Baseline | | | |
| | Pahoa School | single sample | 23 |
| | Upper Leilani | single sample | 11 |
| | Black Sands Estates | single sample | 22 |
| | Cape Kumukahi | single sample | 4 |
| | Leilani Estates | mean of two samples | 8 |
| | Volcano Village | mean of two samples | 13 |
| | Hawaii Volcanoes National Park | mean of two samples | 30 |

* Data based on ten samples collected between January and December, 1983

Table 17

Average Radon-222 Activity - Kilauea East Rift

| Study/Description | Site | Monitoring Duration | Average Radon Exposure Rate ($pCi/m^3$) |
|---|---|---|---|
| Puna Forest Reserve | | | |
| | Kaimu-Makena Homestead | 1 month | 520 |
| | Waikahekahe | 1 month | 160 |
| | 1977 Lava Flow, Lower Site | 1 month | 210 |
| | 1977 Lava Flow, Middle Site | 1 month | 340 |
| | 1977 Lava Flow, Upper Site | 1 month | 300 |
| Kahauale'a Baseline | | | |
| | Fern Forest Subdivision | 1 year | 290 |
| | Mauna Loa Estates | 1 year | 520 |
| | Volcano Golf Course (KMC) | 1 year | 460 |
| | Thurston Lave Tube | 1 year | 430 |
| | Chain of Craters Road | 1 year | 510 |
| | Royal Gardens Subdivision | 1 year | 460 |
| | Kahauale'a Proposed Drill Site | 1 year | 1090 |
| DPED Baseline | | | |
| | Upper Leilani | 1 year | 410 |
| | Hawaii Volcanoes National Park Headquarters | 1 year | 370 |
| | Pahoa School | 1 year | 470 |
| | Black Sands Estates | 1 year | 420 |
| | Kane Nui O Hamo | 1 year | 450 |
| | Napau Crater | 1 year | 1140 |
| Standard | | | |
| | California Ambient Air Standard | | 3000 |

Table 17A

Radon-222 Standards and Activity Levels Characteristic of Other Locations[a]

| Location | | Range of Reported Values (pCi/1) |
|---|---|---|
| Illinois | (outdoor) | 0.05 - 1.0 |
| New York | (outdoor, city & state) | 0.015 - 0.5 |
| Ohio | (outdoor) | 0.07 - 1.04 |
| Florida | (outdoor) | 0.02 - 0.3 |
| California | (outdoor) | 0.0025 - 0.01 |
| Massachusetts | (indoor) | < 0.005 - 0.94 |
| Tennessee | (indoor) | 0.13 - 4.8 |
| Florida | (indoor) | 0.03 - 3.6 |
| New York | (indoor) | 0.06 - 0.39 |
| Above Oceans | | 0.01 |
| OSHA Uranium Mine Standard | | 66 |
| U.S. EPA Indoor Standard for houses around inactive uranium mill tailings | | 4 |
| California Ambient Air Standard | | 3 |
| Houses built on Florida Phosphate Mining Regions: | | |
| Level requiring remedial action | | 4 |
| Level requiring reduction to a reasonably feasible level | | 2 |
| Houses built on Canadian Uranium Mining Regions: | | |
| Prompt remedial action required | | 30 |
| Remedial action required | | 4 |
| Investigation recommended | | 2 |
| Sweden (maximum levels): | | |
| Existing buildings | | 11 |
| Houses undergoing remodeling | | 5 |
| New houses | | 2 |
| Union of Concerned Scientists: | | |
| Remedial action indicated | | > 5 |
| Remedial action suggested | | 2-5 |
| 1% risk increase of dying of lung cancer increment (lifetime exposure) | | 4 |

a. Data is from a collection of numerous studies compiled in: National Background Radiation, Report of Scientific Committee 43, National Council on Radiation Protection and Measurement, March, 1974, and, Indoor Air Pollution, 1983, Hileman, B., Environ. Sci. Technol., v. 17, n. 10, p. 469A.

(Source: Houck, et al. 1985)

Table 17B

Comparison of Radon-222 Activities Measured Outdoors on the Kilauea East Rift with Worldwide Indoor Radon-222 Activities[a]

| Location | Number of Measurements | Highest Reading (pCi/1) | Percent Greater Than 4 pCi/1[b] |
|---|---|---|---|
| Kilauea E. Rift (Baseline Studies) | 58 | 3.43 | 0 |
| N. California | 80 | 7.4 | 15 |
| Midwest | 64 | 7.4 | 20 |
| South | 304 | 2.7 | 0 |
| N. East | 133 | 77 | 20 |
| New York | 413 | 50 | 15 |
| Pennsylvania | 249 | 91 | 42 |
| Maine | 427 | 133 | 21 |
| Canada | 546 | 34 | 21 |
| Switzerland | 634 | 729 | 62 |
| Norway | 293 | 288 | 58 |
| Italy | 67 | 60 | 28 |
| Sweden | 47072 | 1140 | 81 |

a. Data is from: Indoor Air Quality Research: Current Status and Future Needs, Alter, H.W., 1983, Report prepared for: Subcommittee on Energy Development and Application and Subcommittee on Natural Resources, Agricultural Research and Environment of the Committee on Science and Technology of the U.S. House of Representatives.

b. U.S. EPA limit for houses is 4 pCi/1. 40 CFR Part 192 Fed. Reg. Vol. 48 No. 3., Jan. 5, 1983.

Conversion Factors for Atmospheric Radon Acitivity:

1 pCi/1 radon = 1000 $pCi/m^3$ radon

1000 $pCi/m^3$ radon = 1 $nCi/m^3$ radon

1 pCi/1 = 1 picoCurie of radiation/liter air

1 $pCi/m^3$ = 1 picoCurie of radiation/cubic meter air

1 $nCi/m^3$ = 1 nanoCurie of radiation/cubic meter air

(Source: Houck, et al. 1985.)

a monitor was placed over a fresh, still-hot lava flow to replace a monitor that was destroyed several weeks earlier by the flow. The routine higher values obtained at the Napau Crater site are understandable in light of the fact that the site is directly on the rift and consequently the Napau monitors were exposed to vigorous volcanic degassing.

The lowest radon activity (160 pCi/m$^3$) was measured at the Waikahekahe Site. This is consistent with the water-saturated soil observed at the site. The emanation rate of radon from water-saturated soil has been shown to be lower than that of drier soil since soil voids are filled with liquid rather than air under saturated conditions. Radon (a gas) diffuses faster through another gas than through a liquid.

The typical radon activities characteristic of the Kilauea East Rift Zone are between less than a tenth to approximately a sixth of the California standard of 3000 pCi/m$^3$ (Houck, et al., 1985).

The average radon activity levels ranged from 160 pCi/m$^3$ to 1140 pCi/m at the various monitoring locations on the Rift. If the Napau Site and the

Drill Site are excluded, the range of values is from 160 pCi/m to 520 pCi/m. The latter range is more representative than the former of the range of values to which the residents of the Rift area are exposed, since few people live for long periods directly over eruption sites or lava flows. As can be seen from Table 17A, the range in Radon-222 values along the Rift is more or less typical of mainland outdoor exposure values and is below standard levels. The Kilauea outdoor levels are also lower than values typical of many North American and European homes (Tables 17A and 17B). The build-up of indoor radon will not occur in typical Hawaiian homes, as it does in continental homes, due to the single-wall construction and high air exchange rates characteristic of most homes in Hawaii. The high build-up of radon in continental homes is principally due to low air exchange rates caused by intentional weatherization to conserve energy for heating and/or air conditioning, and due simply to keeping windows and doors closed during cold (or hot) weather. Most Hawaiian homes in the Puna and Ka'u districts also have crawl spaces because of moisture and insect problems. Separation of homes from the soil by a crawl space was shown to markedly decrease the indoor radon activity in homes built in Florida above phosphate mining regions.

The values within the project area appear to be representative of the rift zone in general. However, as with all other air pollutants, should an eruption site occur in the project area or should a lava flow enter the project area, the atmospheric radon levels would probably increase (Houck, et al., 1985).

- Other Pollutants

Three other air pollutants which merit discussion are: carbon monoxide (CO), nitrous oxides ($NO_x$), and chlorine gas ($Cl_2$). Even though CO and $NO_x$ are often major air contaminants in many airsheds, they were not considered as high priority pollutants for study on the Kilauea East Rift Zone. They are primarily associated with industrial combustion sources, not geothermal activities. Their current atmospheric concentration above the project area is unquestionably very low. Nitrate ($NO_3$) and nitrite ($NO_2$) concentrations were measured in selected particulate samples and in all rain water samples. Nitrite was below the analytical detection limits in all particulate and rain water samples. Nitrate, on the other hand, occurred at low, but measurable concentrations in the particulate and rain water samples.

Multi-day sampling was conducted for chlorine gas during the DPED and NPS baseline studies. Concentrations on the Rift are very low and well below industrial exposure standards.

b. Impacts and Mitigating Measures

Potential impact of primary concern are those related to emissions from project activities that could potentially cause a deterioration of ambient air quality in the area. The EIS contains data on geothermal project emissions (with emphasis on $H_2S$ under "worst-case" meteorological conditions.

Emissions for the proposed 100 MW geothermal project on the adjacent land area, the potential impacts of those emissions and mitigation measures in relation to the project scope and meteorology of the area are discussed below. Other short term impacts during construction are also discussed below.

All geothermal systems have $H_2S$ present to some degree, although the exact amount is quite variable. In general, the concentrations in the geothermal fluid vary from 10 parts per million (ppm) to over 5,000 ppm. $H_2S$ in the Hawaii geothermal system, as presently known from HGP-A data, appears to be comparable to other places in the world. The HGP-A fluid contains approximately 1,000 ppm of $H_2S$.

$H_2S$ can be emitted to the atmosphere during drilling, testing and production operations. During drilling, after the drill intersects a geothermal reservoir (usually during the last two weeks of drilling), the air discharge stream, along with the cuttings, through the blooie line may contain $H_2S$. The level is measured continuously to determine the amount (in lbs/hr) that is being emitted.

The potential air quality impact during initial well testing and start-up operations stems from the unabated discharge of the geothermal fluid. Hydrogen sulfide, carbon dioxide, hydrogen, nitrogen and other non-condensible gases that generally comprise less than one percent to no more than five percent of the geothermal steam phase, could be emitted to the atmosphere.

Emissions during production can be from such sources as: (1) noncondensible gas emissions from the wellhead gathering system; (2) noncondensible gas emissions from the condenser system; (3) cooling tower emissions; (4) atmospheric flash tank and (5) gaseous emissions from the cooling ponds prior to disposal or reinjection. (Note: See EIS for detailed description of geothermal well, pipeline and power plant components and systems).

Abated emissions, within prescribed standards, from project operations are not expected to impact water catchment systems that may exist in the project area.

To mitigate emissions during drilling, when the measured unabated $H_2S$ emission levels reach allowable limits, chemical abatement will be implemented using sodium hydroxide (NaOH) and hydrogen peroxide ($H_2O_2$). Sodium hydroxide has a high affinity for $H_2S$ and hydrogen peroxide reacts readily with the alkaline sulfide.

A NaOH treatment mole ratio of 4 to 1 ($NaOH/H_2S$) and a hydrogen peroxide ratio of 6 to 1 ($H_2O_2/H_2S$) will be used initially and the abatement efficiency monitored. The optimum mole ratio will be determined during abatement and adjusted

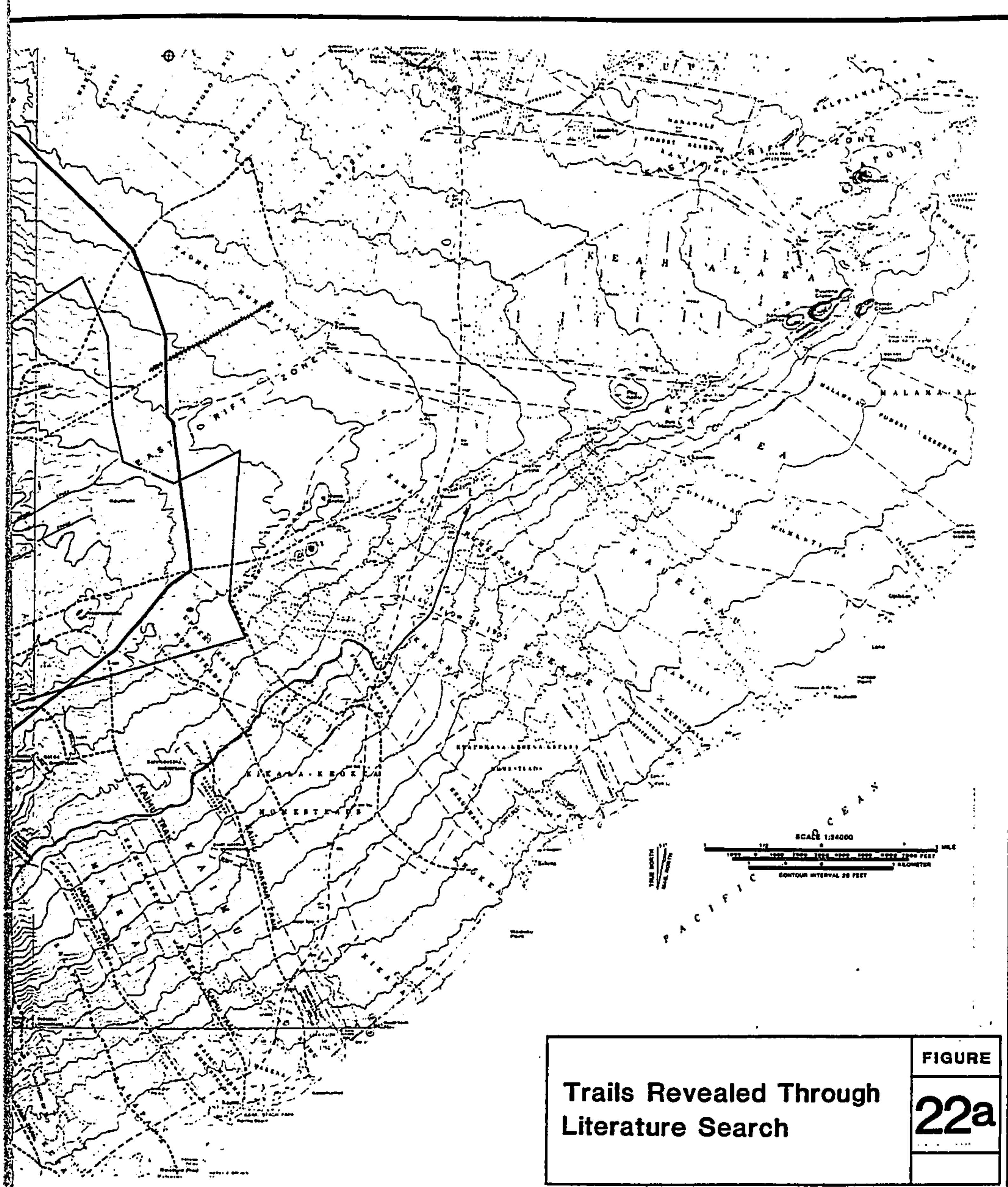
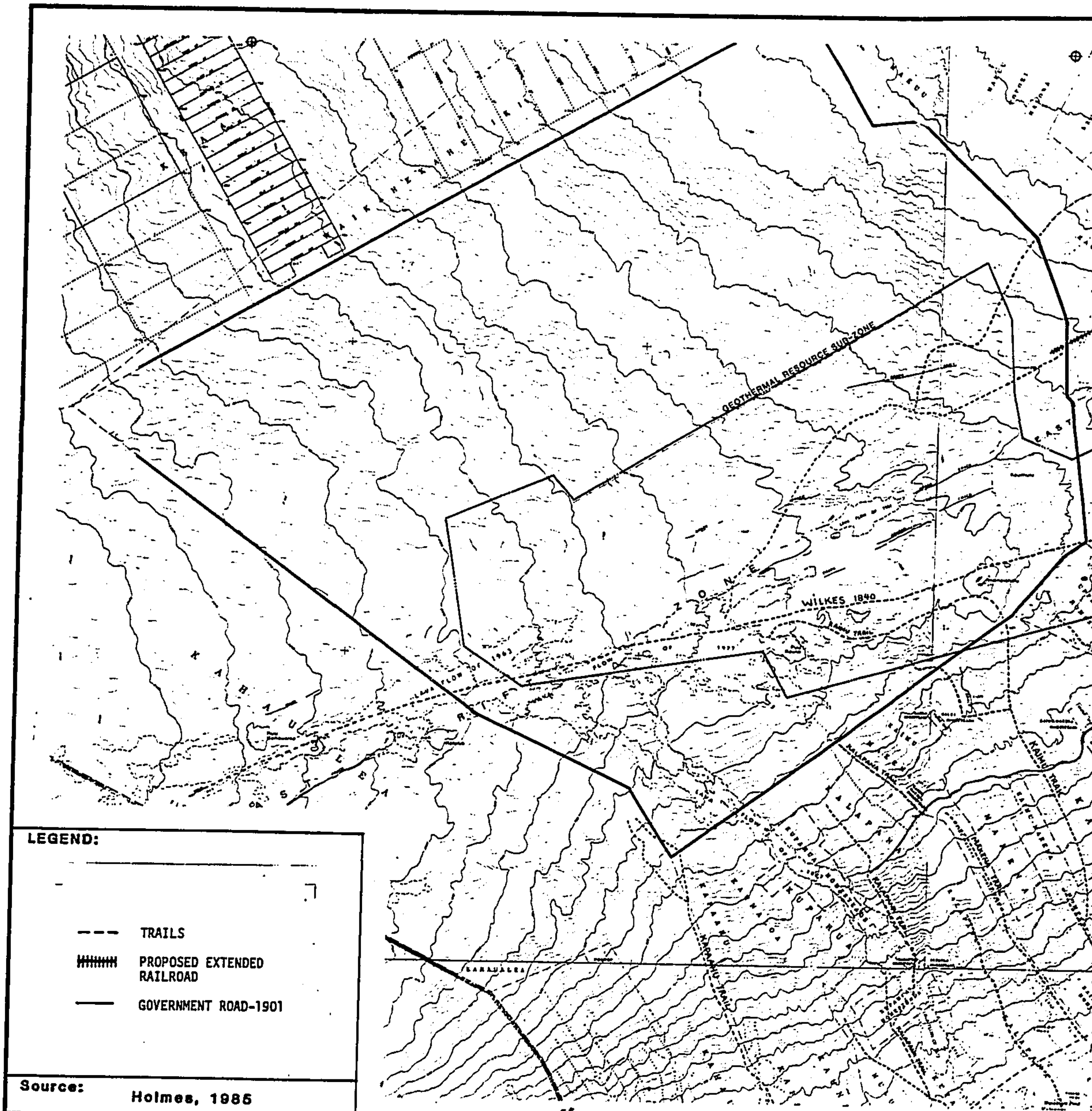
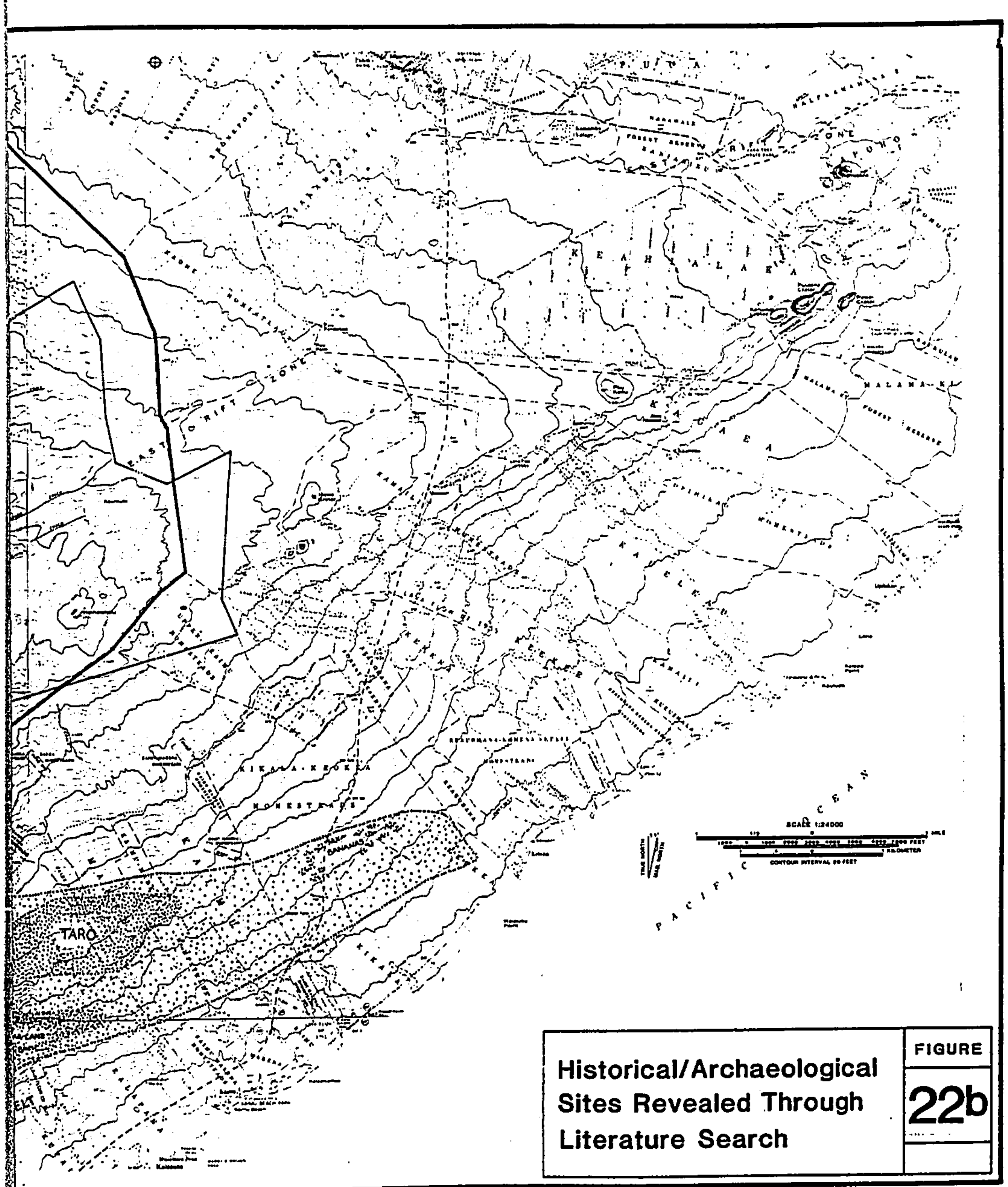



FIGURE 22a

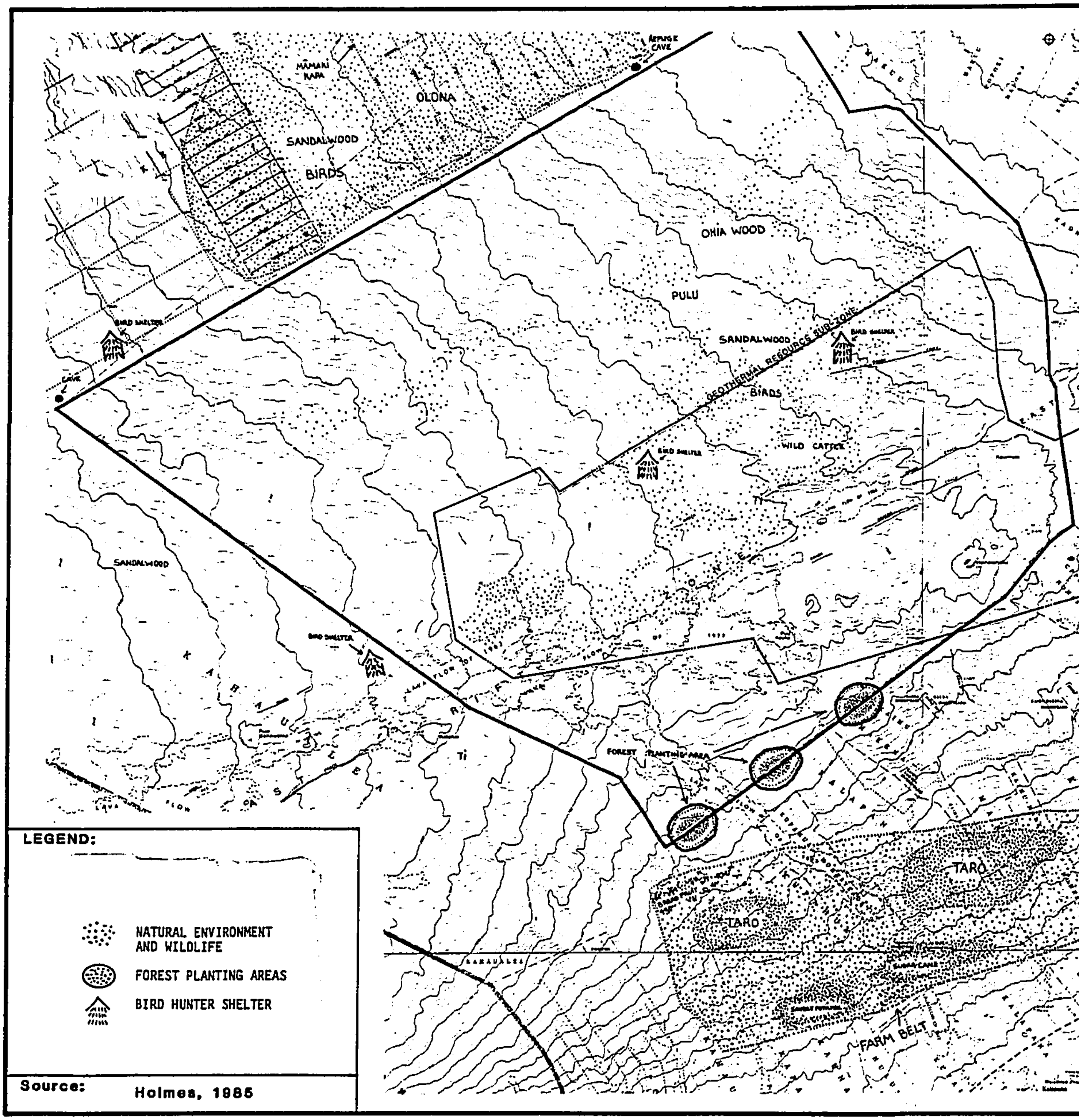
**Trails Revealed Through Literature Search**


GEOTHERMAL RESOURCE SUB-ZONE
WILKES 1840
ZONE
EAST
LEGEND:
TRAILS
PROPOSED EXTENDED RAILROAD
GOVERNMENT ROAD-1901
Source:
Holmes, 1985




Historical/Archaeological Sites Revealed Through Literature Search

FIGURE 22b



REFUGE CAVE
MAMAKI KAPA
OLONA
SANDALWOOD
BIRDS
OHIA WOOD
PULU
SANDALWOOD
BIRD SHELTER
GEOTHERMAL RESOURCE SUB-ZONE
BIRDS
BIRD SHELTER
WILD CATTLE
CAVE
BIRD SHELTER
SANDALWOOD
BIRD SHELTER
Ti
FOREST PLANTING AREA
TARO
TARO
SUGARCANE
FARM BELT
LEGEND:
NATURAL ENVIRONMENT AND WILDLIFE
FOREST PLANTING AREAS
BIRD HUNTER SHELTER
Source: Holmes, 1985

if necessary. In all cases, all applicable air quality standards will be maintained.

The developer is responsible for the monitoring of the well during operations although the monitoring itself may be delegated to an experienced, qualified consultant firm. Continuous recording of the $H_2S$ concentration in the blooie line by use of a lead acetate tape instrument and a recorder will alert personnel of $H_2S$ concentrations to enable the necessary $H_2S$ mass emissions rate calculations and to activate and operate the NaOH and $H_2O_2$ injection system on verification that the $H_2S$ emission rate is exceeding prescribed limits.

DLNR and or Department of Health (DOH) officials will be free to inspect the operation of $H_2S$ monitoring equipment and review the continuous recording of $H_2S$ concentration and abatement procedures. Abatement will be reflected in the reduction of the recorded ppm $H_2S$ at the muffler or sparging box.

Following completion of the well and initial flashing (venting), well testing usually begins. The initial flow (venting) of about 4 hours duration is essential to acquire preliminary data on the well and chemical composition of the fluid and to clear rock fragments and other detritus from the reservoir. This venting is accomplished without benefit of abatement systems. $H_2S$ emissions may be detectable during free flow (venting) periods. Based on analyses conducted at the HGP-A plant, it does not appear that unabated testing operations will have any long-term impacts on the flora, fauna or humans in the vicinity of the project area. Following initial free flow (venting) of the well, well testing will be performed with appropriate air quality abatement systems in place, thereby mitigating potential adverse air quality impacts.

During well and gathering system operations, $H_2S$ emissions will be mitigated by a proper maintenance program associated with good business and plant management practices. Emissions from condenser system non-condensible gas and cooling towers will be mitigated through the use of the Stretford, iron catalyst, burner-scrubber, or new processes now being tested or developed, i.e., the best available control technology (BACT). The process to be utilized will be selected following analyses of the geothermal fluid in the reservoir.

As noted previously, in all instances, State air quality standards will be maintained.

Mitigation of $H_2S$ emissions from cooling ponds is accomplished by maintaining the ponds at a neutral or mildly alkaline pH (8.9).

The atmospheric dispersion model in the EIS for Kahauale'a (Appendix E) provided an initial basis for calculating potential concentration levels of hydrogen sufide ($H_2S$) at various distances from the proposed locations of sources of emissions (e.g., a power plant) under a "worst case" atmospheric condition. The dispersion model can in turn be used to determine the level of abatement at the source that is required under the most unfavorable meteorological conditions to assure that the State's ambient air quality standard for $H_2S$ will not be exceeded at the property boundary.

Information on the meteorological conditions in the EIS project area (Kahauale'a) were derived initially from short term measurements near the project site and from general weather data extrapolated to apply to the project area (See Figure 8). Power plants planned for the Kahauale'a project (25 MW and 110 MW of capacity) were used in the model to project the maximum and minimum emission levels of $H_2S$, using available abatement control procedures, that could occur at the power plant and still enable meeting the air quality standard at the nearest property boundary receptors under "worst case" conditions -- 1 mile for a 25 MW plant and 2.5 miles for a 100 MW plant.

An air diffusion model has also been prepared for this SUP EIS to calculate the potential concentrations of $H_2S$ at various distances down-wind from a 55 MW power plant under two categories of meteorological conditions: 1) with a mean wind direction prevailing throughout the period; 2) with stagnating air for several hours without a distinct mean wind direction.

The first category comprises simple advection situations which were modelled using an EPA (NOAA 1983) recommended model:

```
C = E exp(-H*H/sigz(x)/2)
  / (2*pi*sigz(x)*sigy(x)*U)
```

Where sigz(x) is the spread in the vertical plane and sigy(x) that in the horizontal crosswind plane. pi is 3.14 and H is the effective stack height.

For the second category a non-EPA model was used as no appropriate model for this situation was readily available from the EPA. This model is a puff model variant of the continuous source model used for the first category:

$$C = E \cdot \exp(-((H/sigz(t))^2 + (dx/sigx(t))^2)/2)/(2 \cdot PI)^{1.5} / ( sigx(t) \cdot sigy(t) \cdot sigz(t) )$$

Calculations were made for a 55 MW plant emitting 150 gr/MW/hr or 2.3 gr/sec of hydrogen sulfide during operations and 3.1 gr/sec during stacking. Other plan characteristics used are taken from a Dames and Moore report to the EPA (1984) except for the cooling tower exit velocity temperature where a more conservative value recommended by D. Thomas (1985) was used.

Table 18 gives the highest concentrations found at the different distances used with the corresponding stability class, wind speed and effective stack height for the two types of emissions.

TABLE 18

Maximum Calculated Concentrations of Hydrogen Sulfide from a 55 MW Plant for Five Downwind Distances

| Distance mile | Stability class | Wind Speed mps | Eff. Stack height, m | Concentration ppb |
|---|---|---|---|---|
| Power Production | | | | |
| 0.5 | Neutral | 20 | 37 | 4.2 |
| 1.0 | Neutral | 10 | 58 | 3.0 |
| 1.5 | Neutral | 10 | 58 | 2.4 |
| 2.0 | Neutral | 10 | 58 | 1.8 |
| 2.5 | Stable | 3 | 94 | 2.0 |
| Stacking | | | | |
| 0.5 | Neutral | 20 | 33 | 4.0 |
| 1.0 | Neutral | 15 | 41 | 2.5 |
| 1.5 | Neutral | 10 | 56 | 1.9 |
| 2.0 | Stable | 5 | 79 | 1.4 |
| 2.5 | Stable | 3 | 92 | 1.6 |

The above calculations depend critically on the estimated plume rise calculated from Brigg's expressions (NOAA, 1983) which have been empirically established, widely used and generally accepted.

It can be concluded that for a 55 MW plant, downwind concentrations will not exceed 5 ppb beyond the property boundary during power plant operations or stacking when a discrete mean wind direction prevails.

The best available long term wind station to represent the area during stagnant wind conditions is the HGP-A site. As local wind conditions can vary significantly during stagnation periods, wind data from two sites nearest the project area, sites 20 and 21 (Figure 8) were used. In these data one period at site 20 and four at site 21 were identified when little or no wind prevailed for four to eight hours during night time periods.

Figure 20 shows a time plot of wind directions when data from sites 20 and 21 could be compared with data on one occasion from the HGP-A site.

The direction patterns in these plots reveal the feature that caused the stagnation - the night-time front that forms between the westerly drainage winds and the easterly trades.

The drainage winds are generally strong enough to push the front considerably east of the area except during strong trades. Based on an analysis of open ocean winds from weather charts (U.S. Navy, 1958), it was estimated that these conditions occur on an average six days per year.

The condition at site 21 (March 9-10, 1985) was considered to be the worst scenario on which to base the air quality calculations for stagnation conditions for this period.

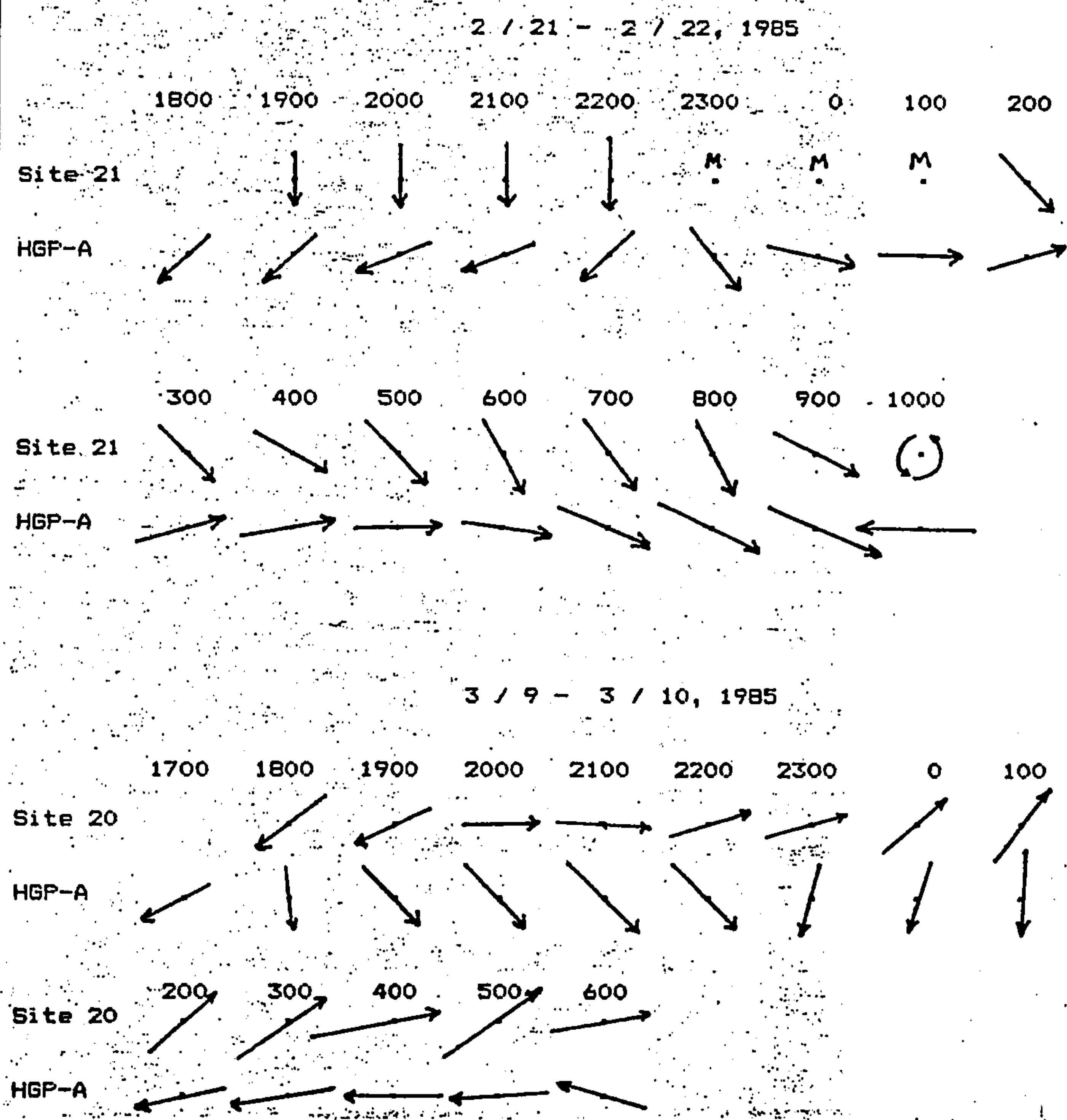
With cold drainage flow submerging the site, stability condition class E (stable) in the Pasquill-Gifford classification (Pasquill, 1974) was used. Though there is a more stable class, F, the plume rise is considerably higher for this class than class E. Therefore in order to be more conservative, class E, which gives higher concentrations was used.

As in the previous analyses for non-stagnant conditions, the commonly accepted Gaussian diffusion model was used.

Pollutants ($H_2S$) from the plant under stagnation conditions can be approximated by a series of smoke puffs which can be modelled using the Gaussian puff model.

The Gaussian puff model estimates the ground level concentration in gr/cum at time t seconds from a source emitting an amount E grams at time zero at a height H m at a distance x m from the receptor as in the above formula.

Estimated concentrations of $H_2S$ under stagnation conditions are shown in Table 19.




**LEGEND:**

**Source:**
**Daniels & Schroeder, 1985**

**Wind Vectors for Two Adverse Wind Conditions at Meteorological Sites 20, 21 and HGP-A**

**FIGURE**

**20**

TABLE 19

Estimated Concentrations of Hydrogen Sulfide
Downwind of a 55 MW Plant Emitting 150 gr/MWhr
Caused by a Build Up During Stagnation Periods

| Downwind distance miles | Duration of stagnation hours | Wind Speed during stagn.,mps* | Concentration ppb |
|---|---|---|---|
| 1 | 4 | 3 | 8.4 |
| 2 | 4 | 3 | 8.3 |
| 3 | 4 | 2 | 7.6 |
| 4 | 4 | 2 | 6.7 |
| 5 | 4 | 2 | 5.7 |
| 6 | 4 | 2 | 4.8 |
| 1 | 8 | 2 | 10.6 |
| 2 | 8 | 2 | 10.6 |
| 3 | 8 | 2 | 9.8 |
| 4 | 8 | 1 | 8.7 |
| 5 | 8 | 1 | 8.0 |
| 6 | 8 | 1 | 7.1 |

*Effective Stack Heights: 148 m for 1 mps; 121 m for 2 mps; 108 m for 3 mps.

To the number in this table must be added the concentrations originating during the period of a distinct mean wind which prevailed when above puff concentrations would have been monitored.

From these data, it can be concluded that concentrations above 15 ppb would not occur even during stagnant conditions from a 55 MW power plant located one mile or more from the property line either during power plant operation or stacking.

It can also be concluded that at least up to 110 MW of geothermal power can be produced in the proposed area without violating the proposed state hydrogen sulfide standard of 30 ppb above background.

It should be noted that this air diffusion model takes a conservative approach in selecting the data used for calculations.

The reviewer should also be aware that following a geothermal resource discovery, and the decision to develop the resource, the developer must submit an application for a permit for "authority to construct" a power plant (see Section VI). The application must be supported by additional air diffusion modeling based on (1) measured meteorological conditions within the project site for a period of 4 to 12 months, (2) the site specific location and size of a power plant, and (3) the levels of concentration of the chemical components of the resource. The diffusion calculations and the design efficiency of the $H_2S$ abatement system proposed for the power plant must demonstrate that the required level of abatement to preclude exceeding State ambient air quality standards can be achieved under the "worst case" conditions as derived from the external meteorological collection effort in the project area.

Short-term impacts due to vehicle and machinery emissions will be mitigated through maintenance of emission control devices and general maintenance of the vehicles and machinery (such as well drilling equipment). Short-term impacts due to emissions from constrtuction activities will be controlled by water spraying of roadways and construction sites as required. Short-term impacts of well venting when required are expected to have minimal impact due to the limited time in which the emissions would occur and the lack of toxicity in the quantity of emissions to be released. During long-term well testing operations, the fluids will be directed through appropriate abatement systems.

Long-term impacts will be minimized through the use of proper well casing and cementing procedures and the use of appropriate abatement systems during drilling and on all power plant equipment and operations. It is noted that oil and coal-fired power plants generally produce and emit more air pollutants (sulfur and nitrogen oxides) than geothermal power plants (DOE 1980). In addition, all operations will be designed to meet all applicable State and/or county air quality standards.

It is noted that the results of a recently completed study of the Rotorua area of New Zealand (Siegel, 1985), indicate that natural concentrations of atmospheric $H_2S$ and $SO_2$ significantly above levels found in Puna District and the level proposed as the ambient $H_2S$ level for the State do not appear to have any adverse short- or long-term impacts on the health and welfare of the resident or tourist population of Rotorua and/or the wildlife inhabiting a wildlife refuge and the environs of Sulfur Bay on Lake Rotorua. The following summary and conclusions are taken from the Siegel (1985) report:

> "Approximately 46,000 people live in the Rotorua Urban Area, about one-quarter of Polynesian ancestry. The city has now existed for more than 125 years, but the area's Maori history extends back to the 14th century A.D. The mild climate, recreational facilities, thermal sites and generally pleasant and comfortable lifestyle attract about 500,000 tourists annually.
>
> Tourism is a major industry, although agriculture and sheep ranching are economically important.
>
> In addition to the rural countryside and forested hills surrounding the city, Lake Rotorua itself is scenic and popular for boating, fishing and nearby camping.

Sulphur Bay at the most southerly end of the Lake is a recognized wildlife refuge area which includes nesting (breeding) populations still on the increase in numbers.

In many respects, Rotorua as a place for people and a congenial place of relatively low density with a keen appreciation for natural beauty and conservation is quite reminiscent of Hawaii -- especially the Big Island.

And like the Big Island, Rotorua lies in a geothermally active area. In the city _per se_ the highest geothermal technology is direct heat usage for homes, hotels, businesses, schools, hospitals and of course, motels. Every tourist establishment has its advertised spas, saunas or thermal pools, hot and smelly. Bore hole emissions are not abated -- and there are hundreds of them. Nevertheless, the greatest sources of hydrogen sulfide are the natural vents, fissures and fumaroles.

Rotorua always smells of $H_2S$.

It was this considerable set of parallels, even overlaps that prompted the comparison of Rotorua and the Puna District geothermal energy development zone in the hope and conviction that the expressed concerns of residents there about geothermal air pollution especially $H_2S$ hazards could be answered by New Zealand experience.

Within the kilometer downwind of HGP-A, along Leilani Drive, the $H_2S$ level has rarely reached 10 ppb, with an average of less than 5 ppb, the most realistic odor threshold for the more sensitive individuals.

Our survey of atmospheric $H_2S$ in Rotorua over the period of May 1984 - July 1985 has revealed a number of areas that always have $H_2S$ above the 10 ppb level. In the 21 sq. km. surveyed, the Western reaches of the city fell below 5 ppb, but nearly half the city lakeward exceeded 10 ppb at every visit;

about 30% of the survey area fell between 30 and 300 ppb; and 15-20%, exceeded 300 ppb. These figures, based on daylight sampling are not corrected for diurnal variation and must not be considered peak values. Some public locations heavily used in downtown Rotorua exceeded 2000 ppb constantly.

In all, of 24 residential areas including Maori centers, 67% experienced $H_2S$, about 40% being above 30 ppb.

Of school/playground and hospital sites, 21 locations in all, 14 experienced continuous $H_2S$ exposure, 50% being above 30 ppb.

Overall, the 'norm' for Rotorua lies above 100 ppb for more than 50% of the time, and possibly well above that time-concentration range if diurnal corrections could be made.

Thus the Rortorua Urban Area runs over 30-fold higher $H_2S$ levels than the Puna Area closest to HGP-A. But Rotorua has many "hot spots" that in our repeated experience always run 100-1000 times higher than the HGP-A average, and these areas cannot be simply worked into an average and forgotten otherwise.

By local standards in Lower Puna, and all other areas of Hawaii at some distance from the active zone in Hawaii Volcanoes National Park, the Rotorua exposure is strong to severe.

What is the health picture for their community with residents of Anglo-European and Polynesian ancestry over every generation? In seeking answers the picture of the Maori as a disadvantaged minority with a history of high mortality from respiratory disease, asthma, lung cancer and other ailments was kept in mind.

'Early Years,' including neonatal, post-natal and age 1-4; congenital birth defects; tuberculosis, lung cancer, bronchial disorders, pneumonia; and other diseases not involving the pulmonary region, were evaluated using data from the New Zealand Health Statistics Center. Male and female, Maori and non-Maori and age-specific factors were noted. Most useful was the comparison of Rotorua Urban Area with other New Zealand communities (13 or 22) all non-geothermal. Here Standardized Mortality Ratios (SMR's) were used. These are age-adjusted ruling out (an important source of) local community differences.

The result of these data searches evaluations and comparisons is simple and we believe, uncomplicated: There is no disease correlation or birth correlation in the Rotorua Urban Area that cannot be found in equal or higher incidence in at least 2 other communities which have no geothermal activity and no detectable $H_2S$. Further, there are many examples, both in respiratory and degenerative disease areas for males, females, Maori and non-Maori that point to Rotorua as one of New Zealand's healthy communities.

We conclude that the average level of ambient $H_2S$ in and around HGP-A could easily be increased 30-fold (and perhaps more) at current abatement state of the art without any hazard to human health.*

*Any other data appended suggests that the native (and cultivated) plants and indigenous bird populations are also "safe" at levels far above HGP-A."

Further, the results of a health survey conducted by the State DOH in the Puna District (DOH, 1984), indicate that the incidence of health problems associated with volcanically induced or produced emissions is no greater in Puna District than other areas of the State.

5. Noise Quality

a. Existing Conditions

Ambient noise levels in the project area are typical of rural, forested areas with daytime noise levels in the 30 to 40 dBA range and nighttime levels about 5 to 10 dBA less. It is expected that as the subdivisions around the project area are built-up, ambient noise levels and single event occurrences will increase. In general, man's own activities as well as naturally occurring noise due to foliage movement in a given location, will mask outside, distant low-level noise sources.

The residual ambient noise level in very rural areas distant from the surf is usually determined by wind in the foliage, birds and insects during periods of time between motor vehicular and aircraft events occurring within several miles. As noted above, observations in the Puna area indicate that during the daytime, distant transportation noise and distant construction projects often control the residual noise levels in a range of 30 to 40 dBA, but the listener is usually not conscious of the noise sources due to his own movements and activities readily masking such low level noise. However, at night when persons are trying to sleep, the sounds of an individual vehicle movement within several miles of a residence in a remote rural area may be detectable. At night, the outdoor residual levels may range from 25 to 35 dBA while interior noise levels in naturally ventilated Hawaiian housing would be 5 to 10 dBA less when there are no inside noise sources, e.g., when the refrigerator is not running. From the above discussion and Table 20, it can be seen that in rural areas, ambient noise levels would be subjectively judged to range from "Very Quiet" to "Quiet".

It is to be noted that large homestead tracts in the vicinity of the project area, which now have relatively few homes, but are gradually developing, will have ambient noise levels which are continuously increasing as a function of the density of population. The building of new homes involving site preparation with bulldozers, construction noises, the transportation of supplies, etc., readily cause daytime ambient levels to increase significantly. After the new homes are occupied, each unit usually generates numerous trips with vehicles and use of lawnmowers, power tools, TV, radios, home generators, etc., which all tend to "fill-in" the quiet periods that may have existed before. Thus, the ambient noise in such communities tends to rise from the "Very Quiet", through the "Quiet" condition to the "Normal" condition as the community grows.

In areas such as the Kaohe Homesteads where there currently is no electricity, the increase in ambient noise level due to population increase would probably increase at a slower rate. However, this area is zoned agricultural and increased agricultural activity such as that which existed prior to the closing of Puna Sugar Company, will increase the ambient noise level. Residents of Kaohe have been subjected in the past to the increased noise due to sugar cane planting and harvesting within the agriculturally zoned Kaohe Homesteads.

The noise level measurable from a source depends on the strength of the source and the sound propagation loss or attentuation, that occurs in the sound transmission path between the source and the listener. In the Puna area on Hawaii, it has been found that the sound transmission path can be variable and a major factor in controlling the propagation of geothermal activity noises. The following excerpt from the Geothermal Noise Level Guidelines of the Hawaii County Planning Department describes these propagation considerations:

TABLE 20

## Sound Levels and Human Response

| Common Sounds | Noise Level (dB) | Effect |
|---|---|---|
| Air raid siren | 140 | Painfully loud |
| Jet takeoff (200 ft)<br>Auto horn (3 ft)<br>Discotheque | 120 | Requires maximum vocal effort |
| Alarm clock (2 ft)<br>Hair dryer | 80 | Annoying |
| Freeway traffic<br>Man's voice (3 ft) | 70 | Telephone use difficult |
| Air conditioning (20 ft) | 60 | Intrusive |
| Light auto traffic (100 ft) | 50 | Quiet |
| Living room<br>Bedroom | 40 | |
| Library<br>Soft whisper (30 ft) | 30 | Very quiet |

This decibel (dB) table compares some common sounds and shows how they rank in potential harm to hearing. Note that 70 dB is the point at which noise begins to harm hearing. To the ear, each 10 dB increase seems twice as loud. (Source: U.S. Environmental Protection Agency)

"As sound waves move through the atmosphere, the energy of the waves are weakened (attenuated) as the distance from the source increases. The factors affecting the amount or level of attenuation include the distance traveled, the frequency of the sound waves, the relative humidity, temperature and wind velocity.

In general, there are three distinct conditions or combinations of factors which affect the rate of attenuation of sound...

Condition 1 - Cylindrical spreading based on 3 dB loss per doubling of distance which is the worst case theoretically. This condition exists when compound sound velocity gradients in the atmosphere cause the ducting of sound...

Condition 2 - Spherical spreading based on 6 dB loss per doubling of distance plus excess attentuation for propagation through air only. This condition exists when sound velocity gradients exist to "bend" sound rays over trees and other obstacles.

Condition 3 - Spherical spreading based on 6 dB loss per doubling of distance plus excess attenuation for propagation through air (Condition 2), plus ground attenuation due to the absorption and scattering caused by trees and other foliage."

The following additional findings are reported in the guidelines:

"(1) The propagation loss may vary by 15 to 20 dB during a 24-hour period for a given distance between source and listener..., indicating the generation and disappearance of sound velocity gradients which bend sound rays over trees and other foliage (Conditions Nos. 1 and 2).

(2) Usually propagation loss was not less than Condition 2, but there are strong indications implying that energy in the lower frequencies...do experience a compound sound velocity gradient at times (Condition No. 1).

(3) For estimating noise levels in residential areas, a reasonable average value for sound propagation loss is to use Condition No. 2 as a worst case understanding that when there are compound sound velocity gradients, noise levels in the low frequencies may be 5 to 10 dB greater."

It is to be realized that accurate estimates of noise levels using sound propagation Condition No. 3 from the Guidelines depends on accounting for attenuation from topographical features and flora in the sound path. It can be shown that sound traveling through about 850 feet or more of 'ohi'a forest will cause excess attenuation of 20 dB if no refractive phenomena are in effect (Edison Electric Institute, 1978). However, in the noise level estimates given below, a generally conservative case of the sound level attenuating 8 dBA for every doubling of the distance is used for Condition No. 3.

Experience has shown that when strong winds exist, the probability of sound effectively refracting over trees and topography as in propagation Condition No. 2 is very low. (Note: See discussion in Paragraph B for information regarding the wind climatology of the Puna Forest Reserve and project area.) This phenomenon is due to the high degree of turbulence in the boundary layer tending to more randomly scatter the sound energy as opposed to the fairly well defined, and relatively stable wind gradient pattern associated with light to moderate winds (Sutherland, 1968). Thus, for strong wind situations, 8 dB per double distance propagation loss (as for Condition No. 3) is assumed for receptors that are downwind of the source.

Table 21 shows a summary of wind conditions obtained in the Puna area as related to the downwind sound propagation conditions. It can be seen that Condition No. 2 is the prevalent downwind sound propagation situation occurring during the daytime about 69 percent of the time and 81 percent during nighttime.

TABLE 21

Frequency (%) Distribution of Winds

Assumed Near Puna Forest Reserve Area 1/

| | | Cond. 1 | Cond. 2 | Cond. 3 | |
|---|---|---|---|---|---|
| | | | Speed (mph) | | |
| Type Wind | Direction | <1 to 2 | 2 to 9 | 10 to >15 | Total |
| NIGHT TIME (8 p.m. - 8 a.m.) | | | | | |
| Trades and Northerlies | NW to N | 6.0 | 35.8 | 1.8 | 43.6 |
| | NNE to ENE | 2.1 | 16.3 | 2.3 | 20.7 |
| Southerlies | ESE to SW | 1.1 | 6.0 | 0.4 | 7.5 |
| Westerlies | WSW to WNW | 4.6 | 23.0 | 0.2 | 27.8 |
| TOTAL | | 13.8 | 81.1 | 4.7 | 99.6 |

TABLE 21 (Continued)

| | | | | | |
|---|---|---|---|---|---|
| DAYTIME (8 a.m. - 8 p.m.) | | | | | |
| Trades and Northerlies | NW to N | 1.3 | 10.0 | 1.6 | 12.9 |
| | NNE to ENE | 2.5 | 47.3 | 21.5 | 71.3 |
| Southerlies | ESE to SW | 1.2 | 9.5 | 2.9 | 13.6 |
| Westerlies | WSW to WNW | 0.4 | 2.0 | 0.1 | 2.5 |
| TOTAL | | 5.4 | 68.8 | 26.1 | 100.3 |

1/ Source: Hariguchi, 1985.

b. Impacts and Mitigating Measures

Short-term noise impacts will be caused by drilling and construction activities. Construction activities, such as road and power plant construction will be limited to daytime periods and will only occur for relatively short periods of time. Well drilling, testing and operations will be performed on a 24-hour basis using modern diesel-driven equipment.

Typically, this equipment, unabated, can generate noise levels of 85 to 95 dBA at 100 feet. Power plant operations will also be conducted 24-hours per day and also can generate unabated noise levels at 100 feet in the 85 dBA range.

Short-term construction noise impacts will be mitigated through the use of proper mufflers on all equipment and limiting construction operations to day time periods. Short-term well drilling and testing impacts will be mitigated through the use of "hospital type" engine exhaust silencers and the use of full or partial acoustical enclosures around selected diesel-powered equipment. The use of these measures has been shown to reduce noise levels to around 82 dBA at 100 feet (Environmental Impact Report, 1977). If necessary, the initial abatement procedures used can be *increased by degrees, as determined to be cost effec*tive through the use of thicker or larger baffels if further abatement procedures to reduce noise levels are required.

Although free venting of the wells into the atmosphere will be required, it will only be done for a limited number of hours during the day time and only if favorable weather conditions exist.

Estimated decibel (dBA) noise levels from geothermal operations are shown in Table 21A. Power plant and other facility noise sources will be effectively controlled through appropriate acoustical design measures. Potential long-term noise impacts will be controlled through the requirement that all operations meet county noise guideline regulations.

6. Geologic Setting/Hazards

a. Existing Conditions

As noted previously, the project area is located in the seismically and volcanically active Kilauea east rift zone. As such, there are potential hazards due to lava flows, explosive eruptions, ground cracking and earthquakes. Any geothermal development activity along the entire length of this rift zone is subject to these potential hazards. However, it appears, based on hazard analyses (Walker, 1985; EIS; Niimi, 1985; and DLNR, 1984a and 1985) that the geologic hazards are not sufficiently severe as to question the feasibility or desirability of drilling and developing the geothermal resources that exist because of the presence of an active volcano. Nearly 50% of the land within the east rift zone has been overlain with historic lava flows at least once (Figure 21). Based on historic records there is roughly a 0.5 probability that any given area within the rift zone will experience lava flows at least once in a century.

Table 21A

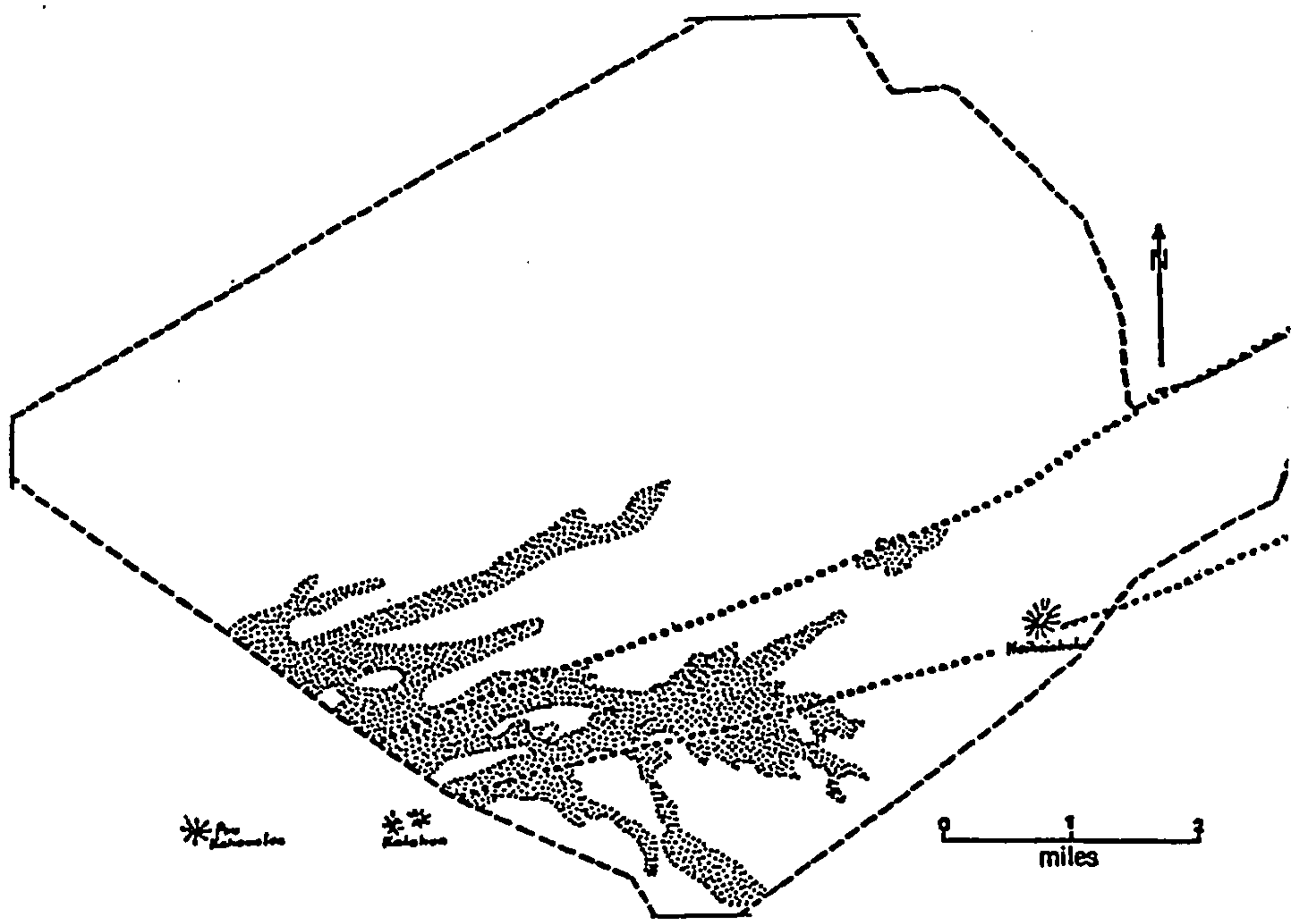
ESTIMATED DECIBEL (dBA) NOISE LEVELS FROM GEOTHERMAL OPERATIONS

| SOURCE | SOUND PROPAGATION CONDITION | DISTANCE 100 FEET | 1/2 MILE | 1 MILE |
|---|---|---|---|---|
| Drill Rig | 4 | | Inaudible | Inaudible |
| | 3 | | 44 | 36 |
| | 2 | 82 | 50 | 42 |
| | 1 | | 53-55 | 47-50 |
| Power Plant | 4 | | Inaudible | Inaudible |
| | 3 | | 34 | 26 |
| | 2 | 72 | 40 | 32 |
| | 1 | | 43-45 | 37-40 |
| Free Venting of Well | 4 | | 38 | Inaudible |
| | 3 | 122 | 74 | 64 |
| | 2 | | 84 | 76 |
| | 1 | | ---* | ---* |

NOTES: Sound Propagation Condition No. 4 - Receptor is upwind of noise source. Conditions No. 1 through 3 - Receptor is downwind of source. Condition No. 3 - Winds greater than 10 mph or some attenuation from trees. Condition No. 2 - No attenuation from topography or trees. Condition No. 1 - Same as No. 2, but on occasion unstable focusing may occur in some locations causing fluctuating noise levels.

* Free Venting of well will not occur during Condition No. 1, e.g. when wind is less than 2 mph and thermal inversions exist.
* Levels from venting through a rock muffler will be between those for Drill Rig and Power Plant.

(Source: Darby & Assoc., 1986)




LEGEND:

active rift zone

post-1955 lava flows

Source: Walker, 1985

Sketch Map of Project Area Showing Location of Active Rift Zone and Extent of Recent Lava Flows

FIGURE 21

b. Impacts and Mitigating Measures

The greatest geologic hazard in the rift zone area stems from lava flows that could surround, over-run, entomb, isolate, bulldoze or batter down buildings, distort metal structures, cause fires or cause the generation and explosive release of steam from stored water.

Volcanic eruptions consisting of fire-fountaining have, during the past 30 years, built up about eight appreciably-sized cinder cones/spatter cones along the 32-mile long east rift zone. Using historic data from 1790, there is a rough probability that one of these cones could form anywhere in the rift zone every 25 years. Fire-fountaining, in addition to creating cinder/spatter cones, spreads a thin blanket of tephra over the area and could throw out volcanic bombs and blocks that can harm people or cause fires. Hydrothermal explosions might be caused by fissuring of cap rocks by earthquake. However, no evidence of hydrothermal explosions or geothermal craters have been found on Kilauea.

Mitigation measures that will be taken to reduce and minimize impacts on equipment and facilities from lava flows, explosive eruptions, ground cracking and earthquakes include careful sitting of drilling pads, roadways and power plants; protective earth berms around sensitive areas and raising facilities above ground level to permit lava to flow around or under them; use of proper building materials, e.g., metal rather than wood; maintaining active liaison with Hawaii Volcano Observatory personnel who monitor the activity of the volcano; and the wide dispersal of facilities to spread the risks and to avoid placing undue reliance on any single facility. Further, all facilities will be designed and constructed to meet all state and county seismic/volcanic related building codes and regulations.

Mitigation measures that will be taken to reduce and minimize impacts on project personnel will include the development of emergency/contingency planning procedures and emergency training of all personnel. The emergency/contingency planning procedures will be included in the Plan of Operation (see Section VI) that must be submitted to the Chairman of the BLNR for approval prior to commencing operations of any kind.

7. Socioeconomic Characteristics

a. Existing Conditions

Puna District is the fastest growing district on the Big Island and second fastest growing district in the state in terms of population increase (Hawaii State Census Statistical Areas Committee, 1985). As such, the Puna population contains a large proportion of newcomers. The population of the District increased 128 percent during the 1970 to 1980 period and almost 41 percent during the 1980 to 1984 period. It is noted that this occurred without any major development activity in the District. The population increase has been partially attributed to diversified agricultural activities in Puna and the emerging role of Puna as a "bedroom" community for Hilo. This latter factor is expected to continue in the future. (DHM Inc., 1985)

Puna has proportionately more Caucasians and fewer Japanese than the Big Island as a whole. A large increase (311%) in the Caucasian population between 1970 to 1980 has increased the size of the Caucasian population to almost the combined population of all the other non-Caucasians excluding Hawaiians.

Puna's Hawaiian population is proportionately smaller than the Big Island's as a whole. However, the Hawaiian population increase (195%) was also high during the 1970-1980 decade. An even larger increase in the Hawaiian population has occurred in Lower Puna. It is estimated that there are about 1,000 Hawaiians residing in Lower Puna, which is about 75% of the total Hawaiian population in the Puna District. The population of the District, by ethnic group is shown in Table 22.

TABLE 22
Puna District Population by Ethnic Group

| Ethnic Group | Total Population | Percent of Total Population |
|---|---|---|
| Caucasian | 7,604 | 46 |
| Hawaiian/Part Hawaiian | 2,975 | 18 |
| Japanese | 2,810 | 17 |
| Filippino | 1,650 | 10 |
| Chinese | 83 | <0.5 |
| Mixed (Not Hawaiian) | 827 | 5 |
| Other | 331 | 2 |

Source: U.S. Bureau of Census.

The cultural practices and lifestyles of Puna District are as varied as the ethnic composition of the population. This diversity contributes to and most likely enriches the quality of life in the District (DHM Inc., 1985). At present, and for the forseeable future, Protestant, Catholic, oriental and ancient Hawaiian religions and cultural ideologies are practiced in the District. Present Hawaiian cultural practices include hunting, the gathering of food, medicinal plants and maile in the project area and belief in the fire goddess, Pele.

Economically, Puna, particularly Lower Puna has traditionally been an agricultural community. Local farmers produce the bulk of the County's papayas, anthuriums, orchids, bananas, vegetables, maile and marijuana (Hauanio, Kinney and Johnson, 1982).

The following tables (Tables 23 and 24) indicate the general economic conditions of the State, Hawaii County and Puna District as of 1980, the latest year for which statistics are available.

Table 23

State, Hawaii County and Puna District
Income Levels by Households and Families

| Area or Census | Households Income | | | Families Income | | |
|---|---|---|---|---|---|---|
| Tract | Number | Median | Mean | Number | Median | Mean |
| State | 294,934 | $20,934 | $24,521 | 227,974 | $22,751 | $26,631 |
| Hawaii County | 19,257 | 16,975 | 20,398 | 22,825 | 19,132 | 22,347 |
| 210 | 2,367 | 15,370 | 18,634 | 1,783 | 18,029 | 20,074 |
| 211 | 1,459 | 12,735 | 16,124 | 1,181 | 13,851 | 17,632 |

Note: Census Tract 210 covers the Keaau-Mountain View (northerly one-half) area of Puna District and Census Tract 211 covers the Pahoa-Kalapana (southerly one-half) area of Puna District. For census tracts 210 and 211, 81.7 percent and 74.0 percent respectively are above the 125 percent poverty level.

Source: U.S. Bureau of the Census, Census of Population and Housing, 1980: Summary Tape File, 3A, Hawaii (1982), Special Tabulation by DPED.

Table 24
State, Hawaii County and Puna District
Civilian Labor Force

(1980)

| Area or Census Tract | Total Labor Force | Number Employed | Number Unemployed | Percent Unemployed |
|---|---|---|---|---|
| State | 435,725 | 415,130 | 20,595 | 4.7 |
| Hawaii County | 41,006 | 38,150 | 2,856 | 7.0 |
| 210 | 2,968 | 2,598 | 370 | 12.5 |
| 211 | 1,635 | 1,441 | 194 | 11.9 |

Source: State of Hawaii Department of Labor and Industrial Relations, Labor Force Data, April, 1985.

b. Impacts and Mitigating Measures

(Note: The potential air quality, noise quality, health and welfare and visual impacts on the socioeconomic characteristics of the project and surrounding areas are discussed in Section III, Paragraph D4, D5 and D9 of this SUP EIS and are not repeated in this paragraph.)

As indicated in Paragraph C of this section (III), approximately 54,000 agriculture and urban use subdivided lots are presently vacant. When and how fast these 54,000 vacant lots in the District will be developed and occupied depends on various interrelated factors, such as the County's overall economy, which is in turn dependent on the State and national economy. In particular, what happens in Hilo in terms of economic activities will directly influence population in-migration to Puna and the development of those lots.

The proposed project is not expected to cause any significant changes to the rural or agricultural lifestyle presently existing in the area. The communities are expected to remain essentially rural and agriculturally oriented.

As indicated in Section II, Paragraph A, the purpose of the proposed project is to explore for, develop and produce geothermal resources sufficient to generate 100MW of electricity to satisfy the needs of the Big Island first, and secondly, for export purposes. In either case, the power generated will be "exported" to the Big Island grid system or interisland cable. The power generated will replace existing oil generated electricity. The scope of the project does not include the development of major energy utilizing industries. Further, it is highly unlikely, given the volcanically and seismically active nature of the project area; its distance from major roadways and/or harbor facilities; the lack of service industries in the area; the predominantly agricultural zoning of the area; and the non-urban setting of the area, that any major energy utilizing industries would locate in or around the project area.

The proposed project is not expected to directly attract a major influx of population in-migration to the District. This is because the project itself is a capital intensive not a labor intensive industry. However, it is expected that there may be a gradual minor population increase due to the proposed project over the life of the project, if employees, presently living in other Big Island districts, move into the Puna District and decide to stay permanently. If it is assumed that one-half of the project employees relocate to Puna District, the total population increase is estimated to be in the range of 158 to 255 persons. This would represent an 0.96 to 1.54 percent increase over the present Puna District population of 16,530 versus the 220 percent increase that has occurred over the past fourteen years. It is noted that all of the employees of the present drilling contractor for the lower east rift zone geothermal project are Puna District residents. The estimated potential population growth resulting from the proposed project is given in Table 25.

Table 25

Estimated Potential Population Growth
Resulting from Proposed Project
(During First 10 Years)

| | |
|---|---|
| New Base Employment | 90-145 |
| Additional Population | 316-509 a/ |

a/ Additional Population = New Base Employment x 3.51*.

*Hawaii County average family size.
Source: 1980 Census of Population and Housing

Based on the preceeding, the proposed project is not expected to significantly impact the population, lifestyle or cultural characteristics of Puna District. As such, specific mitigation measures do not appear to be warranted. Economically, the proposed project will provide employment opportunities in three basic construction areas (road construction, well drilling and pipeline/power plant construction) and in pipeline and power plant operation and maintenance. Table 26 identifies the estimated number of employees required over the life of the project.

Table 26

Estimated Number of Employees Required by Labor Classification

| Task | Type of Work Force | Number of Position | Time Period |
|---|---|---|---|
| Road Construction | Construction Worker | 15-25 | 1st 10 years |
| Well Drilling | Laborer | 15-20 | 1st 10 years |
| Pipeline/Power Plant Construction | Construction Worker | 60-100 | 1st 10 years |
| | Sub Total | 90-145 | |
| Pipeline/Power Plant Operation | Engineer/Operator | 6-10 | 30 years after construction |

Based on the development schedule (Figure 6) given in Section II, Paragraph D, it is probable that the initial labor required for road construction and well drilling activities will be needed as soon as the project begins, i.e., mid-1986. Initial labor forces required are estimated to be around 50 workers, perhaps 10 to 15 for well drilling activities and the remainder for road construction. The pipeline/power plant labor will be required beginning in mid-1987. All labor forces will be employed either continuously or intermittently during the 10-year development/ construction period. Power plant operations and maintenance personnel will be required as power plants come "on-line" in 1989, 1990 and 1995.

It is expected that the majority of the employment positions will be filled by present Big Island residents because there are sufficient levels of work skills and labor forces available (DPED, 1982b). The employment of Puna District and/or island of Hawaii residents to fill the construction and plant operation positions is expected to have a positive impact on the economy of the island in general and specifically the Puna District. It is estimated that the average annual income per employee will be approximately $22,500. Assuming a work force of 100 employees during the first 10 years of construction/operation, total wages would be $2,250,000 per year. If an expenditure multiplier of 2 is assumed and it is assumed that only one-half of the income is expended in Puna District, the net annual increased expenditure in the District would be $2,250,000 and the increased expenditure for the island or the State would be an additional $2,250,000 per year. [Note: DLNR (1984b) used a multiplier of 2.3 in their economic analyses, thereby indicating a greater positive economic benefit to the State, Big Island and Puna District.]

Concerns have been raised regarding potential adverse effects of the project on the cultural practices and lifestyles of the present Puna District residents. Many of the cultural/lifestyle change concerns may stem from the 1970 to 1984 population increase that has occurred. The extent of impacts, if any, could depend on the ethnic composition of any added population and the level of hunting and gathering rights that are transferred from the project area to the Kahauale'a area. At present, hunting is allowed in the Puna Forest Reserve and "gathering" is allowed outside of the Wao Kele O Puna Natural Area Reserve upon issuance of a permit for gathering for personal use only. The transfer of hunting rights from the project area to Kahauale'a would lessen the impact of locating the proposed project on the State lands. As noted previously, the scope of the project does not include the development of major energy utilizing industries, thereby negating any potential impacts on the lifestyles and cultural characteristics of the area.

Meetings have been held with groups and individuals of Hawaiian ancestry including kupunas, Pele practitioners and authorities on Hawaiian culture (see all heavy, slow moving equipment will be performed during off-peak traffic periods during daylight hours and coordinated with the County Police Department. Also, all traffic into and out of the project area will be via a controlled access security gate.

The planned traffic/transportation controls will minimize traffic increases on the roadways in the vicinity of the project area. As such, the limited increased traffic is not expected to impact existing lifestyles, cultural practices or commercial or recreational practices and activities in the areas surrounding the project area.

8. Historical/Archaeological Attributes

a. Historical/Archaeological Attributes

In investigating the potential impacts the project could have on any significant archaeological findings that may exist in the area, the following considerations were taken into account:

1) the nature of geothermal exploration and development activities by which the location of project facilities and service roads is determined progressively as geothermal resources are discovered;

2) the size of the land area in which project activities will occur, i.e. within a GRS of approximately 8,500 acres;

3) the small amount of the land surface that will actually be disturbed or occupied due to the proposed project activities, i.e., about 3% of the GRS.

4) the relatively inaccessible, extremely rugged nature of the GRS which is covered in part with predominantly a'a lava flows, dense forest cover, and numerous cracks.

In view of these conditions, the existing historical/archaeological attributes of the project area tentatively have been determined through a detailed literature/cartographic search and review and a limited archaeological reconnaissance survey of areas adjacent to and within the project area. Both surveys were conducted specifically for this SUP EIS.

As noted by Holmes (1985) the project area has prehistorically and historically been regarded as remote, inhospitable, inclement and difficult to access. Rosendahl (1985) notes that the relative inaccessibility of the area and difficult nature of the terrain were among the factors limiting the field reconnaissance survey efforts.

The detailed literature/cartographic search revealed that the project and surrounding areas were used by the Hawaiians for bird catching (for their

Section VIII) to discuss development of Hawaii's Geothermal resources. Among those contacted, two Hawaiians identified themselves as Pele Practitioners who expressed their opposition to commercial geothermal exploration and development on the grounds that such activity is an offense against Pele and a desecration of her body and being because it involves drilling into Pele's body and removing her energy.

All others of Hawaiian ancestry that have been contacted expressed general support for the commercial development and use of geothermal energy and did not agree with the premise of the Pele Practitioners regarding such development.

From these meetings and discussions, it would appear that the views of the two Pele Practitioners are not widely held or accepted by the Hawaiian community. Rather, those individuals and groups of Hawaiian ancestry who were contacted expressed views similar to others in the community concerning potential environmental impacts and economic benefits to the community especially as related to increased opportunities for jobs as a result of geothermal development.

Increased traffic and transportation into and out of the project area during the exploration and development stages could also impact the few residents living in the vicinity of the project area. A discussion of these impacts, as they related to Kahauale'a, is provided in the EIS. The presently proposed project is for 100 MW versus the originally proposed 250 MW project. The major difference between the 100 MW project and the 250 MW project is that traffic will enter and leave the Project area via secondary State and County roadways rather than the primary Hawaii Belt Road. Also, the level of traffic for the proposed project is expected to be less than the 96 trips projected in the EIS.

During the exploration stage of the project it is estimated that there will be approximately 16 to 20 trips per average 24-hour day. During the development stage it is estimated that an additional 20 trips per average 24-hour day will occur. During the operational stage, it is estimated that a total of no more than about 15 trips per average 24-hour day will occur. This traffic will consist of construction workers, materials and supplies deliveries including any chemicals required by the abatement systems used, operations and maintenance personnel and visitors.

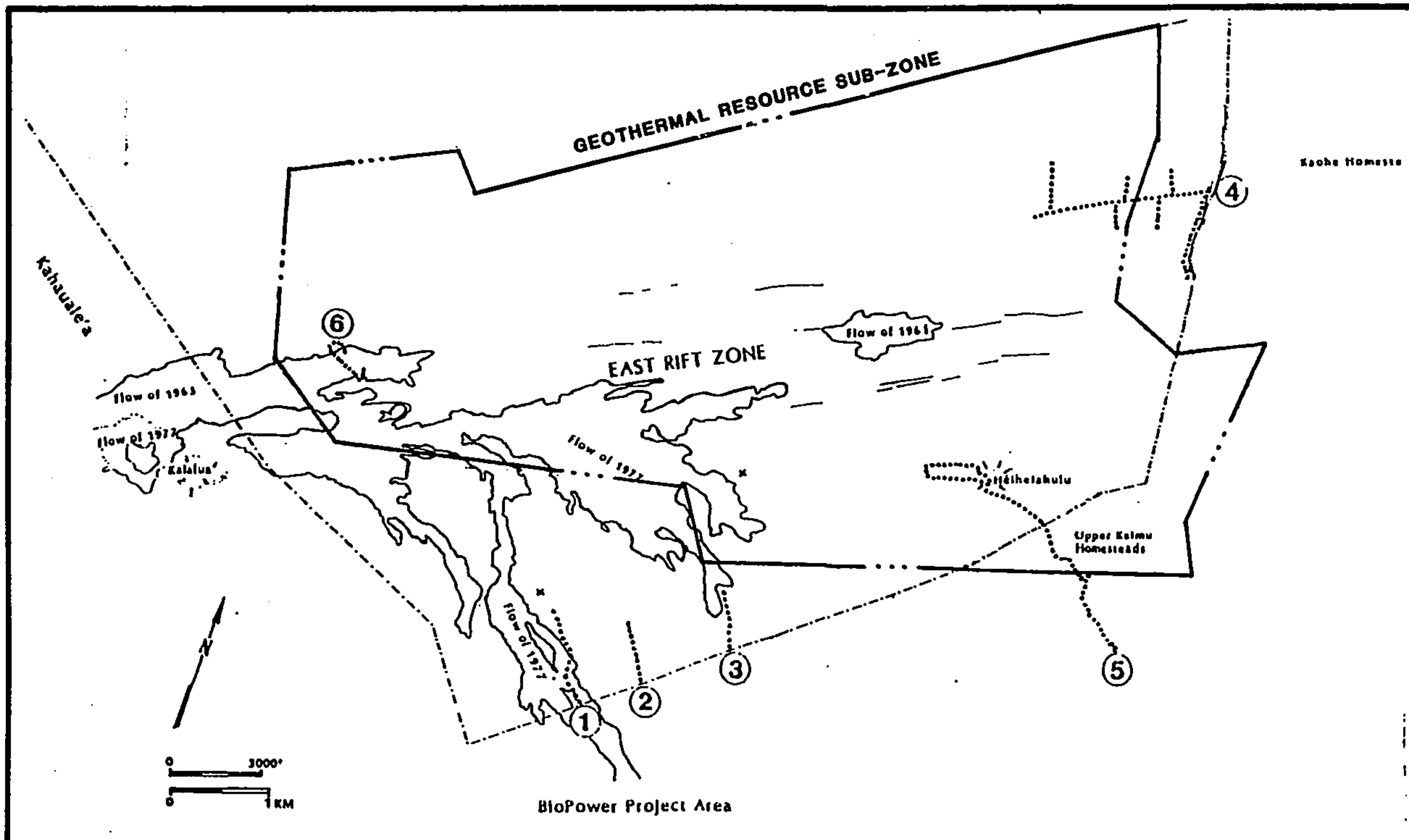
If required, workers could be bussed or car-pooled into/out of the project area. The transportation of colorful feathers), logging for canoes, pulu gathering and limited agricultural purposes. Bird hunting, canoe logging and pulu gathering most likely were conducted over the majority of the project area while agricultural uses appear to have been limited primarily to the southern and eastern boundaries of the project area.

Research indicates that several trails entered the project area (Figure 22a). However, it appears that only one (see Figure 22a, Wilkes, 1840 Trail) crossed the entire area from east to west. Habitation of the area appears to have been limited mainly to the southern boundary, where tree ferns had been cleared and dry upland taro and bananas were planted. It is known that two, and possibly more, bird hunter shelters were constructed in the northern portion of the project area (see Figure 22b) and Rosendahl (1985) located five to six cairns and mounds in an area of fumarole activity on the southeast summit of Puu Heiheiahulu in the southeast corner of the project area (see Figure 23). It is not likely that the bird hunter shelters or other areas within the interior of the project area were places of permanent habitation.

The literature search also revealed [confirmed by a field informant of Rosendahl's (1985) and see Char and Lamoureaux, 1985a] that in the early 1900's (c. 1910) a network of railroad spurs was laid down on the eastern side of the project area for logging operations. However, it does not appear that these spurs penetrated the project area more than a mile.

The limited archaeological reconnaissance survey was conducted to sample several areas adjacent to and within portions of the proposed geothermal resource subzone and development area. The objectives of the survey were to (1) supplement the historical and archaeological documentary research for this area in order to provide a general assessment of the likelihood of the presence and general nature of any remains of any sites or features of possible archaeological significance within the project site and (2) to provide a basis for conducting full reconnaissance surveys when final site selection for each project facility is made as the project progresses.

The ground survey team did not have the benefit of the report of the historical and archaeological documentary research at the time of the reconnaissance. However, the report was subsequently reviewed by the consulting archaeologist and considered in his conclusions.




LEGEND:

(1) Survey Transects (Approx. Locations)

× Banana Sightings (11/18/85)

Source: Rosendahl, 1985

Archaeological Field Survey Transects Location Map

FIGURE 23

Earlier findings of archaeological remains in areas southwest of and adjacent to the proposed subzone and sightings of archaeological features south of Kalalua crater, in Kahauale'a, support a probability that similar remains could be present in the southern portion of the proposed project development area and GRS. No inspections were made of the various and tentatively located project sites since final site selection will be made on the basis of sequential results of drilling operations and environmental considerations including possible discovery of archaeological remains that may require preservation at the site of discovery.

Three of the transects made during the reconnaissance were on the periphery of the project area and two transects were made into the project area (see Figure 23). These transects were supplemented by low altitude aerial sweeps by helicopter of virtually the entire project area, and ground inspection of two additional areas within the project area. The first of these two locations, indicated in Figure 23, Transect 6, was a kipuka situated adjacent to a portion of the 1977 lava flow. The second location consisted of the heavily vegetated crater of Heiheiahulu, an area indicated in Figure 23 as immediately adjacent to Transect 5. All transects provided useful information which contributed to achievement of the objective of this type of survey. On Transects 1, 3, and 4 (southwest of the GRS and northeast of the proposed development area), Hawaiian cultigens such as ki (Cordyline terminalis [L.] Kunth) and kukui (Aleurites moluccana [L.] Willd.) were encountered. Since native cultigens are believed to be indicative of prior native occupancy and/or exploitation in the vicinity, a thorough search of the immediate area was made to determine whether archaeological features were present. Even though historical period sites were not found in the area of these cultigens, there is the possibility that archaeological remains may be present. Residents near Transect 4 (Figure 23) indicated knowledge of an early 1900's railraod bed that leads into the project area, but it was not located (see Figure 22a for probable location).

Transect 5 encountered probable archaeological remains consisting of five to six cairns and mounds in an area of fumarole activity on the southeast summit of Heiheiahulu. These features are tentatively assigned a burial function.

The aerial reconnaissance by helicopter did not reveal the presence of any definite archaeological remains. However, three sightings were made of banana trees (Figure 23) growing within small lava sinkholes in forested areas; the presence of bananas as a cultigen indicator suggests intentional agricultural utilization of the immediate area in the past.

The ground inspection field work in the two areas reached by helicopter did not reveal the presence of any archaeological remains. These results support the indications from Transects "1" through "5" that most archaeological remains to be found within the project area will probably be relatively sparse in density, tenuous in nature and difficult to recognize with certainty.

Based on a review of available archaeological, ethnographic and historical information, one final general observation can be made regarding the apparent distribution of archaeological remains within and adjacent to the present project area. In southwestern Puna, archaeological remains are concentrated within the immediate coastal zone and, for the most part, tend to decline rapidly in both variety and density as one progresses inland (Rosendahl, 1985). Archaeological and documentary evidence for aboriginal patterns of inland habitation and exploitation -- principally dryland agricultural activities and associated short-term residential occupation within the lower reaches of the forest -- indicates that the density of archaeological remains decreases quite rapidly in the vicinity of the southern periphery of the proposed geothermal development area. Therefore, it would seem reasonable to suggest that, with one exception, any archaeological remains present within most of the project area would be widely scattered, as well as physically tenuous. The one exception might be a slightly higher density of remains along the routes of major trails that passed through the inland forest.

b. Impacts and Mitigating Measures

Potential impacts to the historical/archaeological attributes of the project area include the disturbance or destruction of sites with potential historical or archaeological significance. To ensure that these potential impacts are minimized to the greatest extent practicable, a full archaeological reconnaissance survey will be made of any area selected to be cleared for project operations, prior to the initiation of clearing operations. As noted previously, all significant archaeologic sites will be protected as required and recommended by the archaeologist performing the survey.

As indicated by Rosendahl (1985):

"The basic objective of a full reconnaissance survey is to identify and evaluate sites and features of potential archaeological significance present within the project area. The full reconnaissance survey should be conducted in accordance with the standards for reconnaissance level survey recommended by the Society for Hawaiian Archaeology (SHA). These standards are currently being used by the Hawaii County Planning Department and the Hawaii State Department of Land and Natural Resources-Historic Sites Section as guidelines for the review and evaluation of archaeological reconnaissance survey reports submitted in conjunction with various development permit applications.

The appropriate areas to be surveyed should include the proposed access corridors, drill sites, power plant sites, and any other areas to be impacted by construction activities. These areas must be clearly marked on-the-ground prior to archaeological field work. The survey areas should also include sufficient buffer zones--perhaps two to five or more times larger than the actual extent of the access road corridors, drill sites, power plant sites, and any other development areas--to insure that any archaeological resources in the immediate vicinity, but not actually within a specific area to be impacted, would not be inadvertently damaged by construction activities. The buffer area will also insure that the full context of archaeological remains within the specific impact areas will be determined (e.g., the full significance of a seemingly isolated structure cannot be accurately determined if it is part of a larger, but unidentified, complex of structures).

Based on the results of the full reconnaissance survey findings, the level of appropriate further archaeological work could be determined. Such further work could include intensive survey--detailed recording of sites and features, and controlled test excavations; and possibly subsequent mitigation--salvage or research excavations, interpretive planning, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

Because of the extensive area of the GRS in which development is expected to occur over time, it would be appropriate to formulate an archaeological research design if after resource discovery it appears that development can proceed to the full scope of the project as proposed and that development sites (based on exploration results) will be located in dispersed areas within the GRS.

Rosendahl (1985) defines a research design as:

"...a plan for conducting an archaeological investigation. It includes a statement of both general and specific research objectives, specifies the data necessary to address the objectives, and describes the strategies and methods to be utilized for data recovery. General and specific research objectives are formulated on the basis of preexisting information concerning the probable pattern of prehistoric and historic land use, settlement, occupation, and exploitation. The necessary archaeological data consists of the types of archaeological remains which would result from the probable prehistoric and historic activities. Strategies and methods for data retrival are formulated based on the types of data needed, field conditions, and nature of development activities. Because of the extensive nature of both the Proposed Geothermal Development Area and the proposed construction activities, a sampling strategy for data recovery which is based on proposed development areas can potentially provide a valuable data base" and "...facilitate future development planning and make a substantive contribution to archaeological knowledge about the area."

It is expected that because of the active volcanic nature of the project area and extensive past lava flows (Figure 24), few remaining archaeological sites will be found in the project area. However, as noted, archaeological reconnaissance surveys will be conducted to ensure adequate recordation and appropriate protection and preservation of any sites found as the proposed project progresses.

9. Visual Factors

a. Existing Conditions

The existing visual characteristics of the project and surrounding area are rural, forested vistas punctuated by recent barren to older sparsely vegetated lava flows, intermittent cinder/spatter cones, subdivision streets and lots and cultivated papaya and macadamia nut orchards. The majority of the project area is generally not visible within a range of 2-3 miles due to its inaccessibility and due to vegetation that blocks most potential view corridors into the area from surrounding land areas.

Table 27 provides information on distances from various potential observation points to three prospective facility sites (western, central and eastern portion) of the project area. As can be seen, the distances are all over 5 miles except for a point on the eastern edge of the Park boundary which is now blocked by Pu'u O'o and surrounding lava flows. Any project facilities that could be seen at those distances are not expected to create any significant visual impacts. Figures 25 through 28 depict terrain profiles and straight line-of-sight view lines to the three prospective facility sites within the project area from 3 locations considered to constitute potentially sensitive view corridors.

As shown in the Figures, views into the project area are generally blocked from these observation points due to the terrain of the surrounding areas as well as the terrain within the project area. Vegetation was not considered in this analysis, but would serve to increase the line of sight view angle of the observer. This would have the effect of increasing the height that a facility would have to be raised before it could be seen from the same point or allowing the facility to be located closer to the observer without being seen.

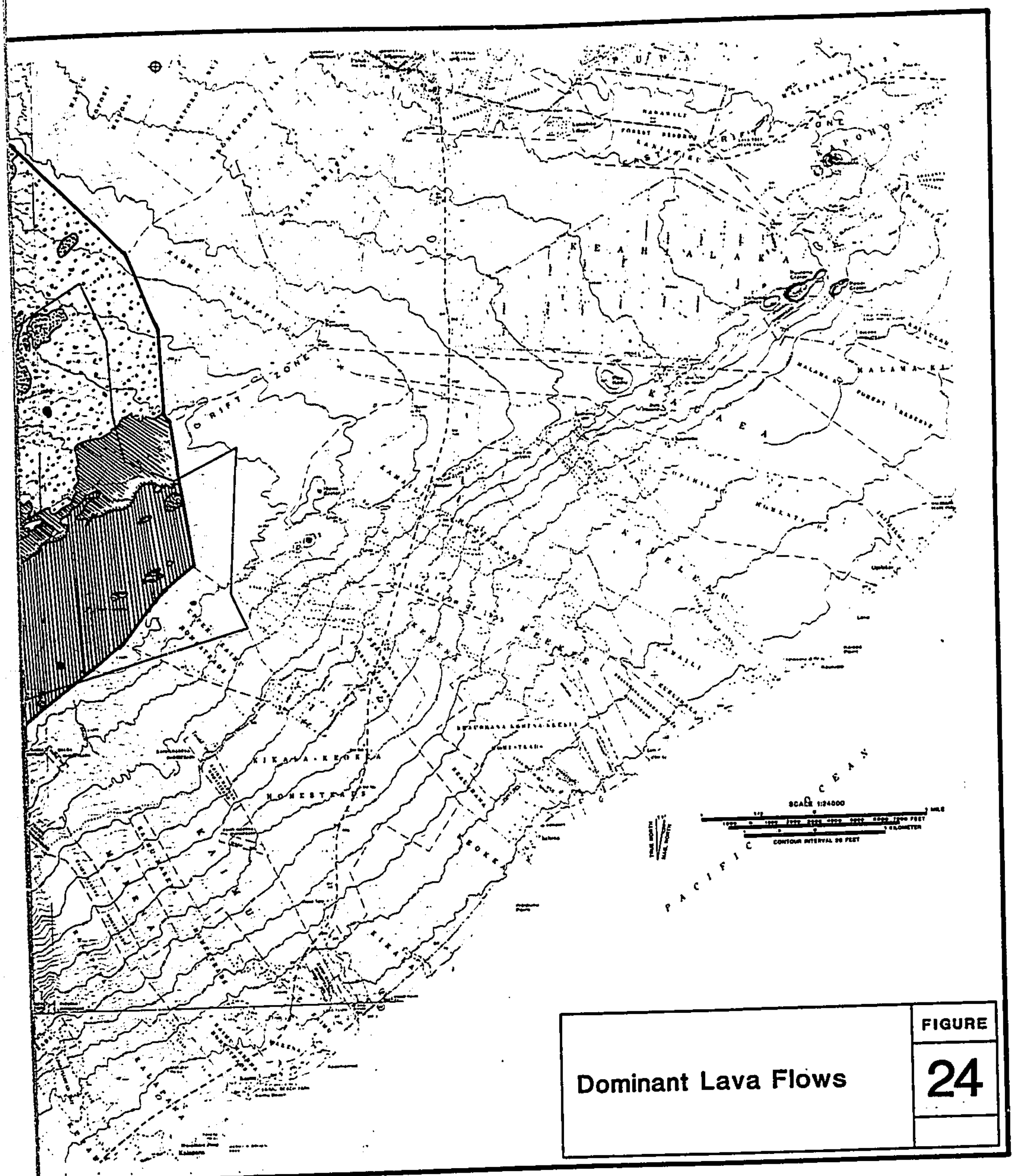
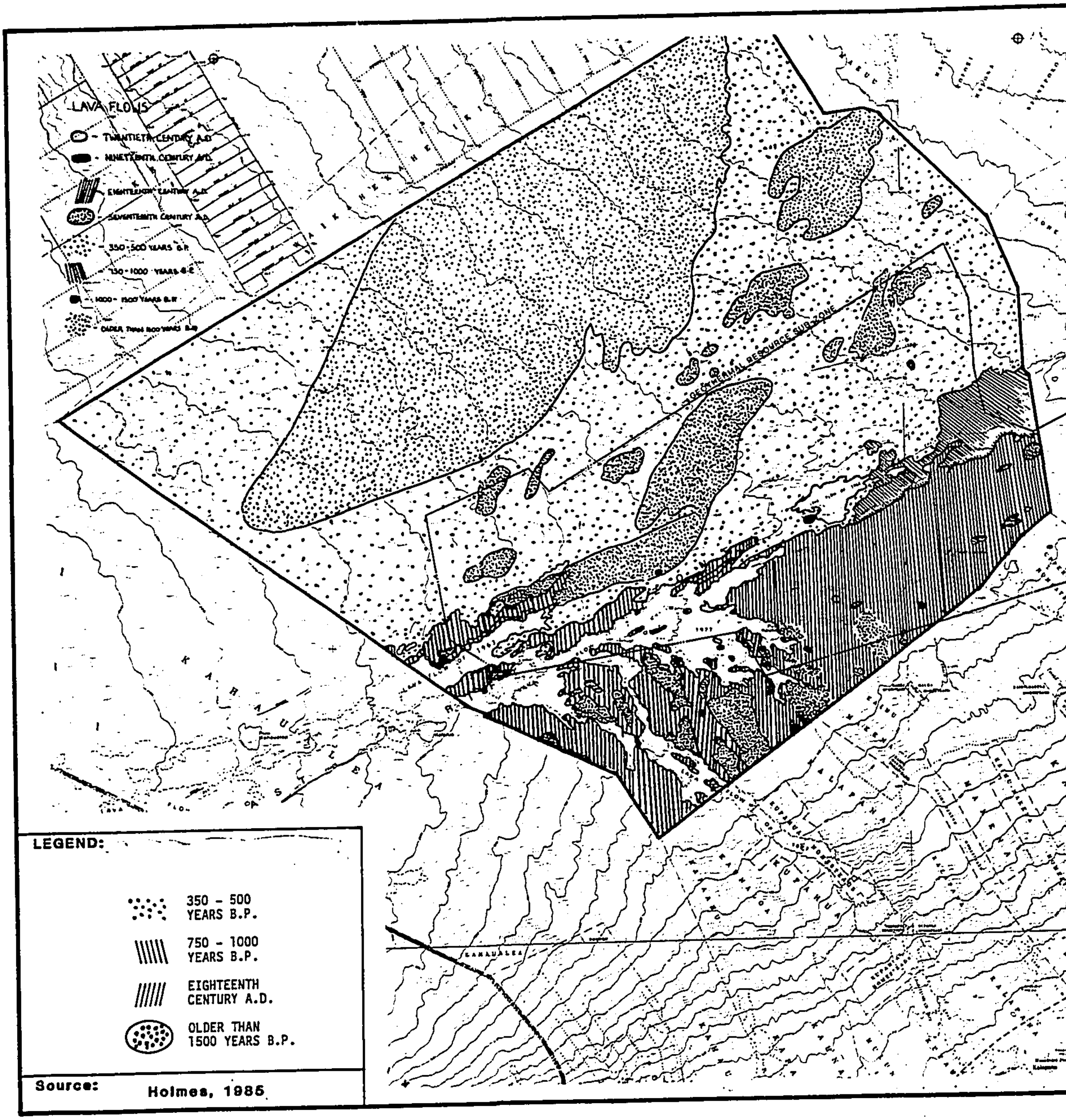



FIGURE 24

Dominant Lava Flows


LEGEND:
350 - 500 YEARS B.P.
750 - 1000 YEARS B.P.
EIGHTEENTH CENTURY A.D.
OLDER THAN 1500 YEARS B.P.
Source: Holmes, 1985
LAVA FLOWS
GEOTHERMAL RESOURCE SUB-ZONE

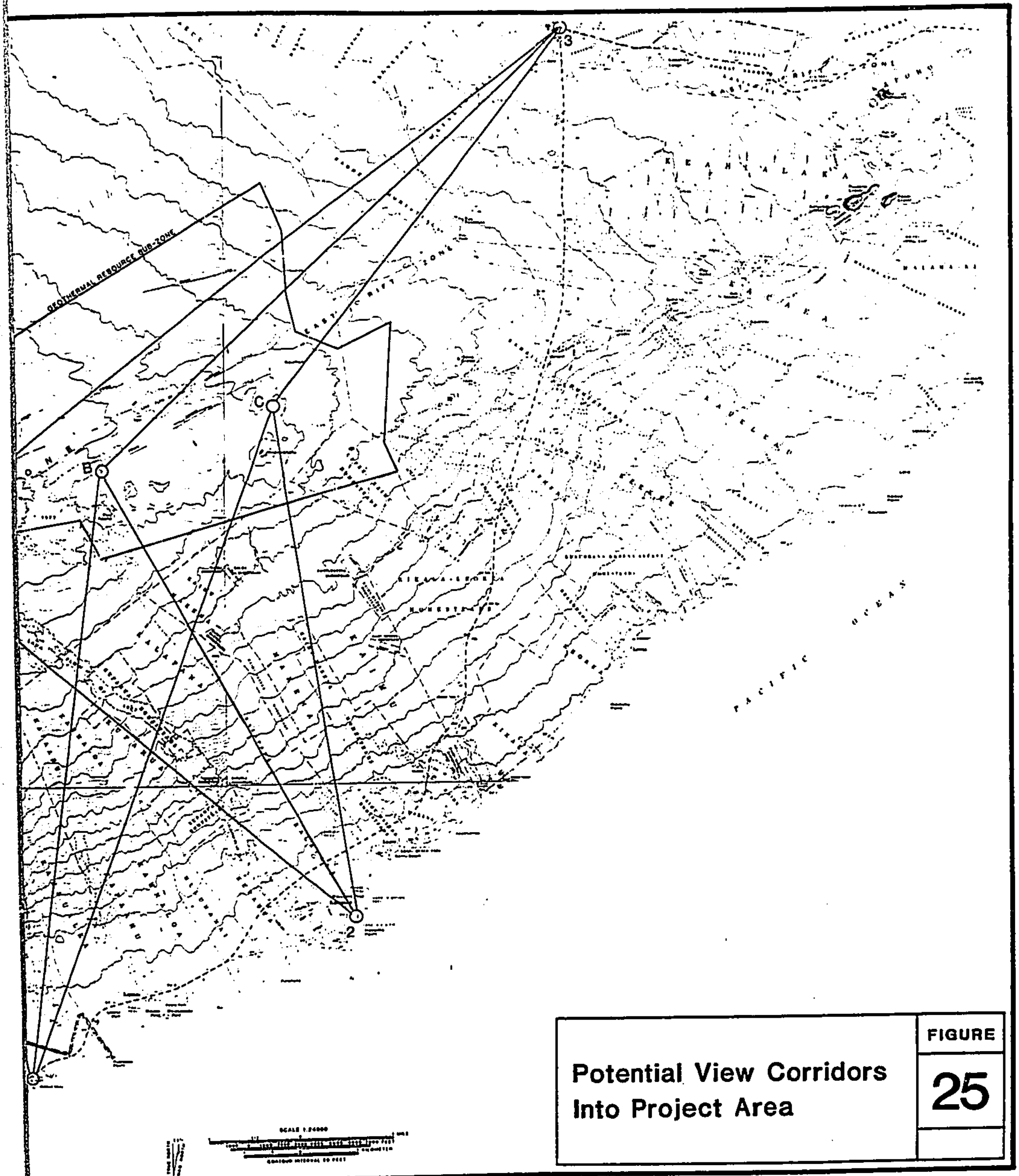
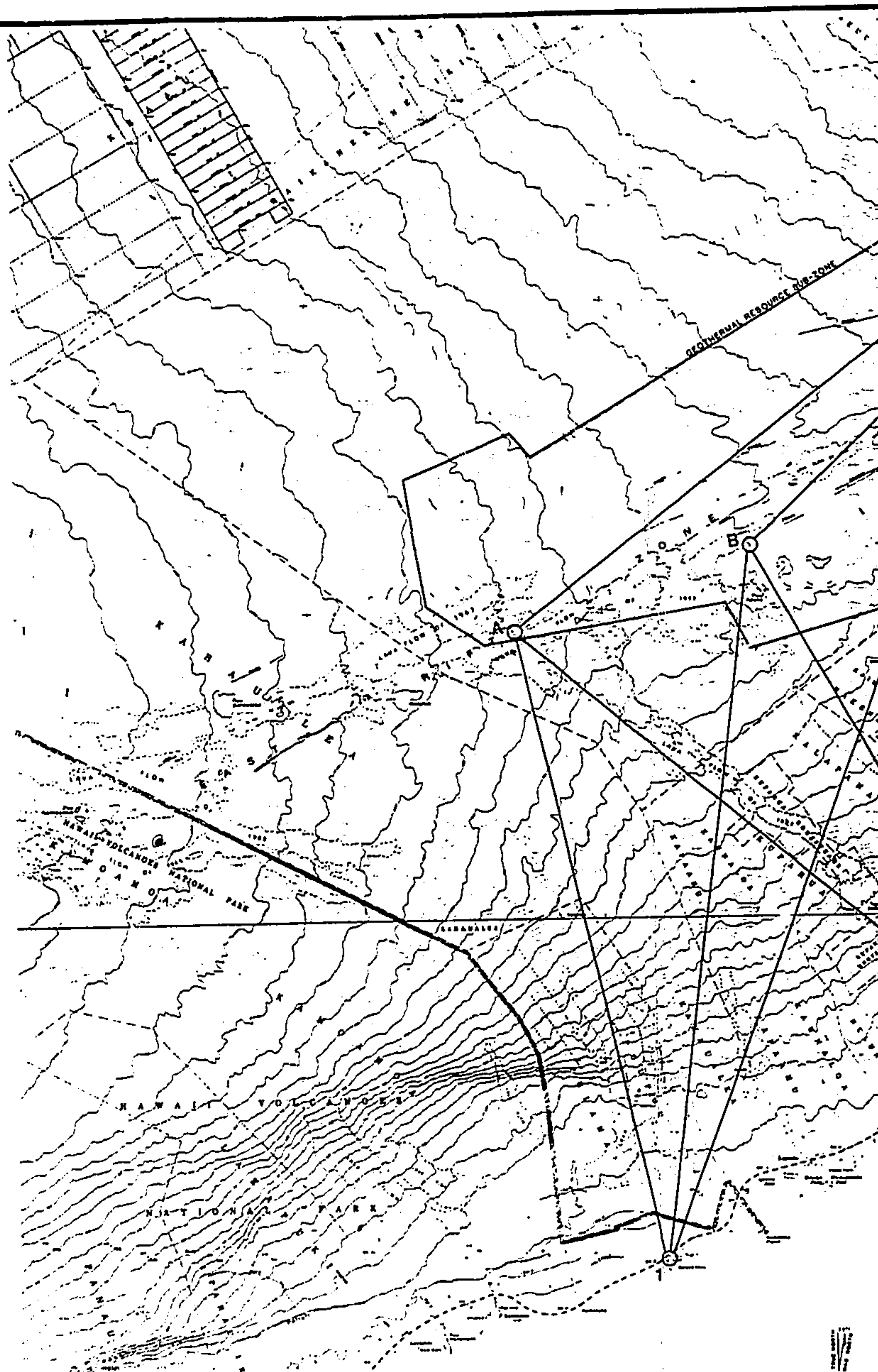



FIGURE 25

Potential View Corridors Into Project Area



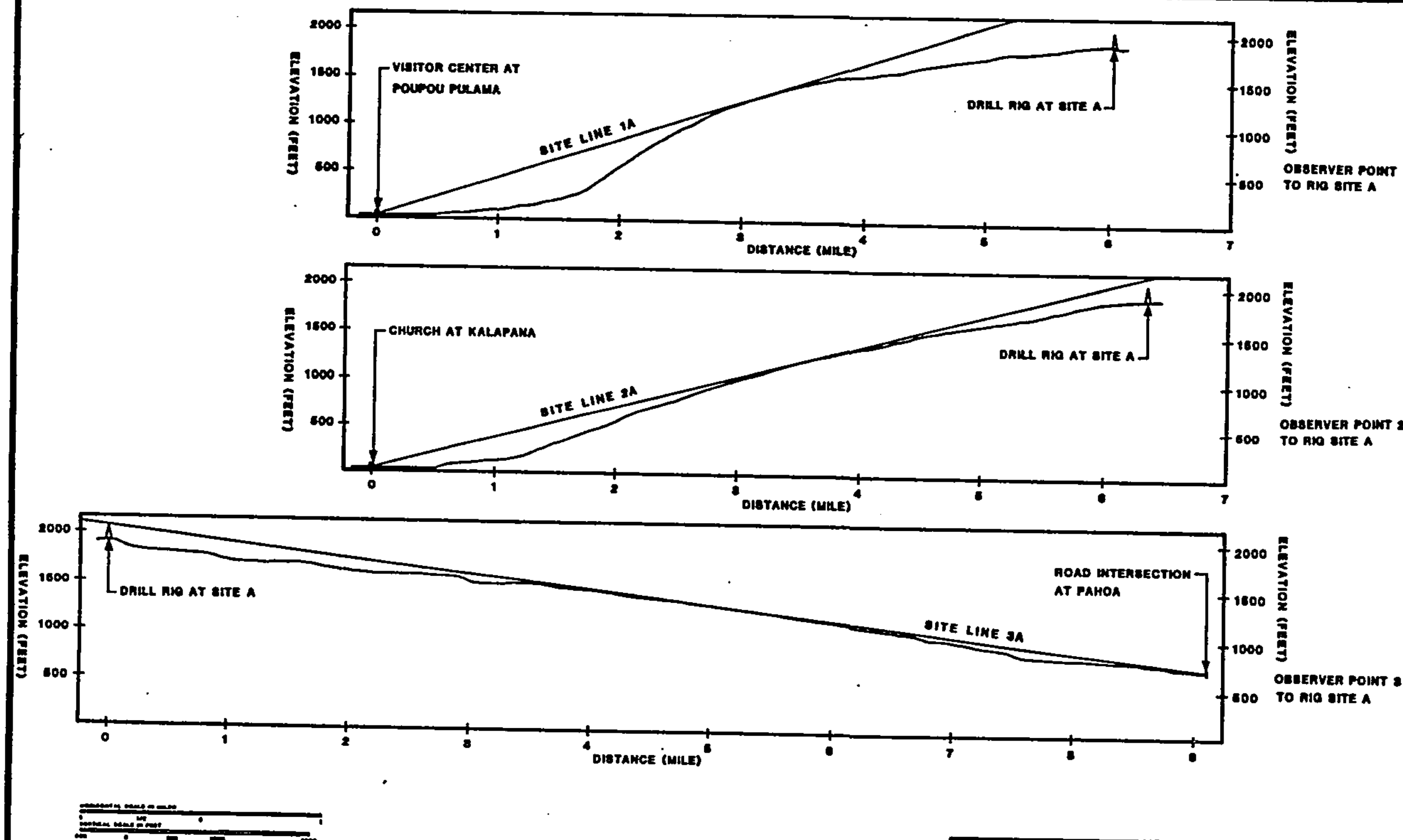

**LEGEND:**

Ⓐ, Ⓑ & Ⓒ Prospective Facility Sites

①, ② & ③ Observation Points

①—Ⓐ View Line

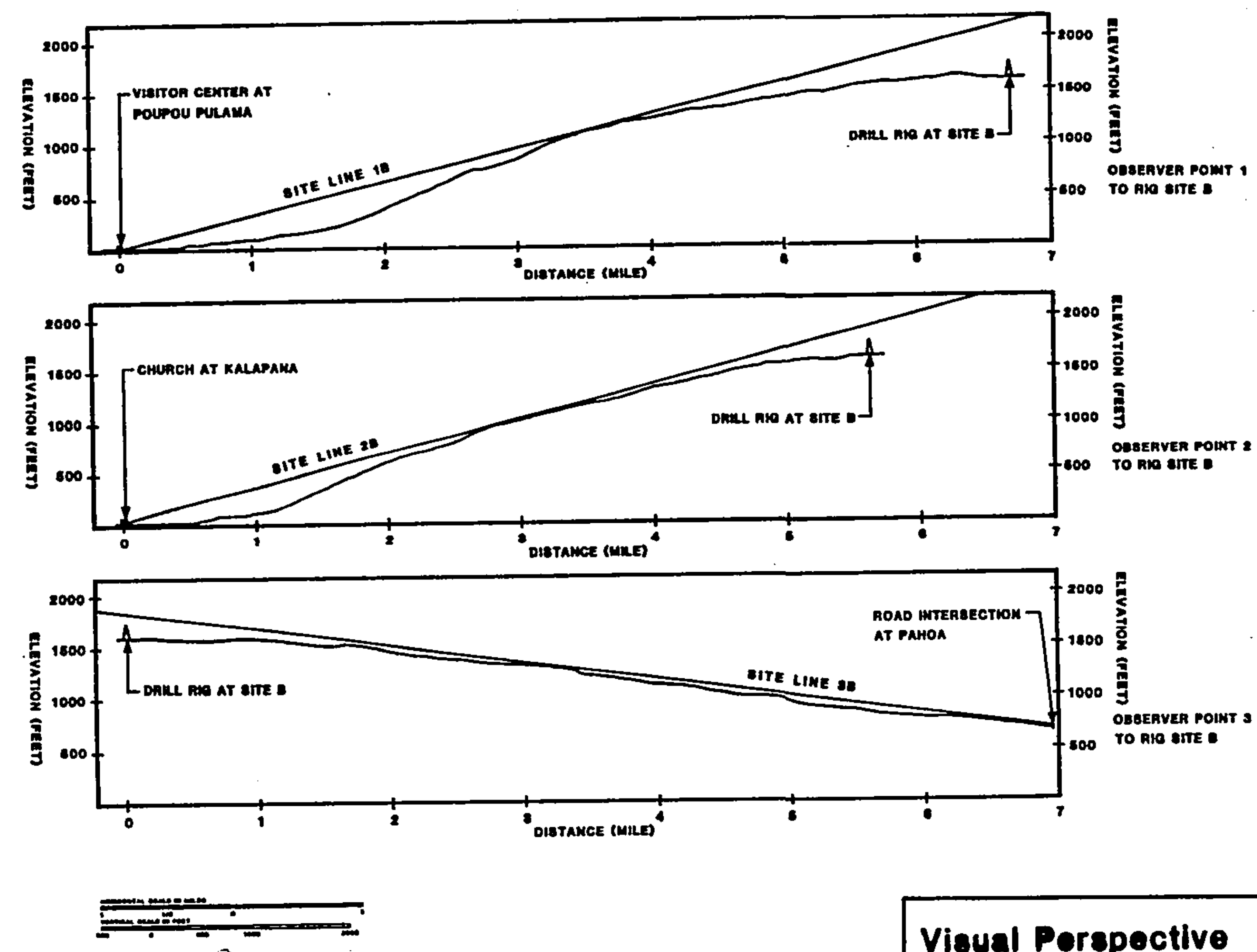
**Source:** KFC AIRPORT, INC.




Visual Perspective From Selected Locations to Project Sites

FIGURE 26

Source: KFC AIRPORT, INC.




**Source:** KFC AIRPORT, INC.

**Visual Perspective From Selected Locations to Project Sites**

FIGURE 27

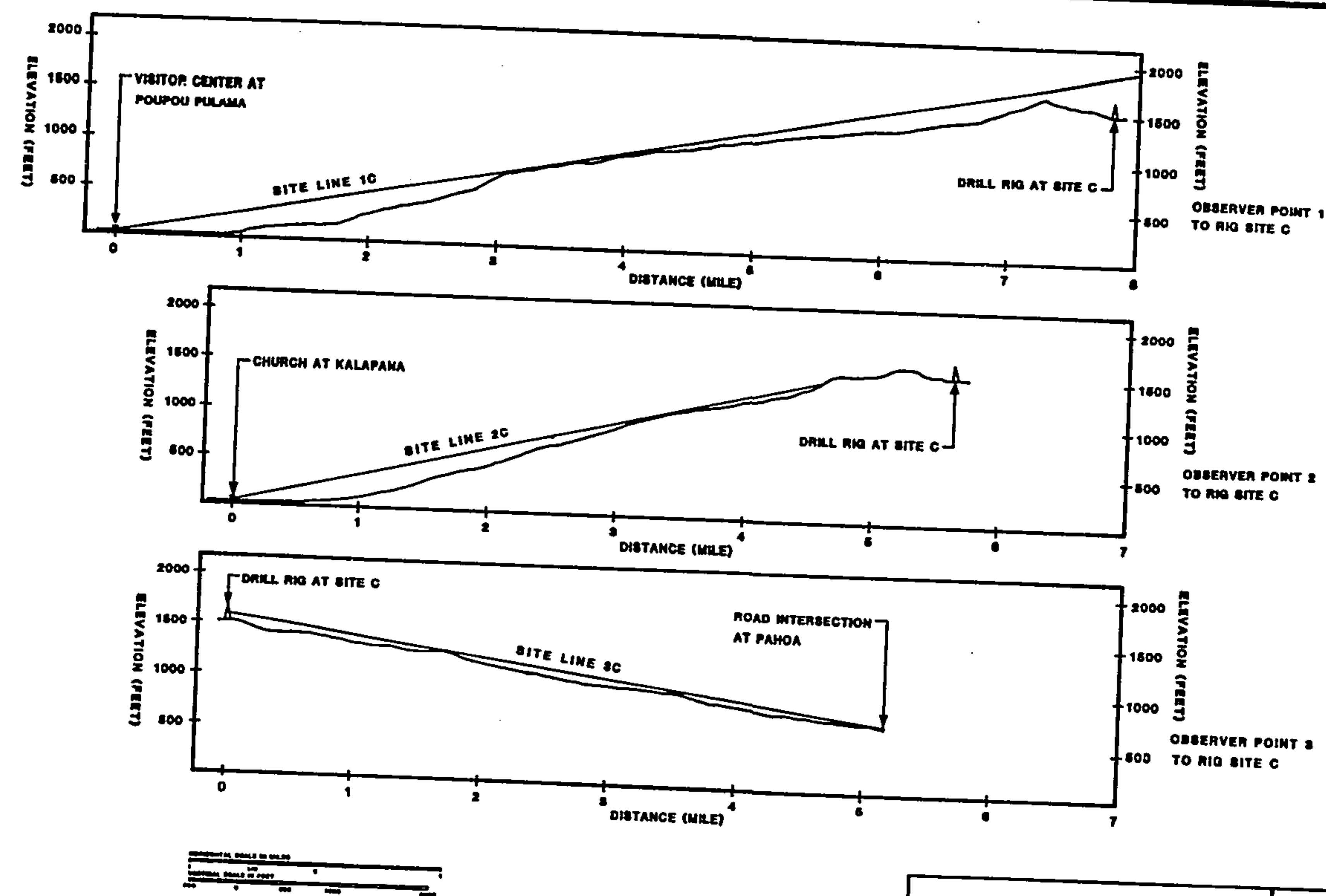



FIGURE 28

# Visual Perspective From Selected Locations to Project Sites

Source: KFC AIRPORT, INC.

TABLE 27

POTENTIAL VIEW CORRIDORS

(Distances From Project Areas To Observation Points)

| OBSERVATION POINT | Project Areas (Along Rift Zone Center) WESTERN EDGE | CENTER | EASTERN EDGE |
|---|---|---|---|
| Visitors Centers, Hawaii Volcanoes National Park (Chain of Craters/ Kalapana Road) | 6 mi | 6.8 mi | 8.7 mi |
| Kaimu Beach Park, (Kalapana) | 6.8 mi | 5.3 mi | 5.7 mi |
| Napau Crater (End of trail, western edge) | 6 mi | 9 mi | 11.7 mi |
| Road to National Park (Nearest point to project activity; Bench marks 2756, 2225 & 2205) | 6 mi | 10.3 mi | 11.4 mi |
| Eastern Edge of Park Boundary | 3 mi | 6 mi | 8.7 mi |
| Volcano Village (Road Entrance) | 10 mi | 13 mi | 15.7 mi |

In general, all but one of the potential view corridors upslope of the project area are blocked by the terrain and/or vegetation of the area [see Figure 26]. Similarly, all but one of the downslope view corridors are blocked by the terrain [see Figure 28]. The view into the project area from those residences that would be closest to project activities is blocked by the terrain and/or existing vegetation that will not be affected by the proposed project.

b. Impacts and Mitigating Measures

Potential visual impacts of the proposed project would include the siting of project activities and facilities such that they are noticeably visible from up- or down-slope view corridors. Steam plumes from cooling towers may be visible from some areas depending on weather conditions and the view corridor. The viewing of the project facilities in a rural, forested area may be objectionable to some depending on the distance and the shape, height, color and design of the facility.

These potential impacts will be mitigated by careful consideration given to the siting of project facilities, especially power plants and other permanent facilities that could disturb views from sensitive observation points. Further, careful consideration will be given to the exterior colors of facilities, and colors that tend to blend into the background will be used on the exterior of all permanent facilities.

It is likely that the drill rig and associated equipment will be visible from limited view corridors for intermittent periods of time as the rig is moved from drill site to drill site. However, as noted, these sightings will be temporary and limited to the period of time the drill rig is at any given location that may be visible from outside the project area.

## E. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

In general, the majority of potential adverse environmental effects of the proposed project can be avoided and/or mitigated and minimized as described in the preceding paragraphs. However, there are a few short- and long-term environmental effects, as described below, that cannot be avoided.

1. Short-Term Impacts

Fauna: During construction, resident avifauna (non-endangered and introduced species) may be disrupted due to construction noise and habitat removal. As noted previously, the endangered 'I'o and O'u are not expected to be imapcted either in the short-or long-term. Additionally, it is likely that mammals (mongoose and feral pigs and goats) may also be disturbed by construction activities.

Air Quality: Increased traffic and the use of construction equipment will lead to the temporary generation of emissions from internal combustion engines. Emissions will be controlled to the extent practicable through emission control devices as required by State laws. Dust also will be generated during roadway and drill site construction activities. To the extent practicable, considering that water must be trucked into the area, dust will be controlled through water spraying and adherence to county excavation and clearing regulations.

Noise: Construction noise may disturb day-sleeping residents closest to the construction sites and, temporarily, the avifauna of the area. As noted, all project activities will comply with county noise guidelines.

Visual: Construction activities, equipment and stored materials may be visible from limited areas up- and down-slope from the project area. This impact, for the most part, will be temporary and occasional and not significant due to the distance between observation points and the project facilities.

2. Long-Term Impacts

Flora: Some vegetation will have to be removed to develop drill sites, roads, fluid transmission pipeline foundations and power plant sites. As noted previously, to the maximum extent practicable, vegetation removal and facility sites will be located in the less sensitive ecosystem types, such as 'ohi'a-b, 'ohi'a-uluhe and lava areas. Additionally, replanting and/or landscaping will utilize vegetation native to the project area. Increased use of the project area could adversely affect the vegetation of the area by increasing the amount of exotic (introduced) plant species in the project area. Vehicular and pedestrian traffic will be limited to roadways, pipeline corridors, drill sites and power plant sites.

Fauna: As noted previously, feral pigs, dogs and goats, mongoose and non-endangered birds may be disturbed during construction as well as during the long-term operation of the proposed project. However, all of the introduced mammals that occur in the area are pest species that threaten the integrity of the forests and/or prey on birds, their nests or young that inhabit the forests. Also, all of the introduced birds are adaptable to changed environments and a number of them are true pest species to agriculture.

Historical/Archaeological Attributes: As noted in the EIS and Section III, Paragraph D8 above, throughout the life of the project, inspections of sites to be cleared will be made by qualified archaeologists prior to clearing to minimize the potential for any important archaeological information or sites within the project area to be inadvertently destroyed or disturbed. It is doubtful that there will be any long term cumulative effects of the continued operation of power plants, drill sites, fluid transmission lines or other facilities on an archaeological site in the immediate vicinity of these operations.

Visual: There is the potential that visual impacts of the project may occur from a limited number of view corridors, especially those down-slope from the project area. To the extent practicable steps will be taken to minimize those impacts. For example, night lighting on drill rigs and power plants will be shielded to the extent that safe operations are not impaired; revegetation will be done with native species when possible; the siting of permanent facilities will consider view corridors and avoid them to the extent practicable; and the design and orientation of permanent facilities will consider structure profiles and heights as a means of minimizing visual impacts. The revised project area reduces the potential visual impacts due to its location 2-3 miles east of the Hawaii Volcanoes National Park, its remote (from populated areas) location and the height of vegetation in the areas surrounding the project area.

## F. RELATIONSHIP OF SHORT-TERM USES AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed project is intended to support the State's goal of electrical energy self-sufficiency and to provide economic development to the Puna District specifically and island of Hawaii in general. Planning for the proposed project has included prime consideration of the environmental attributes of the area, all State and County environmental protection regulations and the State's energy policy.

The tradeoffs of not pursuing the proposed project will be to return to Kahauale'a for development; if that course is not pursued, there will be continued reliance on imported oil or coal for electrical energy generation purposes, continued limited employment opportunities for the area residents and continued underusage of one of the State's major natural resources.

## G. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The exploration, development and operation of the project will involve the irretrievable commitment of certain natural and fiscal resources. Major resource commitments include land, money, construction materials, manpower and energy. The land to be committed to the project, representing about 1 percent of the total project area, will be used for roadways, drill sites, pipeline corridors, power plants and ancillary facilities for at least 30 years. The capital committed to the project will be irrevocably committed. Water, fuel and construction materials committed would most likely be consumed elsewhere if not used for the project. Vegetation that is removed or does not successfully rejuvenate will be lost; some wildlife may relocate to another area.

Over time, there will be natural dissipation of the heat from all geothermal reservoirs. The production of geothermal resources, over time, will increase the rate of heat dissipation if the production rate exceeds the recharge rate.

## IV. ALTERNATIVES TO THE PROPOSED PROJECT

All of the feasible alternative actions/uses described in the EIS are applicable to the revised project and project area. In addition, as noted in the introductory section of this SUP EIS, should the land exchange and environmental permitting for the revised project fail to be consumated, all permit applications and this SUP EIS will be withdrawn. In such an event, actions will be resumed towards obtaining final authority to conduct geothermal development activities within the presently designated Kahauale'a Geothermal Resource Subzone and under authority of the accepted EIS for Kahauale'a.

## V. RELATIONSHIP OF THE PROPOSED PROJECT TO POLICIES AND PLANS FOR THE AREA

A major goal for the State, as set forth in the Hawaii State Plan (DPED, 1985a) and the State Energy Functional Plan (DPED, 1984), is to reduce Hawaii's dependency upon oil through the use of alternate forms of energy. It is a priority objective of the state to "Accelerate the transition to an indigenous renewable energy economy by facilitating private sector activities to explore supply options and achieve local commercialization and application of appropriate energy technologies" (DPED, 1982a and 1984). [Also see: DPED, State of Hawaii Energy Policies Plan (1974); DPED, State Policy Considerations for Geothermal Development in Hawaii (1975); Legal and Public Policy Setting for Geothermal Resources Development in Hawaii (1976), An Assessment of Geothermal Development in Puna, Hawaii (1977); Energy Resources Coordinator Annual Reports (1974-1984); Hawaii Integrated Energy Assessment (1982); and State of Hawaii Public Sector Geothermal Development Plan, 1979-1985 (1982)].

Geothermal energy is considered to be the State's largest alternate near-term baseload electric energy source (DPED, 1982a). Geothermal technology has been proven commercially viable and environmentally compatible in many areas of the world (DiPippo, 1985), and the resource appears to exist in abundant supply in the project area. Past and present (up to that time) actions taken by federal, State and Hawaii County governments to foster geothermal resource development are described in the EIS and DPED, 1982a. One of the key actions taken by the State Legislature in 1983 was the passage of the Geothermal Resource Subzone Act (Act 296-83). This act mandated the designation of geothermal resource subzones wherein proposals for geothermal exploration and development could be considered by appropriate State and County permitting agencies.

The project area is located within the Middle East Rift Zone GRS established by the BLNR on December 20, 1985. This GRS is within a Conservation District and an Agricultural District. The land areas formerly identified as Puna Forest Reserve and Wao Kele O Puna Natural Area Reserve, which were elements of the land exchange, were terminated in conjunction with execution of the land exchange. The proposed project within the GRS is in full conformance with the approved and proposed land use plans, policies and controls for the area.

As indicated in the EIS and this SUP EIS, the proposed project area is within an area considered to have "significant geothermal potential" and as described in the EIS and this SUP EIS, the positive economic and social benefits appear to outweigh the limited potential negative environmental and social impacts. The proposed project is consonant with both the short- and long-term energy policies and goals of the island of Hawaii, Hawaii Electric Light Company and its parent, Hawaiian Electric Company and the State (see DPED, 1982a, 1984 and 1985a). Geothermal resource exploration, development and use is being pursued and encouraged in the east rift zone and the proposed project is consonant with those plans. Further, the federal and State governments along with Hawaiian Electric Company and several other private firms, are pursuing the Hawaii Deep Water Cable Program that is designed to determine the technical and economic feasibility of intertying the islands of Hawaii and Oahu with a high voltage direct current underwater electrical transmission cable. Positive results from this program could lead to the implementation of a commercial cable that would be capable of transmitting geothermally produced electric power from the island of Hawaii to Oahu, thereby further reducing the State's dependence on imported fuel oil. One of the key determinants of the economic feasibility of such a cable is the continued and increased development of the State's geothermal resources especially those located in the Kilauea east rift zone. An important economic benefit of geothermal resource development coupled with the underwater cable will be the retention in the State of much of the $1.2 billion which now leaves the State each year for the purchase of imported petroleum. This retention of monies within the State, along with increased tax revenues, employment revenues, royalty payments and increased purchases of goods and services within the State and County of Hawaii are further substantiation of the consistency of the proposed project with the stated policies and plans for the area.

## VI. PERMITS REQUIRED FOR GEOTHERMAL DEVELOPMENT ACTIVITIES

Except for the land use or Conservation District Use Permit, all other permitting requirements related to geothermal development operations within the jurisdiction of the Board or the Department of Land & Natural Resources are defined in DLNR Administrative Rules, Sub-Title 7, Water and Land Development Chapter 183, Rules on Leasing and Drilling of Geothermal Resources:

(1) The geothermal mining lease, upon issuance by the Board, will "convey to the lessee, the exclusive rights to drill, discover, develop, operate, utilize and sell geothermal resources," granting a primary, ten-year period with continuation periods subject to the conditions defined and will describe all other terms and conditions under which the geothermal development activities will be conducted.

(2) The Plan of Operations must be submitted to the Chairman for Board approval prior to commencing operations of any kind. The Plan of Operations requires specific and detailed data on the level of activity for which the plan is prepared, with the provision that after completion of the operations so authorized, any new or expanded oprations will require a new or amended plan of operations to be submitted in writing to the Chairman for approval in writing. In addition, the Plan of Operations must include provisions for monitoring

to insure compliance with the rules for operations. (The Plan of Operations, on approval, is assumed to be the basic operating permit that will govern and control the incremental development stages within the geothermal resource sub-zone up to the level approved in the land-use permit or CDUA.)

(3) Prior to conducting any drilling operations, an application for permit to drill must be submitted to the Chairman (BLNR) for approval accompanied by plot plans, drawings, and other data required by this rule, with the provision that changes to the original permit require written approval.

(4) Various after action and summary reports on project activity are required to be submitted to the Department of Land and Natural Resources in accordance with the Rules.

(5) Under the rules, the operator for the project is responsible to monitor localized environmental impacts associated with specific activities conducted or caused by the operator. (It is planned that an environmental monitoring plan will be included in the Plan of Operations when it is submitted for approval.)

(6) After completing the analysis of a discovered resource that is determined to be economically producible to generate electricity, and upon identification of a market to utilize that power, an application for "authority to construct" or install an electrical generating facility will be submitted

to DLNR and the Department of Health. Design plans, including emission abatement systems and air dispersion models, will be included as supporting data to demonstrate that power plant emission controls will meet all applicable State and County standards.

Other environmental protection and/or construction permits required for the proposed project include: (1) Underground Injection Control Permit; County Geothermal Resource Permit; and County Building, Electrical, Plumbing, Grading, Grubbing, Stockpiling and Outdoor Lighting permits.

It is noted that site specific biological, archaeological and other environmental monitoring and survey reports generated during the development and progress of the project, will be submitted to appropriate agencies as required by the accepting authority (BLNR).

## SECTION VII
## UNRESOLVED ISSUES

The developer is aware of objections to geothermal development by some individuals including those who identify themselves as Pele Practitioners.

The responses to the comments and recommendations are included in Appendix D.

SECTION VIII
AGENCIES, ORGANIZATIONS AND INDIVIDUALS
CONSULTED IN THE PREPARATION OF THE
DRAFT SUP EIS

A. Agencies, Organizations and Individuals Consulted

The agencies, organizations and individuals listed below have been contacted and consulted about the proposed geothermal development project through (1) distribution of the SUP EIS Preparation Notice (NOP) and (2) personal contacts offering to conduct presentations on the proposed project. Letters from those who responded to the NOP requesting to be consulted parties to the SUP EIS and the responses to those letters are in Appendix B. Also included in Appendix B is a copy of the letter mailed to those organizations and individuals to whom an offer was made to meet for the purpose of describing the proposed project.

1. Agencies Consulted

<u>State</u>

Department of Planning and Economic Development
Department of Land and Natural Resources
Department of Health
Officer of Environmental Quality Control

<u>County of Hawaii</u>

Office of the Mayor
Deparment of Planning
Department of Research and Development

2. Organizations/Individuals Consulted On Request (See Appendix B)

Organizations

Sierra Club, Hawaii Chapter
Conservation Council for Hawaii

Individuals

Councilman Russel S. Kokubun, County Council
Ms. Sonia Javik, University of Hawaii at Hilo
Ms. Lehua Lopez
Ms. Mary Miho Finley
Ms. Diane Ley

B. Agencies, Organizations and Individuals Who Received a Copy of the SUP EIS Preparation Notice (NOP)

1. Agencies

Federal

U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. National Park Service

State

Department of Planning and Economic Development
Department of Health
Public Utilities Commission
University of Hawaii - Hawaii Institute of Geophysics
University of Hawaii - Hawaii Natural Energy Institute
University of Hawaii - Environmental Center
Office of Hawaiian Affairs

County

County Council
Planning Department
Department of Public Works
Department of Water Supply
Department of Research and Development
Civil Defense Agency
Fire Department

Comments and responses to the NOP are included in Appendix B.

2. Organizations/Individuals

Organizations

Alu Like, Inc.
Big Island Business Council
Filippino Chamber of Commerce
Business Association
HGEA ASSCME Local 152
Hawaii Electric Light Co.
Hawaii Island Board of Realtors
Hawaii Island Chamber of Commerce
Hawaii Island Contractors Association
Hawaii Island Economic Development Board
Japanese Chamber of Commerce
Kalapana Community Association
Volcano Community Association
Fair Contracting Co., Ltd.

Individuals

Mr. Andres Narido
The Honorable Andrew Levin
The Honorable Dwight Takamine
The Honorable Harvey S. Tajiri
The Honorable Malama Solomon
The Honorable Richard Henderson
The Honorable Richard Matsuura
The Honorable Robert Lindsey
The Honorable Virginia Isbell
The Honorable Wayne Metcalf, III

C. Agencies, Organizations and Individuals on the Island of Hawaii With Whom Informational Meetings Were Held. (An informational memorandum was distributed at each meeting.)

Clinton Taylor, Executive Director
Hawaiian Islands Economic Development Board

John Decanto
HGEA ASSCME Local 152

Rina Bugado
Hawaiian Island Board of Realtors

Roy Blackshear
Hawaii Island Chamber of Commerce

Larry Isemoto, Albert Nishimura and Albert Nakai
Japanese Chamber of Commerce

Sharon Scheele, President
Big Island Business Council

Norman Oss, President, and George Jenkins
HELCO

Henry Otani
Fair Contracting

Jaine Tomas and Angelo Kagowon
Filipino Business Association

Members of the Hawaii County Council

Al Lyman and Staff, Department of Planning
Hawaii County

Emma Kauhi, President, and approximately 50 members
Kalapana Community Organization

Volcano Community Association (six meetings)
Board of Directors and various members at one or more meetings, including: Ken Kupchek, Mary Finley, Russell Kokubon, Diane Ley, Wendell and Kathleen Ing, Dan Taylor, Jim Jacobi (U. S. Fish & Wildlife Service), and David Ames, Superintendent Volcanoes National Park. Jim Moulds (Kalapana Community Organization) attended several of these meetings.

Al Konishi, Director, Dept. of Economic Development
Hawaii County

Mayor Dante Carpenter and Gene Tiwanak

Eleanor Ahuna, Kupuna

Kahoe Homesteads Residents
Carl and Melissa Kirkendall, Steve Garvey and Mr. Parreira

James Kimo Ahina
Leilani Estates

Eugene Tao, Editor
Hawaii Tribune Herald

Alu Like
Big Island Business Council

D. Letters were sent to the following organizations and associations offering to provide informational meetings on the proposed geothermal project (see Appendix B for example letter):

Puna Hui Ohana
Department of Water Supply (Hilo)
Hui O Puna Jaycees
Kona Outdoor Circle
League of Women Voters of Hawaii County
Pahoa Filipino Club
Pahoa Nikkei Jin Kai
Puna Lions Club
AFL-CIO Building & Construction Trades Council
Hawaii Society of Professional Engineers
ILWU Local 142 Hawaii Division
United Public Workers
Portuguese Chamber of Commerce
Kanoelehua Industrial Area Association
'Ainaloa Community Association
Fern Acres Community Association
Mauna Loa Estates
Aloha Estate Community
Leilani Estates Community Association
Hawaiian Orchid Isle Estates Community Association
Nanawale Estates Community Association
Hawaiian Acres Community Association
Fern Forest Community Association
Hawaii Legal Corporation
Puna Community Council
Puna Geothermal Committee
Puna Speaks
Conservation Council for Hawaii

The following identifies the meetings held between August and November 1985.

| | |
|---|---|
| August 6<br>7:00 p.m. | Various civic organizations from Big Island |
| August 6 | Al Konishi, Director Econ. Dev., Big Island |
| August 7<br>9:30 a.m. | Hawaii County Council |
| August 7<br>Noon | Big Island business representatives<br>Chamber of Commerce members |

| | |
|---|---|
| August 7<br>8:00 p.m. | Kalapana Community Association |
| August 8<br>8:30 a.m. | Hawaii Planning Department<br>(Al Lyman, Ilima Piianaia) |
| August 19<br>Noon | Moanikeala Akaka, OHA Trustee |
| September 11 | Alu Like (Kamuela, Hawaii) |
| September 11<br>8:00 a.m. | Mayor Dante Carpenter and Staff |
| September 11 | Eleanor Ahuna |
| September 11 | Eugene Tao, Editor<br>Hawaii Tribune-Herald |
| September 13 | James (Kimo) Ahia, Leilani Estates |
| September 13 | Hawaii Island Economic Development Board |
| September 13<br>3:00 p.m. | Conservation Council of Hawaii<br>Rick Scudder |
| September 15<br>9:00 a.m. | Volcano Community Association |
| September 23 | Volcano Community Association |
| September 25<br>1:00 p.m. | Volcano Community Association |
| September 25<br>7:00 p.m. | Kaohe Homesteads Residents |
| September 26<br>10:00 a.m. | Volcano Community Association |
| September 29 | Fern Forest Community Association |
| October 1<br>7:00 p.m. | Kupunas from Big Island<br>(Ed Kanahele, Alika & Anita Lancastre,<br>Alice Aumoe, Kawaileleo Hiilawe, C. Ruiz) |
| October 2<br>Noon | Big Island Business Council |

| | |
|---|---|
| October 2<br>4:00 p.m. | Volcano Community Association |
| October 2<br>7:00 p.m. | Kalapana Community Organization |
| October 6 | Volcano Community Association |
| October 9<br>4:00 p.m. | Palekapu Dedman, Sam Kaluna, John Kalani, Palekapu's mother (Punaluu) |
| 7:00 p.m. | Richard Lyman, Historian/BE Trustee, President |
| October 12 | Volcano Community Association |
| October 15 | Volcano Community Association |
| October 16 | Kaohe Homesteads Residents (Perreira, Oishi, Kirkendall, and Kuwahara) |
| October 17<br>Noon | Ruby Johnson, UH Hawaiian Studies |
| October 18 | Kent Keith, Director DPED<br>Dr. T. Yoshihara, Staff |
| October 31 | Kaohe Homesteads Residents (Melissa & Karl Kirkendall, Jonika Perreira, Joseph Kamelamela, Lyles Larkin, Rene Siraeusa, Mark Ornsly, Stephen M. Avery, C. A. Holzgrove, Q. W. Summers, and Terry Kelly) |
| November 1 | Keoni Dudley<br>Instructor, Hawaiian Religion |
| November 5 | UH Hilo Hawaiian Studies Students<br>Jessica Kaihaina, President<br>Skip Ione |
| November 20 | Dr. Donald Mitchell, Bishop Museum |
| December 8 | The Reverend William H. Kaina |

As indicated in the preceding, a total of 37 meetings were held with various federal, State and County agencies, citizen groups and individuals. Also, as noted, letters were sent to 30 organizations offering to meet to discuss the proposed project.

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# PARTICIPATING CONSULTANTS

| | |
|---|---|
| Dr. Andrew J. Berger: | Birds and Mammals |
| Ms. Winona P. Char: | Plants/Ecosystems |
| Dr. Charles H. Lamoureaux: | Plants/Ecosystems |
| Ms. Duk Hee Murabayashi: | Social/Economic Impacts |
| Industrial Analytical Laboratory, Inc.: | Soil and Leaf Tissue Analysis |
| Dr. Anders Daniels: | Air Dispersion Modelling |
| Dr. Thomas Shroeder: | Air Dispersion Modelling |
| Mr. Paul Hariguchi: | Wind/Climatology |
| Darby and Associates: | Sound/Noise Quality |
| Dr. James E. Houck: | Air Quality |
| Mr. Lyle E. Pritchette: | Air Quality |
| Dr. John A. Cooper: | Air Quality |
| Mr. Gerald Niimi: | Geology/Geothermal Resource Potential |
| Dr. George P. L. Walker: | Geology/Geologic Hazards |
| Dr. Charles Helsley: | Geology/Resource Potential |
| Dr. Paul Rosendahl: | Archaeology |
| Dr. Tommy Holmes: | Archaeology/Historic Sites |
| Yamada Enterprises: | Road Alignment and Facility Sites |
| Mr. Gordon A. Chapman: | SUP EIS Preparation |
| KFC Airports: | Graphics Preparation |

# APPENDIX A

# ECOSYSTEM TYPE DESCRIPTION AND PLANT SPECIES CHECKLIST FOR PUNA FOREST RESERVE

Ecosystem Types

1. Lava flows (lava)--Lava flows of different ages can be observed in the project area. These flows are fairly recent and generally are sparsely vegetated. On pahoehoe flows colonization by plants takes place mainly along joint cracks and fissures; on 'a'a flows plants are found scattered over the flow. These different aged lava flows present a series of stages in the succession of vegetation in the climax 'ohi'a forest characteristic of this area.

Two series of flows cover rather extensive areas within the project site. The Pu'u O'o flows (1983 to present) consist largely of 'a'a lava. They are completely barren and, in some places, are still steaming. Newer flows often pour over the earlier flows.

The 1977 flows are a mixture of 'a'a and pahoehoe lavas. The flows support a few, scattered, small 'ohi'a plants. The introduced sword-fern (Nephrolepis multiflora) is quite common. Other plants found widely scattered over the flows include mamaki (Pipturus hawaiiensis), Buddleja asiatica, bamboo orchid (Arundina bambusaefolia), and broom-sedge (Andropogon virginicus). Lichen cover (Stereocaulon vulcani) on the 'a'a lavas may vary from 30 to 40%.

Part of the 1955 lava flow is also included within the study area. The flow consists of 'a'a which is densely covered with Stereocaulon. Higher plant cover varies from 20 to 30%. The vegetation consists primarily of 1 to 3 m tall 'ohi'a with many smaller individuals less than 15 cm tall. Other species occasionally seen on the flow include those species already mentioned in the preceeding paragraphs as well as moa (Psilotum nudum), Spathoglottis plicata, 'amau (Sadleria spp.), 'ohelo (Vaccinium reticulatum), and pukiawe (Styphelia tameiameiae).

2. 'Ohi'a-uluhe woodland (ohia-uluhe)--This ecosystem type covers large areas within the study site. It is usually composed of widely spaced trees with an almost continuous carpet of uluhe fern (Dicranopteris spp.)beneath. In some places, however, the 'ohi'a tree canopy may be nearly closed. The 'ohi'a-uluhe woodland may vary in size from low to tall

stature trees in different localities but in any one stand the trees are fairly uniform in size. The dense fern cover prevents the establishment of many seedlings and as a result only a few scattered plants such as kopiko (Psychotria hawaiiensis), 'uki (Machaerina angustifolia), Malabar melastome (Melastoma malabathricum), and bamboo orchid can be found in the thick uluhe mats.

The 'ohi'a-uluhe woodland is interpreted as one of several stages in the normal succession leading to a closed-canopy 'ohi'a forest on relatively wet 'a'a and pahoehoe flows. Jacobi (1985) noted that the rate of vegetation development may be significantly influenced by the type of lava flow the plants have to grow on. In wet habitats the fastest rate of development towards an 'ohi'a forest is found on broken lava substrates--'a'a or "shelly" pahoehoe.

As this ecosystem represents an early developmental stage in succession towards a closed-canopy 'ohi'a-treefern forest, it does not contain a large number of different species. Rare or endangered plant species are usually not found in this ecosystem type.

Some of the 'ohi'a-uluhe woodlands on the eastern part of the State-owned lands proposed for exchange (i.e., those adjacent to the disturbed "ohia-b" forests) may have been logged at one time. Several old, narrow gauge railway beds lead into the area.

3. 'Ohi'a forest--The following discussion is drawn largely from the report by Char and Lamoureux (1985).

This ecosystem type covers extensive portions of the study area. The dominant tree in this forest type is 'ohi'a or 'ohi'a lehua (*Metrosideros collina*); all three varieties of *M. collina* occur in these forests. However, on the older substrates large trees of *M. collina* var. *macrophylla* are dominant (Stemmermann 1983).

'Ohi'a forests occur in moderately moist to wet situations at fairly low to middle elevations and show variation in structure and composition in different habitats. Four different kinds of 'ohi'a forests are recognized in this study and are discussed in the following sections. Often there is no sharp boundary between these different kinds of forest, and one kind usually grades into the other.

a. Wet 'ohi'a forest with native species (ohia-a(1))--This forest type occurs within the western portion of the study area in the Wao Kele O Puna Natural Area Reserve and is found on moderately old lava substrates. While large unbroken tracts of wet 'ohi'a forests are found in the adjoining Kahauale'a lands, within the study area these wet 'ohi'a forests are smaller and are fragmented by recent lava flows and 'ohi'a forests which have been disturbed to some extent.

The wet 'ohi'a forest with native species is the least disturbed ecosystem type within the study area and is the best example of a more or less intact wet native forest community. Exotic (or introduced) plant species are confined primarily to the trailsides and within the forest (away from trails) they are relatively rare or uncommon except where pigs have rooted or wallowed. Most of these exotic plants are grasses, sedges or herbs and include such species as Hilo grass (*Paspalum conjugatum*), broomsedge (*Andropogon virginicus*), Vaseygrass (*Paspalum urvillei*), *Cyperus haspan*, water purselane (*Ludwigia palustris*), *Hypericum* spp., *Drymaria cordata*, and fireweed (*Erechtites valerianaefolia*). A few scattered shrubs of strawberry guava (*Psidium cattleianum*) and Malabar melastome (*Melastoma malabathricum*) may sometimes be encountered.

These wet 'ohi'a forests with native species are generally closed canopy forests (>60% cover) and are composed largely of mature, tall statured (>10 m) 'ohi'a trees. Trees with trunks 1 to 1.5 m in diameter are not uncommon.

Beneath the 'ohi'a trees is a subcanopy layer of native trees, 8 to 10 m tall, which include kawa'u (*Ilex anomala*), olapa (*Cheirodendron trigynum*), alani (*Pelea clusaefolia*), and kopiko (*Psychotria hawaiiensis*). Treeferns (*Cibotium* spp.) form a third layer, 3 to 5 m tall, which is often dense. A number of shrubs and smaller trees are found scattered among the treeferns. These commonly include kanawao (*Broussaisia arguta*), pilo (*Coprosma* spp.), several *Cyrtandra* species, *Clermontia parviflora*, and 'akia (*Wikstroemia sandwicensis*). Patches of uluhe (*Dicranopteris* spp.) are found scattered throughout the forest, especially in areas where the canopy cover is more open. A large number of terrestrial and epiphytic ferns is found in this forest type. Liverworts and mosses are abundant and form thick mats on the trunks of trees.

In the lower elevation wet 'ohi'a forests such as those in the southwest corner of the State-owned lands proposed for exchange, the composition of the subcanopy layer begins to change. Lama (*Diospyros ferrea*) and kopiko become the common elements in this layer, while the treefern layer begins to thin out.

b. Wet 'ohi'a forest with native species and exotic shrubs (ohia-a(2))--The ohia'a(2) forest is more or less similar in composition and structure to the less disturbed ohia'a(1) forest discussed previously. It may have a closed or open canopy. Exotic species, primarily strawberry guava (*Psidium cattleianum*) and Malabar melastome, are found scattered throughout the forest but are predominant in areas which have been disturbed. Patches of exotic grasses and uluhe are also more frequently encountered. The tree fern layer may not be as well-developed as in the ohia-a(1) forests.

The ohia-a(1) and a(2) forests adjacent to lava flows have been damaged by fire and volcanic fumes. As a result, there is usually a strip of disturbed forest, 5 to 10 m wide, with standing dead 'ohi'a trees bordering the recent flows. Because of the opening of the vegetation and increase in light, there is an abundance of introduced plants such as sword fern, Hilo grass, _Cyperus haspan_, _Pluchea odorata_, _Buddleja_, and broomsedge. _Clidemia hirta_ (a noxious weed) was found in this type of area in the Natural Area Reserve at 1900 ft. elevation.

The ohia-a(1) and a(2) forests in the State-owned lands proposed for exchange lie within the lowland rainforest habitat. Jacobi (1985) notes that this habitat contains a number of plants which have their distribution restricted to, or attain their greatest abundance, below 2,500 ft. elevation. Unique features of the lowland forests include the incorporation of such subcanopy and shrub species as 'ahakea (_Bobea timoniodes_), mehamehame (_Antidesma platyphylla_), and olomea (_Perrottetia sandwicensis_). Certain of the _Cyanea_ and _Cyrtandra_ species are only found in these lowland forests.

Unfortunately, these lowland habitats have generally been heavily impacted by human activities in Hawai'i. Direct impacts include logging and clearing of forests; indirect impacts include habitat degradation by introduced animals such as pigs and cattle and introduced plants such as strawberry guava, Malabar melastome, and _Clidemia_.

It has been estimated that less than 10% of the original area of lowland 'ohi'a rainforest remains in the State today, and most of it contains at least a minor complement of introduced species (Jacobi 1985).

c. _'Ohi'a-kukui forest with mixed native and exotic shrubs (ohia-a(3))_--This forest type is similar to the ohia-a(2) forest but contains a certain admixture of kukui (<u>Aleurites moluccana</u>) trees and other exotic tree and shrub species (Mueller-Dombois 1985). These wet 'ohi'a kukui forest units are easily recognized on the orthophotoquads. They occur at 2000 ft. elevation on relatively old substrate, usually ash soils.

Kukui is a Polynesian introduction, and the Hawaiians most likely cultivated some parts of this forest. The 'ohi'a-kukui forests examined during this survey contained plants of 'awa (<u>Piper methysticum</u>), 'awapuhi-kua hiwi (<u>Zingiber zerumbet</u>), pi'ia (<u>Dioscorea pentaphylla</u>), Hawaiian bamboo (<u>Schizostachyum glaucifolium</u>), and ti (<u>Cordyline terminalis</u>). More recently introduced plants such as jack-fruit (<u>Artocarpus heterophyllus</u>), avocado (<u>Persea americana</u>), and <u>Philodendron</u> sp. were found in these forests. Strawberry guava and Malabar melastome shrubs may form a dense under-story in these 'ohi'a-kukui forests.

d. <u>'Ohi'a forest with exotic subcanopy and shrub layers (ohia-b)</u>--This forest type can be found on the eastern portions of the study area, often adjacent to agricultural lands. The forests may consist of medium to tall stature trees with open or closed canopies. This forest type is often hard to distinguish from the ohia-a(2) forests on the orthophotoquads, especially if the canopy is closed. The understory layers of these forests have, at some time in the past, been more or less greatly disturbed, as exotic species dominate.

Tall strawberry guava forms a dense subcanopy layer, 6 to 7 m tall, while smaller guava plants, 1 to 3 m tall, make up the shrub layer. Malabar melastome is usually a common component of the shrub layer. The ground beneath is usually heavily shaded and groundcover often consists of basketgrass (Oplismenus hirtellus), thimbleberry (Rubus rosaefolius), downy wood fern (Christella dentata), 'awapuhi-kua-hiwi (Zingiber zerumbet), swordfern, and strawberry guava seedlings of all sizes. Other exotics found in this type of 'ohi'a forest include honohono (Commelina diffusa), Spathoglottis plicata, ti (Cordyline terminalis), pi'ia (Dioscorea pentaphylla), a number of ginger species (Hedychium spp.), Hilo grass, and rose apple (Syzygium jambos).

Native species such as lama, treeferns, 'ie'ie, and kopiko are occasional to uncommon.

The more open areas of these forests are usually filled with tangled mats of uluhe.

TABLE 1. PLANT SPECIES CHECKLIST--Middle East Rift Zone of Kilauea, Puna, Hawai'i.

Families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocotyledons, and Dicotyledons. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux's unpublished checklist of Hawaiian ferns; taxonomy and nomenclature of the flowering plants (Monocotyledons and Dicotyledons) follow St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973).

For each species the following information is provided:

1. Scientific name with author citation.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of the species. The following symbols are used:

   E = endemic = native to the Hawaiian Islands only, not occurring naturally elsewhere.

   I = indigenous = native to the Hawaiian Islands and also to one or more other geographic areas.

   P = Polynesian = plants of Polynesian introduction; all those plants brought by the Polynesian immigrants prior to contact with the Western world.

   X = exotic or introduced = not native to the Hawaiian Islands; brought here intentially or accidentally by man after Western contact.

4. Ecosystem types. Six major ecosystem types are recognized in the study area and are discussed in detail in the report. The number heading each of the columns refers to the following ecosystem types:

1 = Lava flows

2 = 'Ohi'a-uluhe woodland

3a = Wet 'ohi'a forest with native species

3b = Wet 'ohi'a forest with native species and exotic shrubs

3c = 'Ohi'a-kukui forest with mixed native and exotic shrubs

3e = 'Ohi'a forest with exotic subcanopy and shrub layers

Within each of the ecosystem type columns the relative abundance of each species (or absence) is given. These ratings reflect the abundance of the particular species within the study area and are not applicable to areas outside the study area. The following symbols are used:

A = abundant = generally the major of dominant species in a given ecosystem type.

C = common = generally distributed throughout a given ecosystem type in large numbers.

LC = locally common = found in large localized patches, although within the ecosystem type it may also occur in large numbers.

O = occasional = generally distributed throughout a given ecosystem type.

U = uncommon = observed infrequently but more than 10 times in a given ecosystem type.

R = rare = observed 1 to 10 times in a given ecosystem type.

5. An asterisk (*) before a species name indicates that it is currently under review by the U. S. Fish and Wildlife Service (1980).

TABLE 1

PLANT CHECKLIST FOR PUNA FOREST RESERVE

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| FERNS AND FERN ALLIES | | | | | | | | |
| ADIANTACEAE | | | | | | | | |
| Adiantum hispidulum Sw. | maiden hair fern | X | - | - | - | - | R | - |
| ASPLENIACEAE | | | | | | | | |
| Asplenium contiguum Kaulf. | | E | - | - | O | O | U | U |
| Asplenium lobulatum Mett. | pi'ipi'i-lau-manamana, 'anali'i | I | - | - | O | O | U | - |
| Asplenium nidus L. | 'ekaha | I | - | - | R | - | R | R |
| ATHYRIACEAE | | | | | | | | |
| Athyriopsis japonica (Thunb.)Ching | | X | - | - | O | LC | LC | - |
| Athyrium microphyllum (J. Sm.)Alston | 'akolea | E | - | - | U | U | - | - |
| Diplazium sandwichianum (Presl)Diels | ho'i'o | E | - | - | O | U | R | R |
| BLECHNACEAE | | | | | | | | |
| Blechnum occidentale L. | blechnum fern | X | - | - | U | U | O | O |
| Sadleria cyatheoides Kaulf. | 'ama'u | E | U | U | U | U | U | R |
| Sadleria pallida Hook. & Arn. | 'ama'u | E | - | - | R | R | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| DENNSTAEDTIACEAE | | | | | | | | |
| Microlepia strigosa (Thunb.)Presl | palai, palapalai. | I | - | - | U | U | U | R |
| DICKSONIACEAE | | | | | | | | |
| Cibotium chamissoi Kaulf. | hapu'u-'i'i | E | - | - | C | C | C | O |
| Cibotium glaucum (J. Sm.)Hook. & Arn. | hapu'u | E | - | - | A | C | O | O |
| Cibotium hawaiense Nakai & Ogura | meu | E | - | - | R | R | - | - |
| ELAPHOGLOSSACEAE | | | | | | | | |
| Elaphoglossum alatum Gaud. var. parvisquameum (Skottsb.)Ands. & Crosby | 'ekaha-ula, hoe-a-Maui | E | - | - | O | O | O | O |
| Elaphoglossum crassifolium (Gaud.) And. & Crosby | 'ekaha-ula, hoe-a-Maui | E | - | U | O | O | O | O |
| GLEICHENIACEAE | | | | | | | | |
| Dicranopteris emarginata (Brack.)Rob. | uluhe | E | R | A | LC | LC | LC | LC |
| Dicranopteris linearis (Burm.)Underw. | uluhe | I | R | A | LC | LC | LC | LC |
| GRAMMITACEAE | | | | | | | | |
| Adenophorus hymenophylloides (Kaulf.) Hook. & Grev. | pai, palai-huna | E | - | - | U | U | - | R |
| Adenophorus pinnatifidus Gaud. | | E | - | - | O | O | U | U |
| Adenophorus tamariscinus (Kaulf.) Hook. & Grev. var. tamariscinus | wahine-noho-mauna | E | - | R | O | O | O | U |
| Adenophorous periens | | E | Sighted during USFWS Survey only | | | | | |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| Adenophorus tripinnatifidus Gaud. | | E | - | - | U | - | - | R |
| Grammitis hookeri (Brack.)Copel | maku'e-lau-li'i | E | - | - | O | U | U | - |
| Grammitis tenella Kaulf. | kolokolo, mahina-lua | E | - | U | O | O | O | - |
| HEMIONITIDACEAE | | | | | | | | |
| Pityrogramma calomelanos (L.)Link | gold fern, silver fern | X | R | R | - | - | - | - |
| HYMENOPHYLLACEAE | | | | | | | | |
| Callistopteris baldwinii (Eaton)Copel. | | E | - | - | R | R | - | - |
| Gonocormus minutus (Blume) v. d. Bosch | | I | - | - | R | - | - | R |
| Mecodium recurvum (Gaud.)Copel. | 'ohi'a-ku | E | - | - | C | O | O | O |
| Sphaerocionium lanceolatum (Hook. & Arn.) Copel. | palai-hinahina | E | - | - | C | O | - | - |
| Sphaerocionium obtusum (Hook. & Arn.) Copel. | palai-lau-li'i | E | - | - | O | O | - | R |
| Vandenboschia cyrtotheca (Hillebr.)Copel. | | E | - | - | - | - | R | R |
| Vandenboschia davallioides (Gaud.)Copel. | palai-hihi | E | - | - | R | R | R | - |
| LINDSAEACEAE | | | | | | | | |
| Lindsaea ensifolia Sw. var. ensifolia | | I | - | R | - | - | - | - |
| Sphenomeris chinensis (L.)Maxon | pala'a, palapala'a | I | R | U | U | U | U | O |
| LYCOPODIACEAE | | | | | | | | |
| Lycopodium cernuum L. | wawae-'iole | I | U | O | O | O | - | O |
| Lycopodium phyllanthum Hook. & Arn. | wawae-'iole | E | R | U | U | U | U | U |
| Lycopodium venustulum Gaud. | wawae-'iole | I | - | - | U | U | - | R |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| NEPHROLEPIDACEAE | | | | | | | | |
| Nephrolepis biserrata (Sw.)Schott | fishtail sword fern | X | - | - | - | R | - | - |
| Nephrolepis cordifolia (L.)Presl | ni'ani'au, kupukupu, 'okupukupu | I | - | - | O | U | - | - |
| Nephrolepis exaltata (L.)Schott | ni'ani'au, kupukupu, pamoho | I | - | R | U | U | - | U |
| Nephrolepis multiflora (Roxb.) Jarrett ex Morton | hairy sword fern | X | C | U | O | O | C | LC |
| OPHIOGLOSSACEAE | | | | | | | | |
| Ophioglossum pendulum L. ssp. falcatum (Presl)Clausen | puapua-moa | E | - | - | U | U | U | U |
| POLYPODIACEAE | | | | | | | | |
| Phymatosorus scolopendria (Burm.)Pic.-Ser. | laua'e, lauwa'e | X | R | R | - | R | R | - |
| Pleopeltis thunbergiana Kaulf. | 'ekaha-'akolea, pakahakaha | I | R | R | R | R | R | O |
| Polypodium pellucidum Kaulf. | 'ae, 'ae-lau-nui | E | U | - | - | - | - | - |
| PSILOTACEAE | | | | | | | | |
| Psilotum complanatum Sw. | moa, pipi | I | - | - | O | O | U | R |
| Psilotum complanatum X nudum | hybrid moa | I | - | - | R | - | - | R |
| Psilotum nudum (L.)Beauv. | moa, pipi | I | U | U | U | U | U | O |
| PTERIDACEAE | | | | | | | | |
| Pteris vittata L. | | X | R | R | - | R | R | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| SELAGINELLACEAE | | | | | | | | |
| Selaginella arbuscula (Kaulf.)Spring | lepelepe-à-moa | E | - | - | R | R | R | - |
| THELYPTERIDACEAE | | | | | | | | |
| Christella cyatheoides (Kaulf.)Holtt. | kikawaio | E | - | - | R | R | - | R |
| Christella dentata (Forsk.)Brownsey & Jermy | downy woodfern | X | - | - | R | R | O | LC |
| Christella parasitica (L.)Levl. | woodfern, oakfern | X | - | - | R | R | R | O |
| Macrothelypteris torresiana (Gaud.)Ching | | X | R | - | U | U | U | R |
| Pneumatopteris sandwicensis (Brack.)Holtt. | | E | - | - | O | O | - | U |
| VITTARIACEAE | | | | | | | | |
| Vittaria elongata Sw. | oheohe | I | - | - | R | - | R | R |
| MONOCOTYLEDONS | | | | | | | | |
| COMMELINACEAE | | | | | | | | |
| Commelina diffusa Burm. f. | honohono | X | - | - | - | R | - | O |
| CYPERACEAE | | | | | | | | |
| Cyperus haspan L. | | X | - | - | U | O | LC | LC |
| Cyperus sp. 1 | | X | - | - | - | - | - | R |
| Cyperus sp. 2 | | X | - | - | - | R | - | - |
| Fimbristylis dichotoma (L.)Vahl | tall fringe rush | I | - | O | U | U | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| Machaerina angustifolia (Gaud.)Koyama | 'uki | I | O | O | U | U | - | U |
| Machaerina mariscoides (Gaud.) Kern ssp. meyenii (Kunth)Koyama | 'uki, 'aha-niu | I | R | R | U | U | R | R |
| Pycreus polystachyos (Rottb.)Beauv. | | I | R | O | R | R | R | U |
| DIOSCOREACEAE | | | | | | | | |
| Dioscorea pentaphylla L. | pi'ia, pi'a | P | - | - | R | R | O | O |
| GRAMINEAE | | | | | | | | |
| Andropogon glomeratus (Walt.)BSP. | bush beardgrass | X | - | O | - | - | - | - |
| Andropogon virginicus L. | broomsedge | X | O | O | U | U | U | U |
| Axonopus affinis Chase | narrow-leaved carpetgrass | X | - | - | R | R | U | O |
| Brachiaria mutica (Forsk.)Stapf | Californiagrass | X | - | - | - | - | - | U |
| Isachne distichophylla Munro ex Hillebr. | ohe | E | - | - | LC | O | U | - |
| Melinis minutiflora Beauv. | molassesgrass | X | - | - | - | - | - | R |
| Oplismenus hirtellus (L.)Beauv. | honohono-kukui, basketgrass | X | - | - | - | - | U | O |
| Paspalum conjugatum Berg. | mau'u-Hilo, Hilo grass | X | - | - | U | O | O | C |
| Paspalum orbiculare Forst. f. | mau'u-laiki, ricegrass | X | - | U | R | R | - | - |
| Paspalum urvillei Steud. | Vaseygrass | X | - | R | R | R | - | R |
| Sacciolepis indica (L.)Chase | Glenwoodgrass | X | - | U | U | O | O | C |
| Schizostachyum glaucifolium (Rupr.)Munro | ohe, Hawaiian bamboo | P | - | - | - | - | R | - |
| Setaria geniculata (Poir.)Beauv. | perennial foxtailgrass | X | - | - | - | - | R | - |
| Setaria palmaefolia (Koen.)Stapf | palmgrass | X | - | - | R | R | - | LC |
| JOINVILLEACEAE | | | | | | | | |
| Joinvillea ascendens Brongn. & Gris. | 'ohe | Ė | - | - | - | R | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| JUNCACEAE | | | | | | | | |
| Juncus effusus L. | | X | - | U | U | - | - | - |
| Juncus planifolius R. Br. | bog rush | X | - | U | U | - | - | - |
| Juncus tenuis Willd. | | X | - | - | - | R | - | - |
| LILIACEAE | | | | | | | | |
| Astelia menziesiana Sm. | pa'iniu | E | - | - | U | R | - | - |
| Cordyline terminalis (L.)Kunth var. terminalis | ki, ti | P | - | R | R | R | U | O |
| Smilax sandwicensis Kunth | hoi-kuahiwi | E | - | - | R | R | - | - |
| MUSACEAE | | | | | | | | |
| Musa sp. | mai'a, banana | P | - | - | - | R | R | R |
| ORCHIDACEAE | | | | | | | | |
| Arundina bambusaefolia (Roxb.)Lindl. | bamboo orchid | X | O | O | U | O | O | O |
| Phaius tankervilliae (Banks ex L'Her.)Bl. | | X | - | - | R | - | R | - |
| Spathoglottis plicata Bl. | Philippine ground orchid | X | R | U | R | R | U | U |
| PALMAE | | | | | | | | |
| Archontophoenix alexandrae (F. Muell.) H. Wendl. & Drude | Alexandra palm | X | - | - | - | - | - | R |
| Pritchardia beccariana Rock | lo'ulu | E | - | - | - | R | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| PANDANACEAE | | | | | | | | |
| Freycinetia arborea Gaud. | 'ie'ie | E | - | - | O | O | O | O |
| XYRIDACEAE | | | | | | | | |
| Xyris complanata R. Br. | | X | R | R | - | - | - | - |
| ZINGIBERACEAE | | | | | | | | |
| Hedychium coronarium Koenig in Retz. | 'awapuhi ke'oke'o, white ginger | X | - | - | - | - | - | O |
| Zingiber zerumbet (L.)Roscoe | 'awapuhi kua hiwi | X | - | - | - | U | O | LC |
| DICOTYLEDONS | | | | | | | | |
| APOCYNACEAE | | | | | | | | |
| Alyxia olivaeformis Gaud. | maile | E | - | - | O | O | O | U |
| AQUIFOLIACEAE | | | | | | | | |
| Ilex anomala Hook. & Arn. | kawa'u | E | - | - | O | U | U | R |
| ARALIACEAE | | | | | | | | |
| Cheirodendron trigynum (Gaud.)Heller | olapa | E | - | - | O | O | - | - |
| *Tetraplasandra hawaiensis Gray var. hawaiiensis | 'ohe | E | - | R | U | U | U | R |
| Tetraplasandra sp. | 'ohe | E | - | - | R | - | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| ASCLEPIADACEAE | | | | | | | | |
| Gomphocarpus physocarpus E. Mey. | balloon plant | X | - | - | - | R | - | - |
| BEGONIACEAE | | | | | | | | |
| Begonia sp. | begonia | X | - | - | R | - | R | - |
| CARYOPHYLLACEAE | | | | | | | | |
| Drymaria cordata (L.)Willd. ex R. & S. | drymaria, pipili | X | - | - | R | R | - | R |
| CELASTRACEAE | | | | | | | | |
| Perrottetia sandwicensis Gray var. sandwicensis | olomea | E | - | - | U | O | - | - |
| COMPOSITAE | | | | | | | | |
| Adenostemma lavenia (L.)Ktze. | kamanamana | I | - | - | R | R | - | - |
| Ageratum conyzoides L. | ageratum, maile-hohono | X | - | - | - | - | - | R |
| Ageratum houstonianum Mill. | ageratum | X | - | - | - | - | U | - |
| Crassocephalum crepidioides (Benth.)S. Moore | | X | - | - | R | R | - | - |
| Dubautia scabra (DC.)Keck | kupaoa | E | U | - | R | - | - | - |
| Erechtites hieracifolia (L.)Raf. | fireweed | X | R | U | U | U | U | U |
| Erechtites valerianaefolia (Wolf)DC. | fireweed | X | - | R | R | - | - | - |
| Erigeron bonariensis L. | hairy horseweed, ilioha | X | - | - | - | R | - | - |
| Eupatorium riparium Regel | Hamakua pamakani | X | R | - | R | R | U | U |
| Lapsana communis L. | nipplewort | X | - | - | - | R | - | - |
| Pluchea odorata (L.)Cass. | pluchea, shrubby fleabane | X | O | U | R | - | R | U |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| Vernonia cinerea (L.)Less. | ironweed | X | - | R | - | - | - | - |
| Youngia japonica (L.)DC. | oriental hawksbeard | X | - | - | U | U | - | - |
| EBENACEAE | | | | | | | | |
| Diospyros ferrea Bakh. ssp. sandwicensis (A. DC.)Bakh. | lama | E | - | - | U | U | O | U |
| EPACRIDACEAE | | | | | | | | |
| Styphelia tameiameiae (Cham.)F. Muell. var. tameiameiae | pukiawe | I | - | O | U | - | - | - |
| ERICACEAE | | | | | | | | |
| Vaccinium calycinum Sm. | 'ohelo-kau-la'au | E | - | - | O | O | - | - |
| Vaccinium reticulatum Sm. | 'ohelo | E | O | R | R | - | - | - |
| EUPHORBIACEAE | | | | | | | | |
| Aleurites moluccana (L.)Willd. | kukui | P | - | - | - | - | O | O |
| Antidesma platyphyllum Mann | hame | E | - | - | LC | O | U | U |
| FLACOURTIACEAE | | | | | | | | |
| Xylosma hawaiiense Seem. var. hillebrandii (Wawra)Sleumer | maua | E | - | - | R | - | - | - |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| **GESNERIACEAE** | | | | | | | | |
| Cyrtandra lysiosepala (Gray)C. B. Clarke | | E | - | - | R | R | - | - |
| Cyrtandra paludosa Gaud. var. integrifolia Hillebr. | | E | - | - | U | U | - | - |
| Cyrtandra paludosa Gaud. var. irrostrata St. John | | E | - | - | LC | LC | O | R |
| Cyrtandra platyphylla Gray | | E | - | - | - | R | - | - |
| Cyrtandra sp. | | E | - | - | R | U | - | R |
| Cyrtandra sp. nov. | | E | - | - | - | R | - | - |
| **GOODENIACEAE** | | | | | | | | |
| Scaevola chamissoniana Gaud. var. bracteosa Hillebr. | naupaka-kuahiwi | E | - | - | U | R | - | - |
| **GUTTIFERAE** | | | | | | | | |
| Hypericum degeneri Fosb. | | X | - | - | U | U | - | - |
| Hypericum mutilum L. | St. Johnswort | X | - | - | O | O | - | - |
| **LABIATAE** | | | | | | | | |
| Phyllostegia vestita Benth. | ulihi | E | - | - | R | - | - | - |
| **LAURACEAE** | | | | | | | | |
| Persea americana Mill | avocado | X | - | - | - | - | R | R |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| LEGUMINOSAE | | | | | | | | |
| Desmodium cajanifolium (HBK.)DC. | tree desmodium | X | - | - | - | - | - | R |
| Desmodium uncinatum (Jacq.)DC. | Spanish clover | X | - | U | U | - | - | U |
| Leucaena leucocephala (Lam.)de Wit | koa-haole, ekoa | X | - | - | - | - | R | - |
| LOBELIACEAE | | | | | | | | |
| Clermontia hawaiiensis (Hillebr.)Rock | 'oha-kepau | E | - | - | U | U | R | - |
| Clermontia parviflora Gaud. ex Gray | | E | - | - | O | O | U | - |
| *Cyanea tritomantha Gray | 'aku'aku, 'aku | E | - | - | R | R | - | - |
| LOGANIACEAE | | | | | | | | |
| Buddleja asiatica Lour. | butterflybush, huelo-'ilio | X | O | U | R | - | - | - |
| Labordia hedyosmifolia Baill. | | E | - | - | R | R | - | - |
| LYTHRACEAE | | | | | | | | |
| Cuphea carthagenensis (Jacq.)Macbride | cuphea, puakamoli | X | - | - | U | U | U | U |
| MELASTOMATACEAE | | | | | | | | |
| Clidemia hirta (L.)D. Don | Koster's curse | X | - | - | R | R | U | - |
| Heterocentron subtriplinervium (Link & Otto) A. Br. & Bouche | pearl flower | X | - | U | - | R | - | U |
| Melastoma malabathricum L. | Malabar melastome | X | - | O | U | LC | LC | A |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| MENISPERMACEAE | | | | | | | | |
| Cocculus ferrandianus Gaud. | huehue, hue'ie | E | R | U | R | U | U | R |
| MORACEAE | | | | | | | | |
| Cannabis sativa L. | marijuana, pakalolo | X | R | - | R | R | R | U |
| MYRSINACEAE | | | | | | | | |
| Embelia pacifica Hillebr. | kilioe | E | - | - | R | R | - | - |
| Myrsine lessertiana A. DC. | kolea-lau-nui | E | - | R | O | U | U | R |
| Myrsine sandwicensis A. DC. var. sandwicensis | kolea-lau-li'i | E | - | - | U | - | - | - |
| MYRTACEAE | | | | | | | | |
| Melaleuca quinquenervia (Cav.)Blake | paperbark | X | - | R | - | - | - | - |
| Metrosideros collina (J. R. & G. Forst.) Gray var. glaberrima (Levl.)Rock | 'ohi'a-lehua | E | C | C | C | C | C | C |
| Metrosideros collina (J. R. & G. Forst.) Gray var. incana (Levl.)Rock | 'ohi'a-lehua | E | A | A | U | U | U | U |
| Metrosideros collina (J. R. & G. Forst.) Gray var. macrophylla Rock | 'ohi'a-lehua | E | O | O | A | A | A | A |
| Psidium cattleianum Sabine forma cattleianum | strawberry guava, waiawi-'ulua | X | - | O | U | O | LC | A |
| Psidium cattleianum Sabine forma lucidum Deg. | yellow strawberry guava, waiawi | X | - | - | - | - | - | R |
| Psidium guajava L. | guava, kuawa | X | - | - | R | - | U | U |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| NYCTAGINACEAE | | | | | | | | |
| Pisonia umbellifera (J. R. & G. Forst.) Seem. | papala-kepau | I | - | - | - | - | U | R |
| ONAGRACEAE | | | | | | | | |
| Ludwigia octivalvis (Jacq.)Raven | kamole, primrose willow | I | - | - | - | U | U | U |
| Ludwigia palustris (L.)Ell. | water purselane | X- | - | - | U | U | U | - |
| PASSIFLORACEAE | | | | | | | | |
| Passiflora edulis Sims forma flavicarpa Deg. | yellow liliko'i | X | - | R | - | - | R | U |
| PIPERACEAE | | | | | | | | |
| Peperomia cf. lilifolia C. DC. | 'ala'ala-wai-nui | E | - | - | R | - | - | - |
| Peperomia cookiana C. DC. | 'ala'ala-wai-nui | E | - | - | U | U | - | - |
| Peperomia hypoleuca Miq. var. hypoleuca | 'ala'ala-wai-nui | E | - | - | O | O | O | U |
| Peperomia hypoleuca Miq. var. pluvigaudens (C. DC.)Yuncker | 'ala'ala-wai-nui | E | - | - | R | R | - | R |
| Peperomia sp. | 'ala-ala-wai-nui | E | - | - | - | R | - | - |
| Peperomia tetraphylla (Forst. f.) Hook. & Arn. var. tetraphylla | 'ala'ala-wai-nui | I | - | - | - | - | R | - |
| Piper methysticum Forst. f. | 'awa | P | - | - | - | - | U | - |
| ROSACEAE | | | | | | | | |
| Rubus ellipticus Sm. var. obcordatus Focke | yellow Himalayan raspberry | X | - | - | R | R | - | - |
| Rubus rosaefolius Sm. | thimbleberry | X | - | - | U | U | O | O |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| RUBIACEAE | | | | | | | | |
| *Robea timonioides (Hook. f.)Hillebr. | 'ahakea | E | - | - | U | U | - | - |
| Coprosma menziesii Gray | pilo, kopa | E | - | - | O | U | R | - |
| Coprosma ochracea Oliver var. rockiana Oliver | pilo, kopa | E | - | - | O | U | - | R |
| Coprosma rhyncocarpa Gray | pilo | E | - | - | U | U | - | - |
| Gardenia remyi Mann | nanu | E | - | - | R | - | - | - |
| Gouldia terminalis (Hook. & Arn.)Hillebr. | manono | E | - | - | O | O | U | - |
| Hedyotis centranthoides (Hook. & Arn.) Steud. forma centranthoides | Kilauea hedyotis | E | R | - | - | R | - | - |
| Hedyotis cf. corymbosa (L.)Lam. | | X | R | - | - | - | - | - |
| Paederia foetida L. | maile pilau | X | - | - | - | - | - | U |
| Psychotria hawaiiensis (Gray)Fosb. var. hawaiiensis | kopiko | E | - | U | C | C | O | O |
| RUTACEAE | | | | | | | | |
| Citrus limonia Osbeck | lemon | X | - | - | - | - | R | - |
| Citrus sp. | | X | - | - | - | - | R | - |
| Pelea clusiaefolia Gray var. cuneata St. John & Hume | alani | E | - | - | O | O | U | - |
| Pelea radiata St. John | alani | E | - | - | U | U | - | - |
| SAXIFRAGACEAE | | | | | | | | |
| Broussaisia arguta Gaud. | kanawao | E | - | - | C | C | O | O |
| SCROPHULARIACEAE | | | | | | | | |
| Castilleja arvensis Schlecht. & Cham. | field Indian paintbrush | X | R | - | - | - | - | R |
| Torenia asiatica L. | Ola'a beauty, nani-o-Ola'a | X | - | - | - | - | - | R |

| BOTANICAL NAME | COMMON NAME | STATUS | 1 | 2 | 3a | 3b | 3c | 3e |
|---|---|---|---|---|---|---|---|---|
| STERCULIACEAE | | | | | | | | |
| Waltheria indica L. var. americana (L.) R. Br. ex Hosaka | hi'aloa, 'uhaloa | I | - | R | - | - | - | - |
| THYMELAEACEAE | | | | | | | | |
| Wikstroemia sandwicensis Meisn. | 'akia | E | - | O | R | R | R | - |
| UMBELLIFERAE | | | | | | | | |
| Centella asiatica (L.)Urban | Asiatic pennywort, pohekula | X | - | - | - | - | - | U |
| URTICACEAE | | | | | | | | |
| Pipturus hawaiensis Levl. | mamaki | E | O | - | U | U | O | U |
| Pipturus sp. | mamaki | E | - | - | - | U | - | - |
| Touchardia latifolia Gaud. | olona | E | - | - | R | - | R | - |
| Urera sandvicensis Wedd. | [illegible] | E | - | - | U | U | R | - |
| VERBENACEAE | | | | | | | | |
| Stachytarpheta australis Mold. | Cayenne vervain | X | - | - | R | R | R | O |

## TABLE 2. SPECIES RECORDED DURING THIS SURVEY

Table 1 is a composite of all those species found within the study area by Char and Lamoureux (1985) and by the current survey teams. Species which were found during the course of this survey but not during the previous survey are:

Nephrolepis biserrata
Cyperus sp. 1
Pritchardia beccariana
Tetraplasandra sp.
Gomphocarpus physocarpus
Lapsana communis
Xylosma hawaiiense var. hillebrandii
Phyllostegia vestita
Peperomia aff. lilifolia
Peperomia sp.
Coprosma rhynchocarpa
Gardenia remyi

# APPENDIX B

## LETTERS TO/FROM AGENCIES, ORGANIZATIONS AND INDIVIDUALS REQUESTING TO BE CONSULTED PARTIES

## RESPONSES TO SUPPLEMENTAL EIS NOTICE

| DATE | WHO | COMMENTS |
|---|---|---|
| 9/13/85 | Hawaii County Fire Department | None. |
| 9/13/85 | Hawaii Electric Light Co., Inc. | None. |
| 9/16/85 | Department of Public Works<br>County of Hawaii | Comments, if any, sent to Planning Department. |
| 9/17/85 | Planning Department<br>County of Hawaii | None. |
| 9/18/85 | Public Utilities Commission<br>State of Hawaii | None. |
| 9/18/85 | Hawaii County Civil Defense Agency | Emergency plans must be developed to ensure public safety. |
| 9/18/85 | Office of Environmental Quality Control<br>State of Hawaii | Concerned about effects on wildlife in Puna Forest and noise and odor effects on nearby residents. |
| 9/18/85 | Department of Health<br>State of Hawaii | None. |
| 9/19/85 | United States Department of Interior<br>Fish and Wildlife Service | None. |
| 9/19/85 | Department of Planning and Economic Development<br>State of Hawaii | Identify purpose and need for land exchange; address quality of native forest areas in State property as compared with those at Kahauale'a. |
| 9/20/85 | Environmental Center<br>University of Hawaii at Manoa | General botanical overview including existing botanical surveys and information; detail and focus on specific site, roadways and well sites; potential impacts to avifauna. |

| DATE | WHO | COMMENTS |
|---|---|---|
| 9/20/85 | United States Department of the Interior | None. |
| 9/20/85 | County Council<br>County of Hawaii | None. |
| 9/23/85 | State of Hawaii<br>Department of Health | Comments inadvertently left out of 9/18 correspondence.<br>Air Pollution:<br>1. Does proposed land swap bring the proposed geothermal development area closer to people?<br>2. If two parcels are "approximately equivalent" for producing economically producible geothermal resources, why the land swap, especially if the move would place development closer to the population?<br>3. Fluid reinjection would help control air emissions, page 11.<br>4. Air emissions would also occur during well venting and plant stacking, page 24.<br>5. At higher concentrations $H_2S$ can become a health hazard, page 24.<br>6. Proper controls would be effective against fugitive dust emissions during construction, only if property applied and maintained. |

LEHUA LOPEZ
REALTOR

August 20, 1985

Mr. O.K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender,

I would like to be a consulted party to your Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project, in Puna, Hawaii.

Mahalo a nui loa.

Me ka ha'aha'a,

Lehua Lopez

Lehua Lopez

209 Kinoole Street #9 • Hilo, Hawaii 96720 • Ph. 968-6278 • 935-1661

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THE ESTATE OF JAMES CAMPBELL

August 27, 1985

Ms. Lehua Lopez
Lehua Lopez Realtor
209 Kinoole Street, #9
Hilo, HI 96720

Dear Ms. Lopez:

<u>Consulted Party of Supplemental E.I.S.</u>

This is in response to your letter dated August 20, 1985, requesting to be a consulted party of the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project.

Your request has been recorded and you will be notified of any meetings, hearings, or additional information.

Thank you for your interest.

Sincerely,

Gail A. Chew
Manager, Community Affairs

jo:04601

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

**CONSERVATION COUNCIL for HAWAII**
STATE BOARD AND OAHU CHAPTER • P.O. BOX 2923 • HONOLULU, HI 96802 • (808) 375-6969

August 20, 1985

22

Mr. O. K. Stender,
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

The Conservation Council for Hawaii requests to be a consulted party in the development of the supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project, Puna, Hawaii.

Please send us a copy of the Preparation Notice so that we may provide comments on the project.

Thank you for your assistance on this.

Sincerely,

Rick Scudder,
President



---

*THE ESTATE OF JAMES CAMPBELL*

August 27, 1985

Mr. Rick Scudder
President
Conservation Council for Hawaii
P. O. Box 2923
Honolulu, HI 96802

Dear Mr. Scudder:

<u>Consulted Party of Supplemental E.I.S.</u>

This is in response to your letter dated August 20, 1985, requesting to be a consulted party of the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project.

Your request has been recorded and you will be notified of any meetings, hearings, or additional information.

Thank you for your interest.

Sincerely,

Gail A. Chew
Manager, Community Affairs

jo:04601

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

19

August 15, 1985
P. O. Box 388
Mountain View, HI 96771

Mr. O.K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender,

Please add my name and address to your list of consulted parties for the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project on the Big Island.

Thank you,

Diane Ley

Diane Ley

THE ESTATE OF JAMES CAMPBELL

August 27, 1985

Ms. Diane Ley
P. O. Box 388
Mountain View, HI 96771

Dear Ms. Ley:

Consulted Party of Supplemental E.I.S.

This is in response to your letter dated August 15, 1985, requesting to be a consulted party of the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project.

Your request has been recorded and you will be notified of any meetings, hearings, or additional information.

Thank you for your interest.

Sincerely,

Gail A. Chew
Manager, Community Affairs

jo:04601

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

**SIERRA CLUB, HAWAI'I CHAPTER**
P.O. BOX 11070 HONOLULU, HAWAI'I 96828
(808) 946-8494

22

Mr. C.K. Strnder
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

August 20, 1985

Dear Mr. Stender,

Sierra Club requests to be a consulted party in the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project, Puna, Hawaii.

Areas of concern we would like to raise are included in our Position Paper on the land exchange and geothermal subzone (see enclosed) dated August 1, 1985.

In addition, we question if it is possible to produce a detailed Supplemental EIS when no final delineation has been made to designate a subzone, nor any lands exchanged?

Please send the Supplemental EIS and any hearing notices or correspondence to P.O. Box 590, Mountain View, Hawaii, 96771.

Thank you.

Sincerely,

N. Ho

Nelson Ho
Conservation Chair
Sierra Club, Hawaii Chapter

**SIERRA CLUB, HAWAI'I CHAPTER**
P.O. BOX 11070, HONOLULU, HAWAI'I 96828
(808) 946-8494

**SIERRA CLUB POSITION STATEMENT ON PROPOSED GEOTHERMAL SUBZONE IN MIDDLE EAST RIFT ZONE OF KILAUEA AND POSSIBLE LAND EXCHANGE WITH KAHAUALE'A**

Adopted August 1, 1985

The Board of Land and Natural Resources, in a December 1984 Decision, not only created a geothermal subzone at Kahauale'a, but also mandated that Campbell Estate and the Department of Land and Natural Resources consider creating a geothermal subzone in the Middle East Rift of Kilauea to replace the subzone at Kahauale'a.

If the following suggestions are implemented, it is Sierra Club's position that the Middle East Rift would be a more appropriate place for geothermal than Kahauale'a.

1. One guiding principle should be to subzone the least amount of high-quality, native forest on conservation land necessary for geothermal exploration and development.

2. The total acreage to be designated in the Middle East Rift should not exceed 5,300 acres, the acreage granted by the Board of Land and Natural Resources (BLNR) in creating a geothermal subzone at Kahauale'a in December, 1984.

Likewise, the total area of the initial exploration zone should not exceed 800 acres, the area granted by the BLNR in creating an exploratory zone at Kahauale'a.

3. We support, as did the BLNR's 1984 Decision, the acquisition of Tract 22 in Kahauale'a by Hawaii Volcanoes National Park (HVNP). This approximately 5000 acre parcel, adjacent to the National Park, is of wilderness quality.

4. The remaining acreage of Kahauale'a which is not aquired by the National Park should be rezoned to a Natural Area Reserve (NAR). This will help to compensate for the area to be lost in the Middle East Rift Zone through the cration of a new subzone and subsequent land exchange. This will also help provide a secure buffer zone from geothermal impacts for the National Park.

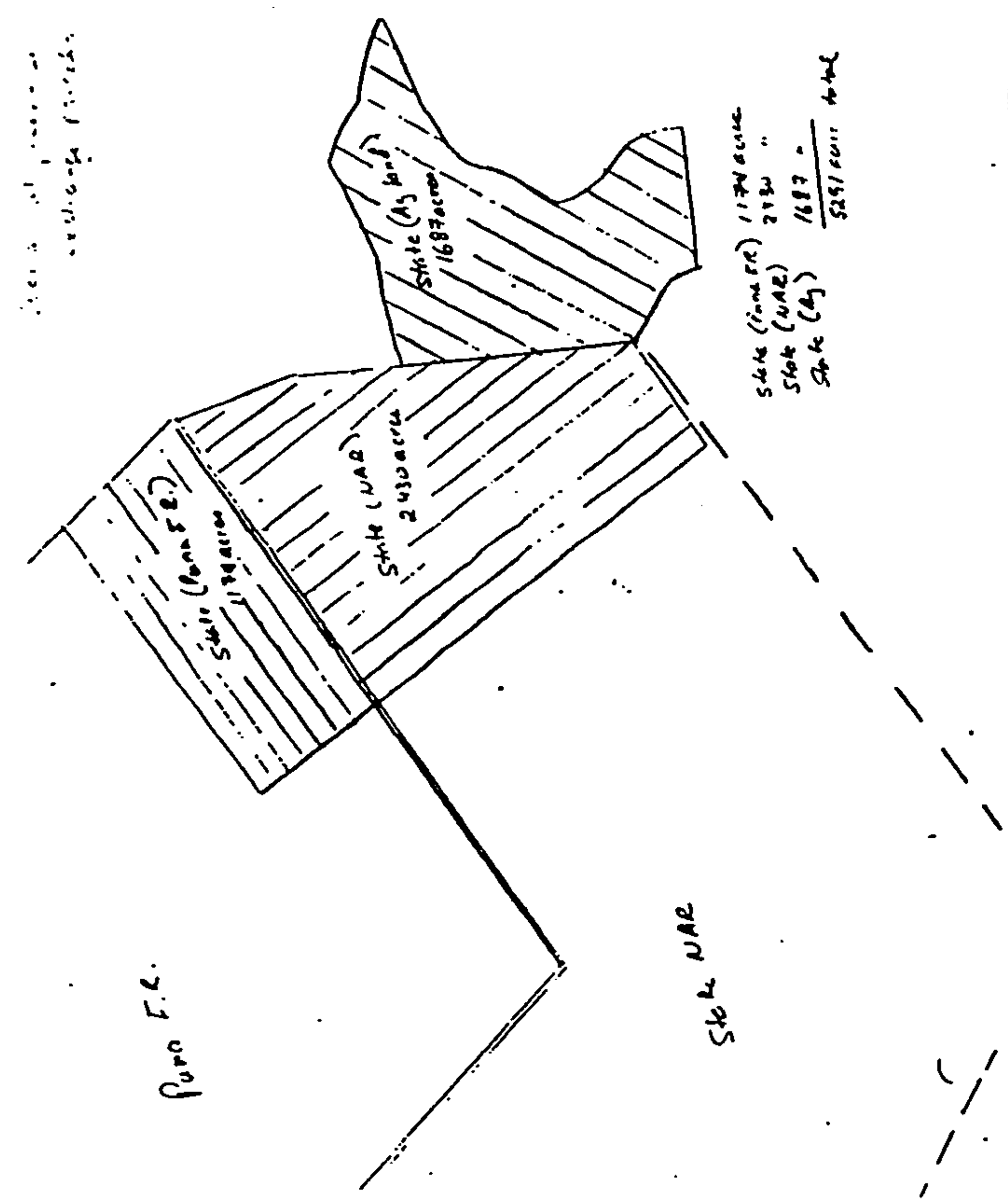
5. We suggest boundary configuration of the Midde East Rift subzone to be only the easternmost part of the Wao Kele O Puna Natural Area Reserve which lies north of the rift.

The western portion of Wao Kele O Puna (vertical block of the L-shaped NAR) contains forests which are exceptionally valuable for biological and ecological reasons.

Also, placing the subzone north of the Kilauea rift will avoid the most geologically hazardous and unstable areas. In this manner, a reasonable buffer will be created for the communities and biota south of the rift zone.

6. We suggest consideration of including State-owned agricultural lands in the Kama'ili geothermal subzone as part of the subsequent land exchange. This may help encourage direct heat utilization by industry.

7. We suggest that all appropriate conditions in the BLNR's previous Decisions concerning Kahauale'a be likewise applied to any development which takes place in the Middle East Rift area.



THE ESTATE OF JAMES CAMPBELL

August 27, 1985

Mr. Nelson Ho
Conservation Chair
Sierra Club, Hawaii Chapter
P. O. Box 11070
Honolulu, HI 96828

Dear Mr. Ho:

**Consulted Party of Supplemental E.I.S.**

This is in response to your letter dated August 20, 1985, requesting to be a consulted party of the Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project.

Your request has been recorded and you will be notified of any meetings, hearings, or additional information.

Thank you for your interest.

Sincerely,

Gail A. Chew
Manager, Community Affairs

jo:04601

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

---

...TE K. CARPENTER
MAYOR

HAWAII COUNTY FIRE DEPARTMENT
466 KINOOLE STREET, HILO, HAWAII 96720
PHONE 961-2978

FRANCIS E. SMITH
FIRE CHIEF

DON COLOMA
DEPUTY FIRE CHIEF

September 13, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

We have no comments or objections to the Supplemental EIS Preparation Notice for the Kahauale'a Geothermal Project.

Thank you for giving us the opportunity to submit our comments.

Sincerely,

Francis E. Smith

FRANCIS E. SMITH
FIRE CHIEF

FES/mo

HEI

GENPP 19-3
H-W/G

September 13, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Gentlemen:

Subject: Supplemental EIS for the Kahauale'a Geothermal Project

Thank you for the opportunity to review the subject document. We do not have any comments at this time.

Very truly yours,

Alva K. Nakamura, Manager
Engineering Department

AKN:DHT:ts

A Hawaiian Electric Industries Company

# DEPARTMENT OF PUBLIC WORKS

COUNTY OF HAWAII 25 AUPUNI STREET HILO HAWAII 96720 TELEPHONE (808) 961-8321

DANTE K. CARPENTER
Mayor

HUGH Y. ONO
Chief Engineer

BRUCE C. McCLURE
Deputy Chief Engineer

September 16, 1985

MR O K STENDER
CHIEF EXECUTIVE OFFICER
THE ESTATE OF JAMES CAMPBELL
828 FORT STREET MALL SUITE 500
HONOLULU HI 96813

SUBJECT: PREPARATION NOTICE FOR SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE KAHAUALE'A GEOTHERMAL PROJECT

Please be advised that comments, if any, have been sent to our Planning Department. They will then consolidate the comments from various County Agencies and forward them to you.

HUGH Y. ONO
Chief Engineer

cc: Planning Department

COUNTY OF HAWAII

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

DANTE K. CARPENTER
Mayor

ALBERT LONO LYMAN
Director

ILIMA A. PIIANAIA
Deputy Director

September 17, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, HI 96813

Dear Mr. Stender:

Kahauale'a Geothermal Project
<u>Preparation Notice for the Supplemental EIS</u>

We have received your letter of September 5, 1985 and the "Supplemental EIS Preparation Notice." We believe your Notice adequately addresses the issues which will be amplified in your forthcoming Supplemental EIS and look forward to reviewing the document.

Sincerely,

A. Lono Lyman

ALBERT LONO LYMAN
Planning Director

RN:lkt

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STATE OF HAWAII
PUBLIC UTILITIES COMMISSION
DEPARTMENT OF BUDGET AND FINANCE

Albert Tom
Chairman

Hideto Kono

September 18, 1985

Mr. O.K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Thank you for the "Supplemental EIS Preparation Notice" enclosed in your letter dated September 5, 1985. We have no specific comment regarding the Notice, reserving any response after receipt and review of the Supplemental EIS. We reiterate our interest in your Geothermal Project based on its potential impact on the energy objective of the State.

Very truly yours,

Albert Tom

Albert Tom
Chairman

AT:lyt

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
LETITIA N. UYEHARA
DIRECTOR
TELEPHONE NO.

September 18, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estates of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Subject: Supplemental EIS Preparation Notice for Kahauale'a Geothermal Project

We are particularly concerned about the effects of this project on the wildlife in the Puna Forest Reserve and about noise and odor effects on nearby residences. We ask that these concerns be fully covered in the draft EIS.

Sincerely,

Letitia N. Uyehara

Letitia N. Uyehara
Director

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HAWAII COUNTY CIVIL DEFENSE AGENCY
34 A Rainbow Drive
HILO, HAWAII 96720

September 18, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, HI 96813

SUPPLEMENTAL EIS PREPARATION NOTICE

The Hawaii County Civil Defense Agency has no comments to the supplemental EIS Preparation Notice.

As in all geothermal projects on the Island of Hawaii, emergency plans must be developed to ensure public safety. This plan development is the responsibility of the private developer.

Harry Kim

Harry Kim, Administrator
Hawaii County Civil Defense Agency

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STATE OF HAWAII
DEPARTMENT OF HEALTH

September 18, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Subject: Request for Comments on Supplemental Environmental Impact Statement (EIS) to the Environmental Impact Statement for Kahauale'a Geothermal Project, Puna District, Hawaii

Thank you for allowing us to review and comment on the subject supplemental EIS. Please be informed that we do not have any comments or objections to this project at this time.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

Sincerely,

MELVIN K. KOIZUMI
Deputy Director for
Environmental Health

cc: DLNR
OEQC

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3

DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

Ref. No. P-2711

September 19, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Subject: Supplemental EIS Preparation Notice for Kahauale'a Geothermal Project, Hawaii

We have reviewed the subject preparation notice and have the following comments.

The draft EIS should identify the purpose and need for the land exchange which were not covered in the preparation notice. Section V of the preparation notice should also be expanded to address the quality of the native forest areas in the State property as compared with those at Kahauale'a. We will be pleased to review the draft EIS when it is available.

Thank you for the opportunity to review and comment on the subject document.

Very truly yours,

Kent M. Keith

cc: Office of Environmental Quality Control

6

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

EPHSO

September 23, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Subject: Amendment to the Request for Comments on Supplemental Environmental Impact Statement (EIS) to the Environmental Impact Statement for Kahauale'a Geothermal Project, Puna District, Hawaii

The following comments were inadvertently left out of our September 18, 1985 response on this supplemental EIS:

Air Pollution

1. Does the proposed land swap bring the proposed geothermal development area closer to people? The text does not address this.
2. Page 8 - If the two parcels of land are "approximately equivalent" for producing economically producible geothermal resources, why the land swap, especially if the move would place development closer to the population?
3. Page 11 - Fluid reinjection would help control air emissions.
4. Page 24 - Air emissions would also occur during well venting and plant stacking.
5. Page 24 - At higher concentrations $H_2S$ can become a health hazard.
6. Proper controls would be effective against fugitive dust emissions during construction, only if properly applied and maintained.

If there are any questions regarding these comments, please contact Mr. Denis Lau, Chief, Environmental Permits Branch at 548-6410.

We reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

Sincerely,

MELVIN K. KOIZUMI
Deputy Director for
Environmental Health

cc: DLNR
OEQC

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3

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

September 20, 1985

PN:0046

Mr. A. K. Stender
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Supplemental EIS Preparation Notice for the
Kahauale'a Geothermal Project
Puna District, Hawaii

Due to constraints in time and available personnel, the Environmental Center does not usually review Environmental Impact Statements at the preparation stage. However, since we have been so actively involved in the various environmental considerations relative to geothermal development it seemed appropriate to briefly call attention to those issues which we perceive to be among the more significant.

Botany

The nature of the terrain under consideration for exchange suggests that two levels of botanical studies should be considered. The first should provide a general botanical overview of the proposed area, incorporating, whenever possible existing botanical surveys and information. The second should be in greater detail and focus on site specific roadways and well sites. Comprehensive botanical assessments are essential for optimum environmental planning for these well sites and roadway developments.

Avifauna

It is widely recognized that potential impacts to the avifauna are one of the major significant concerns. The EIS should devote considerable effort toward documenting the avifauna of this new area. Concerns expressed during the review of the original EIS for Kahauale'a should be reviewed and those which may also apply to the avifauna at this new site should be fully discussed.

We appreciate the opportunity to comment at this preparation stage and look forward to reviewing the Draft EIS when it becomes available.

Yours truly,

Jacquelin Miller
Acting Associate Director

cc: Patrick Takahashi
OEQC

AN EQUAL OPPORTUNITY EMPLOYER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PATUXENT WILDLIFE RESEARCH CENTER
Mauna Loa Field Station
P.O. Box 44
Hawaii National Park, HI 96718

September 19, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, HI 96813

Dear Mr. Stender,

Thank you for providing our office with a copy of the Supplemental EIS Preparation Notice for the proposed Campbell Estate True/Mid-Pacific geothermal development project in the Puna District. We have reviewed this document and feel that all potentially significant environmental impacts are proposed to be addressed in the Supplemental EIS. We would appreciate receiving a copy of the Supplemental EIS for this project for our review when it becomes available.

Sincerely,

James D. Jacobi
Botanist

JDJ:at

United States Department of the Interior

NATIONAL PARK SERVICE
PACIFIC AREA OFFICE
300 Ala Moana Blvd., Box 50165
Room 6305
Honolulu, Hawaii 96850

IN REPLY REFER TO:
L7621(PAAR)
xN40

September 20, 1985

Mr. O. K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

We have reviewed the Preparation Notice for the Supplemental EIS to the Environmental Impact Statement for the Kahauale'a Geothermal Project enclosed with your September 5, 1985 letter to Hawaii Volcanoes National Park. We support the land exchange and look forward to the opportunity to review the Supplemental Environmental Impact Statement. Please send copies of the Supplemental EIS to this office, as well as to the Superintendent, Hawaii Volcanoes National Park, P. O. Box 52, Hawaii National Park, Hawaii 96718-0052, and to our Regional Director, National Park Service, Western Regional Office, 450 Golden Gate Avenue, Box 36063, San Francisco, California 94102-3491.

We appreciate your cooperation in this matter and look forward to a successful culmination of the land exchange.

Sincerely,

Bryan Harry
Director, Pacific Area

NANAWALE COMMUNITY ASSOCIATION, INC.
PAHOA, HAWAII 96778 ● TELEPHONE (808) 965-8080

*Dedicated to keep Nanawale the Big Island's most beautiful community.*

August 2, 1985

Ms. Gail Chew
The Estate of James Cambell
828 Fort Street Mall, #500
Honolulu, Hawaii 96813

Re: Geothermal Energy

Dear Ms. Chew,

Thank you for writing concerning geothermal development on the Big Island. Our organization is very familiar with all aspects of geothermal and are enthusiastic in our support. We are happy to support any well managed exploration.

If we can assist you in any way please call on us.

Sincerely,
Nanawale Community Association, Inc.

Lyle Smith
President

LS/vk

---

THE ESTATE OF JAMES CAMPBELL

August 19, 1985

Mr. Lyle Smith
President
Nanawale Community
Association, Inc.
Pahoa, HI 96778

Dear Mr. Smith:

Thank you for your letter dated August 2, 1985 expressing the support of the Nanawale Community Association for geothermal development.

Enclosed you will find a copy of the information memorandum which we have made available to citizens and organizations interested in the future of geothermal development.

In the future, if your organization would like to discuss any issues related to geothermal development, please do not hesitate to contact me.

Again, our thanks for your response and support.

Most sincerely,

Gail A. Chew
Manager, Community Affairs

4331

Enclosure

COUNTY COUNCIL
County of Hawaii
Hawaii County Building
Hilo, Hawaii 96720

4

September 20, 1985

Mr. O.K. Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, HI 96813

Dear Mr. Stender:

Thank you very much for notifying us of the Supplemental Environmental Impact Statement being prepared for the Kahauale'a Geothermal Project. I am pleased to see that progress is being made concerning the State's proposal to exchange Campbell Estate's Kahauale'a lands for adjacent State lands in Puna.

The Hawaii County Council has long supported the development of geothermal energy as a step towards energy self-sufficiency and as an alternative to our dependence on fossil fuels. As such, we look forward to geothermal development in the designated geothermal resource subzones and await the resolution of the land exchange between the State and Campbell Estate.

We would appreciate the opportunity to comment on the Supplemental Environmental Impact Statement when it becomes available.

Sincerely,

Stephen K. Yamashiro, Chairman
HAWAII COUNTY COUNCIL

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Mr. Susumo Ono
Chairperson
Board of Land & Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 22 which we received on January 23 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. Susumo Ono
Chairperson
Board of Land & Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 22 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

August 20, 1985

(SAMPLE OF LETTER SENT TO ORGANIZATIONS AND INDIVIDUALS LISTED IN SECTION VIII - PROVIDING BASIC INFORMATION AND OFFERING TO MEET TO FURTHER DISCUSS THE PROPOSED PROJECT)

Mr. Peter Hauanio
Puna Hui Ohana
P. O. Box 611
Pahoa, HI 96778

Dear Mr. Hauanio:

Your name was given to us as someone who is interested in geothermal development. Representatives from Campbell Estate, True Geothermal, and Mid-Pacific Geothermal, Inc. would be available to share with you and/or your organization information related to geothermal development, as well as answer any questions.

The enclosed information memorandum has been presented to individuals and organizations throughout the community at various meetings held on the Big Island in recent weeks.

If you would like to arrange a presentation, please contact me at 536-1961.

Sincerely,

Gail A. Chew
Manager, Community Affairs

bie:043211

Enclosure

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

# APPENDIX C

## COMMENTS AND RESPONSES TO DRAFT SUPPLEMENTAL EIS

Draft SUP EIS comment/response letters are organized as follows:

Comment Letter

Acknowledgement Letter from The Estate of James Campbell

Detailed Response Transmittal Letter

Detailed Responses to Comments

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

JAN 22

JAN 22 1986

REF. NO.: CPO-0086-86
DOCUMENT NUMBER: 0664B

Mr. O.K. Stender, Chief Executive Officer
True/Mid-Pacific Geothermal, Inc.
800 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

We have had an opportunity to review your comments relating to the draft Supplemental EIS prepared for the Kahauale'a geothermal project in Puna District, Hawaii. Our comments are as follows:

1. Figures 2, 4, 19, 10, among others, erroneously show all conservation district lands of the project area to be in the Puna Forest Reserve. Most of the Conservation land involved is a Natural Area Reserve.

2. Figures 5, 7, 12, etc., identifies the eastern section of the Wao Kele 'O Puna Natural Area Reserve as part of the Puna Forest Reserve. The base map for these figures was apparently made by joining two USGS topographic quadrangles: the Kalalua quad and the Pahoa South quad. The Kalalua quad, 1982 edition, correctly identifies the Natural Area Reserve boundaries; however, the Pahoa South quad, the latest edition of which is 1980, identified as Forest Reserve where there is a Natural Area Reserve.

3. Page 113. Hunting is a permitted activity in the Natural Area Reserve when performed in accordance with Department hunting regulations. Also, "gathering rights" should be removed from the statement "the transfer of hunting and gathering rights from the project area to Kahauale'a would lessen the impact of locating the project on the state lands".

4. In a decision issued by the Land Board on December 20, 1985, the Kilauea Middle East Rift Geothermal Subzone was adopted where the entire GRS lies within the conservation district and Wao Kele 'O Puna Natural Area Reserve.



5. The revised EIS should reflect the boundary of the GRS adopted by the Land Board on December 20, 1985.

6. Hawaii Forest Bird Recovery Plan. February 1983 shows a distributional area of close proximity to the common boundary of the Puna Forest Reserve and Kahauale'a. This area should be identified for protection.

The main historical concerns with this Draft EIS center around the problem that archaeological sites in upland forest areas are poorly visible. Such areas were usually used for short-term activities to exploit forest resources such as bird-catching, canoe-building, pulu-gathering, etc. Historic sites in such areas would include access trails, short-term camps, and work sites. Activities at the camps and the work sites would be expected to leave archaeological remains -- e.g., food debris (bones, shell), tool maintenance debris (stone flakes, broken tools), cooking remains (fireplaces, charcoal), etc. The problem is that these sites are difficult to identify archaeologically in the forest because permanent material (stones) were probably not used in their architecture and because the smaller remains of activities are likely to be covered by leaves and soil. Archaeological reconnaissance surveys, such as walk-through, will not usually uncover any surface remains in such forests; but sites will be there, and some may be significant. The problem is how to locate these sites so their significance can be assessed and mitigation plans can be developed prior to construction.

An archival study was done by the applicant for this Draft EIS, and the preliminary report (Holmes, 1985) was the supportive document for the EIS. This report adequately reviews past land use, although clearer treatment by time periods might be useful in the final report. The expected patterns of land use were confirmed, and some additional uses were also indicated (e.g., a major trail along the rift, cultivation in patches within the forest in the southern fringes of the area). No, or few, specific locations were identified for these sites. And, as expected, it is suggested that these sites would be very difficult to identify in archaeological surveys.

The Draft EIS adequately summarizes this report's information (p. 116-118). However, the summary statement on p. 38 is not quite correct. It should note the full-range of land use activities and former sites identified for the project area.

An initial, limited archaeological reconnaissance survey was also done (Haun, Rosendahl and Landrum, 1985) as a supportive study for the Draft EIS. The limited archaeological survey report is also an acceptable document. This survey covered a very small portion of the project area in extremely narrow transects. Surprisingly, some stone mounds were found on Puu Heiheiahulu, and these were considered possible graves (p. 7). This find indicates that some sites with stone architecture may be present, at least on the cones. However, no other sites were found elsewhere, which was the expected pattern. The researchers indicate that the project area is likely to contain sites as noted in the archival research, but they again emphasize that site visibililty will be a problem. Importantly, they suggested that the presence of Hawaiian cultigens noted in a few spots may be evidence of Hawaiian occupation and/or exploitation activities (p. 8).

The Draft EIS adequately summarizes the results of this survey (p. 119-123). However, again the general statement on p. 38 is not complete. It would note the fact that, as yet, no archaeological sites have been located, except for the cairns and mounds.

In summary, the researchers doing the archival and archaeological studies, as well as our office are clearly in agreement that a number of historic sites were formerly present in this area (camps, work sites, trails, forest cultivation areas, etc). However, the Draft EIS should include a statement on probable archaeological site patterns and problems in identification. The statement on p. 126 that few archaeological sites are expected to be found because of volcanic flows cannot be accepted and should be deleted. The archival and archaeological reports both indicate that sites are likely to be present, and 20th century lava flows which may have covered sites are restricted in area.

In the Draft EIS, the applicant proposes a plan to handle historic preservation concerns in the area. While we concur with the plan for incremental survey and research design development (if sites are found), an attempt to resolve the problem of poor site visibility must be included as a step in the historic preservation plan -- a step to be done prior to any archaeological survey of project elements. Methods need to be developed to ensure that archaeological surveys in this forest zone can find most archaeological sites, so their significance can be assessed and so significant sites can be adequately mitigated. Otherwise, the archaeological reconnaissance surveys will be largely worthless.





We recommend that this prior step include the following:

1. Further archival research to document in detail the appearance of the site types (camps, trails, fields, canoe-building loci, etc.). This research should take little time, as the current archival report contains portions of this information, and presumably the researcher has gathered most of the information already.

2. Once this additional archival work is done, a professional archaeologist should prepare predictions of what these site types should look like archaeologically, given the details of the project's environmental setting. Also, this archaeologist should prepare alternative plans for field methods which will enable these sites to be located.

3. A professional archaeologist should conduct more detailed survey and test excavations to evaluate the idea that Hawaiian cultigens in the project area are indicators of the presence of sites. This experiment can be conducted at several of the areas located during the limited reconnaissance survey. If this idea proves correct, it will be an imporant means of locating sites in the project area during future reconnaissance surveys. If this idea proves incorrect, then time and concern need no longer be placed on the presence of these plants.

4. The field methods for the incremental archaeological reconnaissance surveys should be based on the findings of the preliminary work and should also attempt to further improve site identification methods.

Future archival and archaeological studies, significance assessments of any sites, and mitigation plans should be submitted to our department for adequacy review and agreement. If disagreement occurs, consultation should follow to resolve the problems.

Very truly yours,

SUSUMU ONO, Chairperson
Board of Land and Natural Resources

## RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY DEPARTMENT OF LAND AND NATURAL RESOURCES

1. As appropriate all figures have been revised to indicate the middle east rift zone GRS and project area.

2. As noted above all figures have been revised to indicate the GRS and project area.

3. The requested modification to the sentence on page 113 will be incorporated into the Final SUP EIS.

4. See responses 1 and 2 above.

5. See responses 1 and 2 above.

6. The Hawaii Forest Bird Recovery Plan describes the Puna Forest Bird Essential Habitat as: "The lands within the Puna Forest Reserve above 2,000 feet elevation being a portion of Parcel 2, State of Hawaii Tax Map Kep 1-2-10, Third Revision." No part of the project site as shown in Figure 5 is located within the essential habitat area. As noted on the SUP EIS, archaeological surveys of all construction areas will be conducted prior to construction to ensure that plants, wildlife and archaeological sites are properly protected.

7. Regarding archaeological/historical comments, the archaeological survey research design approach described in the SUP EIS contains the majority of work recommended in the DLNR letter. Documenting what the expected appearance of various types of sites that may have been used or occupied in the area will facilitate the archaeological reconnaissance. Given the nature and scale of the geothermal development project, the more detailed survey and test excavations experiment specified in the DLNR letter would be more appropriately carried out in the initial phases of archaeological field work that will be performed within and immediately adjacent to specific sites and access road corridors selected for development, rather than as prior experimental work at other locations within the project area that will not be used for project purposes. However, should Hawaiian cultigens be present in a project site to be used, the utility of such plants in locating sites of potential archaeological interest can be validated.

   Potential resolutions to the problem of site identification methods as well as future studies and assessments will be included in the historic preservation plan that is submitted to DLNR for adequacy review and agreement.

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT
KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII

JAN 27 1986

GEORGE R. ARIYOSHI
KENT M. KEITH
MURRAY E. TOWILL
LINDA KAPUNIAI ROSEHILL

Ref. No. P-3373

January 22, 1986

MEMORANDUM

TO: The Honorable Susumu Ono, Chairperson
Department of Land and Natural Resources

FROM: Kent M. Keith *Kent M. Keith*

SUBJECT: Draft Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project, Puna, Hawaii

We have reviewed the draft supplemental EIS and have the following comments.

Page 79, Lines 1 and 2. The wording of this sentence should be modified so that it is clear that the developer (EIS proposer) is responsible for monitoring the well during the drilling operations, but that the task will be delegated to a consultant firm. We suggested the following revision: "The developer is responsible for the monitoring of the well during drilling operations although the monitoring itself may be delegated to a consultant firm."

Page 99, Table 21. The total frequency distribution of night winds, trades and northerlies, should be 43.6 not 93.6.

Page 100, Lines 20-22. After this last sentence, examples of further abatement procedures to reduce noise levels should be provided.

Page 100, Lines 23-26. There are effective methods for abating the noise of free venting wells. These methods should be identified in the supplemental EIS.

Page 101, Lines 1-3. The estimated operational stage noise level could be stated for several distances from a representative power plant and related facilities to clarify the actual noise levels to be controlled.

Page 106, Tabel 23. The number of State households should be checked and corrected in the supplemental EIS.

Page 107, Paragraph b. In the note, the paragraphs cited are not found as numbered (pp. 130-133).



Page 115, Paragraph 2. The supplemental EIS should indicate whether the estimate of daily trips to the site during the operational stages includes trucks, especially chemical delivery and removal trucks. Chemical truck traffic in the Geysers area of California has become a major concern in that area.

Page 139, Line 17. "It has been estimated that the potential annual economic benefit of geothermal resource development coupled with the underwater cable would be the retention in the State of approximately $400 million ..." Because the amount of fuel oil used to generate electricity fluctuates with the amount of alternate energy resources used, we suggest changing this sentence to read: "An important economic benefit of geothermal resource development coupled with the underwater cable will be retention in the State of much of the $1.2 billion which now leaves the State each year for the purchase of imported petroleum."

Thank you for the opportunity to review and comment on the subject document.

cc: ✓Mr. O. K. Stender
The Estate of James Campbell
Office of Environmental Quality Control

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Mr. Kent Keith, Director
Department of Planning and
Economic Development
Kamamalu Building
250 South King Street
Honolulu, Hawaii 96804

Dear Mr. Keith:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 22 which we received on January 27 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Sincerely,

O. K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. Kent Keith, Director
Department of Planning and
Economic Development
Kamamalu Building
250 South King Street
Honolulu, Hawaii 96804

Dear Mr. Keith:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 22 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS
ON THE DRAFT SUP EIS TO THE EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY
DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT

1. The suggested change will be incorporated in the Final EIS.

2. The noted typographical error will be corrected in the Final EIS.

3. The statement in the SUP EIS indicating further abatement procedures would be used if necessary will be modified for clarification to indicate that the initial abatement procedures used can be increased by degrees, i.e., a thicker or larger baffle, as determined to be required to abate to needed levels.

4. See above comments.

5. Estimates of operations stage noise levels will be included in the SUP EIS (see attachment).

6. The typographical error will be corrected in the Final EIS.

7. The typographical error will be corrected in the Final EIS.

8. The information in the SUP EIS refers to estimates of all vehicle trips during the construction and operational stages of the project. This traffic will consist of construction workers, materials and supplies deliveries including any chemicals required by the abatement systems used, operations and maintenance personnel and visitors. The information requested will be included in the Final EIS.

9. The suggested wording change will be included in the Final EIS.

TABLE A

ESTIMATED DECIBEL (dBA) NOISE LEVELS FROM GEOTHERMAL OPERATIONS

| SOURCE | SOUND PROPAGATION CONDITION | DISTANCE 100 FEET | 1/2 MILE | 1 MILE |
|---|---|---|---|---|
| Drill Rig | 4 | | Inaudible | Inaudible |
| | 3 | | 44 | 36 |
| | 2 | 82 | 50 | 42 |
| | 1 | | 53-55 | 47-50 |
| Power Plant | 4 | | Inaudible | Inaudible |
| | 3 | | 34 | 26 |
| | 2 | 72 | 40 | 32 |
| | 1 | | 43-45 | 37-40 |
| Free Venting of Well | 4 | | 38 | Inaudible |
| | 3 | 122 | 74 | 64 |
| | 2 | | 84 | 76 |
| | 1 | | ---* | ---* |

NOTES: Sound Propagation Condition No. 4 - Receptor is upwind of noise source. Conditions No. 1 through 3 - Receptor is downwind of source. Condition No. 3 - Winds greater than 10 mph or some attenuation from trees. Condition No. 2 - No attenuation from topography or trees. Condition No. 1 - Same as No. 2, but on occasion unstable focusing may occur in some locations causing fluctuating noise levels.

* Free Venting of well will not occur during Condition No. 1, e.g. when wind is less than 2 mph and thermal inversions exist.
* Levels from venting through a rock muffler will be between those for Drill Rig and Power Plant.

GEORGE R. ARIYOSHI
GOVERNOR

**STATE OF HAWAII**
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 South King Street, Room 115
HONOLULU, HAWAII 96813

JAN 27 1986

LETITIA N. UYEHARA
DIRECTOR

TELEPHONE NO.
548-6915

January 20, 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Draft Supplemental Environmental Impact Statement for the Kahauale'a Geothermal Project, Puna, Hawaii

We have reviewed the supplemental EIS and offer the following comments for consideration:

1. According to the supplemental EIS, the project will require 35 drilling sites located in up to five exploration/development areas with up to five power plant sites. We recommend the preparation of a supplemental EIS for each of the exploration/development areas as sufficient details become available. The present supplemental EIS pertains primarily to the exchange of Kahauale'a lands outside of the geothermal resource subzone with those in the subzone, and details of each exploration/development area have not been discussed.

2. The access roads should not disturb any endangered plants or archaeological sites. Additionally, the roads should be situated so as to minimize erosion.

3. The Department of Health's letter dated September 23, 1985 has not been responded to. We ask that the questions be answered.



4. The hydrogen sulfide, sulfur dioxide, and noise levels should be kept sufficiently low as not to disturb the Hawaiian hawk which is resident in the Puna Forest Reserve.

Thank you for providing us the opportunity to review this EIS.

Sincerely,

Letitia N. Uyehara

Letitia N. Uyehara
Director

cc: Mr. O. K. Stender

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Ms. Letitia N. Uyehara, Director
Office of Environmental
 Quality Control
465 South King Street, Room 115
Honolulu, Hawaii 96813

Dear Ms. Uyehara:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 20 which we received on January 27 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak



THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Ms. Letitia N. Uyehara, Director
Office of Environmental
 Quality Control
465 South King Street, Room 115
Honolulu, Hawaii 96813

Dear Ms. Uyehara:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 20 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

## RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY THE OFFICE OF ENVIRONMENTAL QUALITY CONTROL

1. We are confident that the environmental setting of the proposed project is adequately understood and satisfactorily described in the SUP EIS. Information considered included the State's botanical survey of the Kilauea east rift zone, our botanical survey of the proposed geothermal resource sub-zone in the Kilauea middle east rift zone, the U.S. Fish & Wildlife Service forest bird survey, leaf tissue and soil sample survey, and air quality and meteorological surveys conducted over a two year period along the Kilauea east rift zone.

   While the specific project sites that will ultimately be selected are within this environmental setting, we have committed to conduct site specific environmental surveys of each site before it is disturbed. The results of these site specific surveys will be included as additional supporting data for subsequent administrative review by the BLNR.

   This process will enable the permitting agency to ascertain at each step of the project expansion whether (1) the environmental quality of the site(s) to be occupied is consistent with the baseline data, (2) whether any special precautions or additional information is required or (3) whether the selected sites should be relocated or realigned. Since the location and quality of the resource can only be determined by drilling, the sequence of drilling (and the location) is determined by results of drilling the preceding well as described in Section II of the SUP EIS. It may be necessary to conduct exploration drilling in several of the exploration/development areas before development in one or two areas would occur. The exploration/development areas are idealized groupments of wells and plants assuming uniform distribution and quality of the underlying resources, and drilling could shift quickly from one area to another. Delays in drilling occasioned by the requirement to process a supplemental EIS before each of the E/D areas is occupied, or before a surface area outside of the idealized areas can be occupied would have serious economic impacts on the project.

   In view of (1) the incremental, "permit-controlled" development process that will be characteristic of geothermal development after a land-use permit is obtained, and (2) the site specific environmental survey information that will be available to permitting authorities in acting on applications to occupy new sites, we feel that a supplemental EIS as proposed would not be compatible with the process, procedures and economic risks associated with geothermal development.



2. As noted above and in the SUP EIS, prior to road or other facility construction, qualified biologists and archaeologists will survey the areas to ensure that endangered species and significant archaeological sites are protected. All roads and sites will be graded and maintained to minimize erosion.

3. The Department of Health comments provided in their letter of September 23, 1985 were made on the SUP EIS Preparation Notice. These comments as well as all others received were considered in preparing the draft SUP EIS.

4. Hydrogen sulfide ($H_2S$) emission and ambient levels of $H_2S$ will be determined by the State. The developer will comply with noise guidelines published by the County of Hawaii. The process of converting geothermal energy into electricity does not result in the production of sulfur dioxide.

GEORGE R. ARIYOSHI
GOVERNOR

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

SUZANNE D. PETERSON
DEPUTY TO THE CHAIRMAN

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822

January 17, 1986

MEMORANDUM

To: Mr. Susumu Ono, Chairman
Board of Land and Natural Resources

Subject: Supplemental Environmental Impact Statement (EIS) to the Revised EIS for the Kahauale'a Geothermal Project
TMK: 1-1-01: por. 01 and 1-2-08: por. 01
Puna, Hawaii
Acres: 25,461

The Department of Agriculture has reviewed the subject document and has the following comments to offer.

The proposed land exchange area lies to the east of the previously proposed site. Updated soils information should be provided in the Supplemental Revised EIS.

The subject EIS briefly describes the existing farm activities in Kaohe Homesteads and states that "... geothermal development is not considered incompatible with an agricultural area" (Supplemental EIS, page 42). The EIS should state whether there may be adverse impacts to agricultural crops or livestock in the general vicinity due to normal geothermal explorations or operations. This issue was also raised in our memorandum concerning the Preparation Notice for the Kahauale'a Geothermal Project EIS (see attached copy of memorandum to Mr. Susumu Ono, dated January 28, 1982).

The air, soil, rainwater and plant tissue sampling information found in the EIS indicates "low" readings for the chemicals monitored. However, there is no indication that geothermal emissions will not have adverse effects on plant tissue. This would be of particular concern to those

"Support Hawaiian Agricultural Products"



agricultural activities that are situated in the vicinity of the proposed geothermal resource subzone.

Thank you for the opportunity to comment.

Jack K. Suwa
JACK K. SUWA
Chairman, Board of Agriculture

Attachment

cc: Mr. O. K. Stender, Campbell Estate

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Mr. Jack Suwa
Chairman
Board of Agriculture
1428 South King Street
Honolulu, Hawaii 96814

Dear Mr. Suwa:

Subject: <u>Comments Relating to Supplemental EIS to Revised EIS</u>

This is to acknowledge receipt of your comments dated January 17 which we received on January 21 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. Jack Suwa
Chairman
Board of Agriculture
1428 South King Street
Honolulu, Hawaii 96814

Dear Mr. Suwa:

Subject: <u>Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a</u>

This is with regard to your letter of January 17 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

**RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT LETTER SUBMITTED BY STATE OF HAWAII DEPARTMENT OF AGRICULTURE**

1. Based on soils analyses conducted in the original Kahauale'a project area and soil samples taken from the revised project area and the fact that the two land areas along the Kilauea east rift zone are adjoining parcels, the soils characteristics of the project area are expected to be the same as those identified for Kahauale'a. Upon the initiation of project activities, soil samples in areas to be disturbed will be taken for classification purposes as additional base-line data, and for engineering and construction design purposes. The soils information collected will be included, as required, in construction and drilling permit applications.

2. Based on experiences in Imperial Valley, California, where crops are planted up to the fenceline of geothermal facilities, and based on the experience of HGP-A operations and increased plantings of papaya near the HGP-A plant, agricultural activities appear to be compatible with geothermal operations. Further, there is evidence that $H_2S$ enhances some crops. For example, Thomson and Kats (Environmental Sciences and Technology, May 1978, 12:550) report that concentrations of $H_2S$ below 300 ppb either have no effect or stimulate alfalfa, grapes and sugar beets after about 100 days of continuous exposure. At a concentration level of 100 ppb, Douglas fir and head lettuce were in healthy condition after continuous fumigation of 30 days (lettuce) or 240 days (Douglas fir). Additional papers by Thompson, Kats and Dawson (HortScience 17(2):233-235, 1982); Thompson, Kats and Lennox (Calif. Agri., March 1979); and Thompson, Kats and Dawson (Geoth. Res. Council Trans., (6) Oct. 1982), indicate that controlled $H_2S$ emissions have no deleterious effects on a number of plants and crops, and in some cases, as noted above, may be beneficial to growth.

   Given the level of air emission control to be employed on project operations, agricultural activities are considered to be compatible with geothermal operations. Similarly, although no data has been found relative to livestock reaction to the stimuli, the level of air and noise controls to be in effect for project operations, will meet applicable air and noise control standards. Noise impact analyses conducted for the proposed project indicate that if free venting of a well is required for a limited period of time to clear the well bore, noise levels, at the nearest locations where livestock may be located, would be less than 55 dBA under favorable wind conditions and approximately 73 dBA under the least favorable wind



conditions with no attenuation from trees or topographic features.

3. As indicated above, available evidence and studies tend to indicate that neither short- or long-term exposure to low levels of geothermal emissions adversely affect plant tissue. As noted, project operations will conform to applicable air quality standards that are being established by the Department of Health and the Hawaii County Noise Guidelines and applicable State standards. Air and noise quality of the project will be monitored throughout the life of the project. Part of the planned monitoring is designed to determine long-term impacts to soil and leaf tissues. The data collected will be submitted to DLNR on a regular basis.

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

JAN 23

January 22, 1986

(RE:0354)

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Supplemental to the
Revised Environmental Impact Statement
Kahauale'a Geothermal Project
Puna District, Hawaii

The above cited document addresses the potential environmental impacts associated with the proposed exploration and development of a 100 megawatt (mw) geothermal facility in the Kilauea Middle East Rift Zone, Puna District, Island of Hawaii. Our review has been prepared with the assistance of Clifford Smith, Botany; Sheila Conant; General Science; Joseph Halbig, UH Hilo; Kenneth Kaneshiro, Entomology; and Walington Yee, Environmental Center.

Fauna

The "thorough forest bird survey" cited (p. 58) is for the island of Hawaii. In order to assess and mitigate the environmental impact to fauna in the project area, a site specific investigation of the area should be undertaken. Our reviewers commented that the Pueo (Hawaiian owl) an endangered species on the island of Hawaii, has been reported to frequent the Kahauale'a region.

Deforestation of the rainforest will impact the fauna. The EIS indicates that noise, transmission lines and $SO_2$ will not have a significant affect on birds. The specific studies leading to this conclusion should be cited. Inferences drawn on the behavior of mainland species are not likely to be applicable to Hawaiian avifauna.

Evidence has indicated a feeding population of Dark-Rumped Petrels and Newell's Shearwaters on the island of Hawaii at the summit of Mauna Loa in the Hawaii Volcano National Park above Kahauale'a, and on Maku Opuhi Crater (Conant, 1980) and (Kepler, Jeffry, Scott, 1979). The small colonies of breeding Newells and Dark-Rumped Petrels in the Hawaii National Volcanic Park have not been referred to in the EIS nor the potential environmental impacts of the project on their habitat or flight paths.





The suggestions that if $H_2S$ is high enough to cause adverse affects that birds could leave the area is not an environmentally acceptable alternative when dealing with rare species and limited acceptable habitats. A 1925 study on the deleterious effects of $H_2S$ on birds should be included in the references. (Mitchell, C.W. and Yant, W.P., 1925, Dept. of the Interior Bureau of Mines, Bull. 231:59-81.) The effect of $SO_2$ on insects as a food source for birds should also be included in the EIS.

Invertebrates

On page 57, there is mention of the lack of information about invertebrate species in the project and surrounding areas. Since invertebrate forms may be as equally endangered and/or threatened as some of the plant and bird species it would be appropriate to include a more comprehensive discussion of their distribution and diversity in the project area. Perhaps, it is not generally recognized that insects in the Hawaiian ecosystem are the most important group for evolutionary studies and which may be the most important resource for medically and/or agriculturally important genetic material. With the astounding advancements in genetic engineering and biotechnology and with the tremendous invertebrate fauna endemic to the Hawaiian ecosystem, there may be rare species with genetic qualities useful for medical and agricultural advancements. Certainly, the Hawaiian Drosophila is one group of insects which is becoming increasingly important for DNA studies, but it is only one of many potential insect groups which may be important as genetic resources. Therefore concluding that impacts to the invertebrate species will be minimal because of the small amount of land (about 1 percent) to be disturbed by the development may not be correct.

Many of the invertebrate species comprise extremely small and fragile populations. This is especially important in the mosaic ecosystems ("kipukas") found in the southwest corner of the proposed geothermal resource subzone (GRS). Some species are restricted to certain plant species and are not found widely distributed. For example, a new species of Hawaiian Drosophila has recently been discovered in the Olaa Forest area that appears to be strongly associated with Pritchardia and cannot be found any distance away from one of these rare endemic palms. Furthermore, most of the endemic forms are highly susceptible to any kind of perturbation to their environment and despite the seemingly small "percentage" of land to be developed, many unique species may be lost forever. The developers should be encouraged to be exceedingly cautious about development activities near these "kipukas", i.e., planned exploration area E. The decision of the BLNR to remove much of the mosaic ecosystems from the original proposal is to be commended, but at the same time, surveys of the flora and fauna within the new boundaries of the GRS should be encouraged. The EIS states that "all areas to be cleared will be inspected by qualified biologists and archaeologists prior to clearing...." This is especially important for the invertebrate fauna since concern continues about the lack of emphasis and in fact, a deemphasis on their significance.

Yours truly,

Jacquelin N. Miller

Jacquelin N. Miller
Acting Associate Director

cc: OEQC
O.K. Stender, Campbell Estate
Patrick Takahashi,
Acting Director, Environmental Center
Clifford Smith
Sheila Conant
Joseph Halbig
Kenneth Kaneshiro
Walington Yee

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Ms. Jacquelin N. Miller
Acting Associate Director
Environmental Center
University of Hawaii at Manoa
Crawford 317, 2550 Campus Road
Honolulu, Hawaii 96822

Dear Ms. Miller:

Subject: <u>Comments Relating to Supplemental EIS to Revised EIS</u>

This is to acknowledge receipt of your comments dated January 22 which we received on January 23 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Ms. Jacquelin N. Miller
Acting Associate Director
Environmental Center
University of Hawaii at Manoa
Crawford 317, 2550 Campus Road
Honolulu, Hawaii 96822

Dear Ms. Miller:

Subject: <u>Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a</u>

This is with regard to your letter of January 22 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

## RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY U. H. ENVIRONMENTAL CENTER

1. The Pueo or Hawaiian Owl is not classified as an endangered species by the U.S. Fish and Wildlife Service. The State Division of Forestry and Wildlife (DLNR) considers the Pueo to be endangered on Oahu but not on Hawaii. The owl, as noted in the Revised Kahauale'a EIS, has not been reported by Scott, et al. (in press), or Berger (EIS) in the project area, although it may be present there.

2. The limited clearing that will be required for the proposed project (approximately 300 acres) is approximately 1% of the total land parcel (26,000 acres) in which development will occur. As noted, protective measures will be taken to ensure that all project generated noise is within Hawaii County Noise Guidelines and applicable State regulations on air emissions will be controlled to meet applicable air quality standards. Inferences can be drawn on the behavior of mainland or other area species when considering Hawaiian avifauna just as the evolutionary and ecological inferences recorded by Darwin while in the Galapagos Islands have been applied to organisms throughout the world. References on which the statements regarding the impacts of noise, $SO_2$ and transmission lines on birds are cited in the birds and mammals report (Berger 1985).

3. The evidence you have cited notes that the Dark-Rumped Petrels and Newell's Shearwaters may have established possible breeding populations on the north coast of the Big Island and at the higher elevations (9,000 - 10,000 ft.) of Mauna Loa. The references cited also note "...a possible colony (of Shearwaters) at Makaopuhi Crater..." where an adult bird and an egg were found in 1972. No other nests have been found since 1972. This crater is approximately 8 miles from the project area. The references cited also imply that the sides of craters may provide nesting sites for the birds. It is unlikely that project activities will be conducted on the sides of craters. The possibility of small numbers of individual Newells Shearwaters or Dark-Rumped Petrels in the Hawaii Volcanoes National Prak was not discussed in the SUP EIS since their presence has not been firmly established. As to the project site, all birds that are known to inhabit the project area are listed. Because these two species have not been sighted in the project area, comments on the potential environmental impacts on their habitat or flight paths would be speculative. However, the SUP EIS did note that unshielded night lighting could pose a problem to such species if their flight paths passed over or near areas with bright, unshielded lights.



4. As noted in the SUP EIS, the only endangered bird known to inhabit the project area is the Hawaiian Hawk and its continued status as an endangered species has been questioned by expert biologists. Also, as noted in the SUP EIS, air emissions from project activities will be controlled to meet applicable air quality standards. Further, as noted by Siegel (1985), birds are known to feed, nest, and thrive in high $H_2S$ emission areas without deleterious effects. The Mitchell and Yant (1925) reference cited does not appear to be relevant to outdoor situations and therefore was not referenced. As noted in the SUP EIS, habitat removal will be limited to those areas considered by qualified biologists as lower quality habitat than the 'ohi'a a(l) areas. Geothermal projects do not produce $SO_2$.

5. It is recognized that Hawaiian insects are an important group for evolutionary and medical studies. We concur with your observations about the need for caution in conducting development activities near any "kipukas" of ecosystems which may be habitat for invertebrate species that should be protected. As noted in the subject letter and SUP EIS, the biological surveys conducted prior to construction will allow appropriate protective measures to be taken prior to construction.

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

JAN 16 ....

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

LESLIE S. MATSUBARA
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSD

January 13, 1986

Mr. Susumu Ono, Chairperson
Board of Land & Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Request for Comments on Draft Supplemental Environmental Impact Statement (EIS) to the Revised Environmental Impact Statement for Kahauale'a Geothermal Project, Puna District, Hawaii

Thank you for allowing us to review and comment on the subject supplemental EIS. We provide the following comments for your consideration.

Air Pollution

1. The Department is presently in the process of formulating and promulgating geothermal rules for geothermal wells, power plants and other geothermal facilities.

2. Geothermal wells, power plants and other geothermal facilities will be required to submit applications for air pollution control permits. A State Authority to Construct (ATC) permit must be received by the applicant prior to the commencement of construction. Construction activities include the drilling of the geothermal well.

3. Once construction is completed and the facility is operating, a Permit to Operate would be issued by the Department provided that the applicant can meet all State and Federal regulations and has complied with the applicable ATC permit requirements.

4. For all geothermal wells, power plants and other geothermal facilities, the Best Available Control Technologies (BACT) will be required as a minimum to control air emissions.

Sincerely,

JAMES K. IKEDA
Deputy Director for
Environmental Health

cc: Mr. O. K. Stender ✓

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GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

JAN 30 1986

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

LESLIE S. MATSUBARA
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSD

January 22, 1986

Mr. Susumu Ono, Chairperson
Board of Land & Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Request for Comments on Draft Supplemental Environmental Impact Statement (EIS) to the Revised Environmental Impact Statement for Kahauale'a Geothermal Project, Puna District, Hawaii

Several comments concerning the subject Supplemental EIS were inadvertently omitted from my letter of January 13, 1986. We provide them for your further consideration.

Air Quality and Air Pollution Models

The Siegel report, extensively quoted on pages 90-93, does not adequately address the possible short- or long-term impacts on the health of residents exposed to low levels of hydrogen sulfide. Mortality data, which the report uses exclusively, is not sensitive enough to ascertain the possible adverse health impacts of long-term exposure to low levels of hydrogen sulfide (i.e., less than 10 ppm).

A major problem that Dr. Seigel and other investigators must overcome in evaluating possible health impacts of exposure to hydrogen sulfide in a community is the lack of appropriate health statistics. Effects associated with long-term exposure to low levels of hydrogen sulfide, such as eye and upper respiratory tract irritation, possible nervous sytem changes, and others, are not reflected in vital statistics. In fact, the use of mortality data from vital statistics is inappropriate to address most probable impacts of hydrogen sulfide on human health.

The use of mortality data certainly does not address community concerns regarding odor nuisance that may result from the development of geothermal resources in Hawaii. Rotorua and Puna may be similar in climate and other environmental factors; however, residents' outlook on the advantages and disadvantages of geothermal development most likely vary considerably. Residents in Rotorua depend on geothermal energy for heating, electricity, and other uses. Most residents in Puna perceive very little immediate benefit from the development of geothermal resources in the area; consequently, they are less likely to ignore or tolerate odor nuisance and other adverse health impacts that have been associated with geothermal emissions. Odor nuisance associated with fugitive hydrogen sulfide emissions is not adequately discussed in the Supplemental EIS.

"Odor effects" must be considered in keeping with the current World Health Organization's definition of health, i.e., "A state of physical, mental and social well-being, not just the absence of disease...." Although there may be no evidence of excessive mortality in Rotorua, the conclusion that exposure to hydrogen sulfide produces "no adverse effects on human health" is not supported by data presented in Dr. Seigel's report.

Sincerely yours,

JAMES K. IKEDA
Deputy Director for
Environmental Health

cc: Mr. O. K. Stender

---

THE ESTATE OF JAMES CAMPBELL

January 30, 1986

Mr. James K. Ikeda
Deputy Director for
Environmental Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Mr. Ikeda:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 22 which we received on January 30 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Sincerely,

O. K. Stender
Chief Executive Officer

OKS:sak

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. James K. Ikeda
Deputy Director for
Environmental Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Mr. Ikeda:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 22 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS
ON THE DRAFT SUP EIS TO THE EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT
LETTERS SUBMITTED BY STATE OF HAWAII
DEPARTMENT OF HEALTH

1. Letter of January 13, 1986:

All comments included in this letter will be incorporated directly into the text of the Final SUP EIS.

2. Letter of January 22, 1986:

a. The intent of citing the Seigel (1985) report was to present the most recent available information regarding reported health effects of geothermal area air emmissions of $H_2S$. It is believed that if the people of Rotorua or other geothermally active areas suffered short- or long-term adverse health effects from geothermal emissions, political and administrative actions would have been taken by appropriate health agencies. The Seigel study is the first of its kind which reported that the general good health of the Rotoruans compared with New Zealanders elsewhere in New Zealand where $H_2S$ is not present. The State Department of Health survey in Puna District tends to support the Seigel report findings. As is noted throughout the SUP EIS, State air quality standards, which are being formulated and promulgated by DOH, will be met by project operations. Further, air quality monitoring and reporting throughout the life of the project will enable regulatory agencies to evaluate the effectiveness of the Best Available Control Technologies (BACT) that will be used to control air emissions.

b. Odor nuisance will be controlled, as will other emissions, through the use of BACT and the requirement to meet applicable DOH air quality standards. Fugitive hydrogen sulfide emissions will have to be considered and controlled through the use of BACT and the requirement for the project is to meet applicable air quality standards, regardless of the source of emissions from project activities.

The use of mortality data, as used in the Siegel report as an indicator of the potential of some condition or phenomenon to cause adverse health impacts is not without precedent. For example, FDA Commissioner Frank Young, M.D. Ph.D, has stated publicly (February 2, 1986) that in the assessment of aspartame for mass consumption as a sugar substitute, including carcinogenicity, effects on behavior and neurology, immune responses and other clinical parameters, the epidemiology section at the USPHS Center for Disease Control in Atlanta, Georgia, used mortality as a criterion of safe use.

THE ESTATE OF JAMES CAMPBELL

February 6, 1986

Mr. Albert Lono Lyman
Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Lyman:

Subject: <u>Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a</u>

This is with regard to your letter of January 23 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

Dave McCoy

David H. McCoy
for O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536 1961

COUNTY OF HAWAII

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720
(808) 961-8288

DANTE K. CARPENTER
Mayor

ALBERT LONO LYMAN
Director

ILIMA A. PIIANAIA
Deputy Director

JAN 28 1986

January 23, 1986

Mr. Oswald K. Stender
Chief Executive Officer
The Estate of James Campbell
Suite 500, 828 Fort Street Mall
Honolulu, HI 96813

Dear Mr. Stender:

Kahauale'a Geothermal Project
<u>Draft Supplemental EIS</u>

Thank you for the opportunity to review this draft EIS. We have the following comments:

1. This Supplemental Environmental Impact Statement (EIS) attempts to assess the environmental impacts of the proposed project at its maximum requested size of 100 MW of geothermally generated electrical power, up to 55 acres of roadways, 64 acres of electrical transmission line corridors, 35 drilling sites, 3 to 5 power plant sites and other related uses. This maximum is based upon several assumptions which may be lumped into two categories (1) the absence of "unusual or unique engineering construction problems", and (2) the presence of a commercially viable geothermal resource. These assumptions must be confirmed in the field throughout the life of the project. Although the information contained in the EIS and this Supplement gives us an indication of what the "order of magnitude" the potential cumulative impacts may be, this Supplemental EIS should also assess the impacts of the first stages of this project.

   At the very least, this request includes an exploration plan which would consist of: (1) the construction of a roadway to a drill site; (2) the preparation and construction of the drill site; (3) the actual drilling;



   and (4) flow testing. "Success" or "failure" will determine the second well site location. Steps 1 to 4 will be repeated. Again, "success" or "failure" will determine the third well site location and steps 1 to 4 will be repeated. After completing four "successful" or three unsuccessful wells, a decision to continue with development or to suspend or terminate the project will have to be made

   The environmental setting and the environmental impact analysis of each roadway and each drill site which must be constructed up to the major decision point for the applicant should be presented. Greater detail is needed to support your assumption that there is an absence of unusual or unique engineering construction problems or that these "problems" may be mitigated.

2. This document includes information which was originally reported in other references and is accurately cited, some new information generated specifically for this project and other information which appear to to summarized from other sources. These latter sources, especially those from which the Puna District's socioeconomic characteristics were derived, do not appear to be appropriately cited.

3. The lots referred to on pages 40-41 are also "substandard" in that the roads providing access to most of these lots do not meet County dedicable standards.

4. The County of Hawaii's Geothermal Noise Level Guidelines do not apply to this project. The Noise Level Guidelines were developed to provide the Planning Director with the necessary guidance to review and assess certain geothermal operations approved by the Planning Commission. These guidelines are attached to specific Special Permits as conditions of approval. The County Planning Commission and the Planning Director do not have any regulatory authority for this project within the State Land Use Conservation District.

5. The general sequence of exploration drilling will be dictated by the "success" of each well. We have experienced a difference of opinion on the definition of "successful" with the two developers in lower Puna. Perhaps a definition of the term "successful" should be included in this EIS.

6. On page 34 the Puna District's water supply and distribution system is described. There is also a privately owned water system which distributes water much like the County's system. While there are no known springs, wells or potable water supplies in the project area, there are wells down slope from the project site. Another more appropriate adjective than "around" should be used to better describe Puna's hydrology.

7. On page 68, the project area's air quality has been generalized as "relatively high". Again a more appropriate characterization appears to be in order.

We hope these comments will assist you in finalizing this EIS. Please feel free to contact us if you have any questions. Again, thank you for the opportunity to comment.

Sincerely,

for Ilima Piianaia
ALBERT LONO LYMAN
Planning Director

RN/IP/ALL:lv

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THE ESTATE OF JAMES CAMPBELL

January 28, 1986

Mr. Albert Lono Lyman
Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Lyman:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 23 which we received on January 28 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Sincerely,

O. K. Stender
Chief Executive Officer

OKS:sak

RESPONSES TO COMMENTS AND RECOMMENDATIONS
ON THE DRAFT SUP EIS TO THE EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY
PLANNING DEPARTMENT, COUNTY OF HAWAII

1. We concur with your summary statement that the information presented in the EIS/SUP EIS provides an indication of what the "Order of Magnitude" potential cumulative impacts may be for the proposed 100MW geothermal development project. However, the EIS and SUP EIS were also organized to allow assessments of the potential impacts, incrementally, for any stage or level of development by describing the components of the project activity at each stage of progression and by showing (by map and tables) the surface areas required for all facility sites including the access road, individual wells and segments of service roads connecting project sites.

For example, Section II of the EIS describes the type and dimensions of roads to be constructed for the project, drilling site layout, drilling procedure and safety provisions, well profile, $H_2S$ detection and abatement system during drilling, flow testing of wells, i.e., all activities in the initial stages of the project. In this respect, the draft SUP EIS did not identify all of the data in the EIS that was applicable to the project as it is proposed in the land parcel adjoining and east of Kahauale'a. In general, all data relative to geothermal development activities that is contained in the EIS is applicable to the proposed action described in the SUP EIS.

We feel the "environmental setting" of the new project site (land adjacent to Kahauale'a) is satisfactorily described in the SUP EIS applying the results of the State's botanical survey of the Kilauea east rift zone, our botanical survey, the U.S. Fish and Wildlife survey, leaf tissue and soil sample survey, air quality surveys and meteorological surveys, and the archaeological literature, historical and limited ground surveys. The various components of the project such as individual drilling sites and road segments are within this "environmental setting" which is assumed to be applicable for each specific surface area that may ultimately be used. However, as noted in your comments, "the assumptions" that must be made in the development plan "must be confirmed throughout the life of the project." In this regard, we have stated in the EIS/SUP EIS, our commitment to obtain detailed site specific information as a basis for further impact analyses prior to disturbing any area in the project site beginning with the access road to the first drill site.



This site specific information will be reported to BLNR for administrative review (and Hawaii County Planning Department). This process will enable the permitting authority to ascertain at each step of project expansion whether (1) the environmental quality of the site(s) to be occupied is consistent with the base line data and (2) whether any special precautions or additional information is required, or (3) whether the sites should be relocated or realigned.

The draft SUP EIS did not describe the sequence, timing and method of reporting additional survey results of specific sites to be used and has been modified accordingly.

We will also be submitting quarterly reports to DLNR and the County on project operations which will include, as applicable, the results of environmental monitoring within and adjacent to the project site. This monitoring will record noise levels, air quality and meteorological conditions during operations in addition to the results of analyses of soil and leaf tissue, water catchment and periodic flora and fauna surveys of impact areas. Monitoring will occur at varying sites appropriate to the progress and incremental increases in project activity. An environmental monitoring plan will be submitted as part of the project "Plan of Operations" which must be submitted to DLNR and approved prior to commencement of any project operations.

2. All socioeconomic information cited in the SUP EIS has been derived from federal, State or county sources, such as census reports, county plans, State labor data and previously published reports. A careful review of the SUP EIS will be made prior to printing the Final EIS to ensure that all data and information are cited correctly.

3. The notation that the lots referred to are "substandard" will be included in the Final EIS.

4. The developer is aware that the County of Hawaii Noise Guidelines do not legally apply to the proposed project. However, it is the intention of the developer to meet those guidelines, as stated in the SUP EIS, since statewide noise standards applicable to geothermal operations do not exist.

5. A "successful" geothermal well is one which has discovered an economically producible resource. The Final SUP EIS will include this definition.

6. The privately owned water distribution system and the water wells downslope from the project will be noted in the Final EIS.

7. The sentence regarding the air quality of the project area will be modified in the Final SUP EIS to be more descriptive. The data on pages 68 through 76 indicates ambient air quality conditions and has been included to allow the reviewers to reach their own conclusion regarding the air quality of the project area.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P O BOX 50167
HONOLULU, HAWAII 96850

JAN 2 4 1986

ES
Room 6307

JAN 2 2 1986

Mr. Susumu Ono
Chairperson, Board of Land
and Natural Resources
State of Hawaii
P.O. Box 621
Honolulu, Hawaii 96809

Re: Draft Supplemental Environmental Impact Statement (SEIS) to the Revised Environmental Impact Statement, Kahaualea Geothermal Project, Hawaii

Dear Mr. Ono:

The U.S. Fish and Wildlife Service has reviewed the referenced SEIS and offers the following comments for your consideration.

General Comments

The Board of Land and Natural Resources has proposed an exchange of State lands in the Kilauea middle east rift zone for Campbell Estate lands at Kahaualea for geothermal energy development. In general, geothermal energy development at the Kilauea middle east rift zone is environmentally preferable to development at Kahaualea.

However, the Service remains concerned about the long-term potential impacts to the biological integrity of the native forest ecosystems in the Puna Forest Reserve. In particular, the Service is concerned about maintaining the high biological value of the west and southwest portion of Wao Kele O Puna Natural Area Reserve.

Specific Comments

Page 48. This section states that four rare or candidate endangered plant species found within the proposed geothermal resource subzone are shown on Figure 11. These species cannot be found on Figure 11.

Page 49. The definition for a Category 1 species is incomplete.

Appendix A. <u>Adenophorus periens</u> is not included in the species list in Appendix A.

Summary Comments

The long-term impacts of the proposed geothermal development on the native forest ecosystem is generally unknown. There is no project of similar design or magnitude in Hawaii to confirm the potential long-term and cumulative impacts. The proposed geothermal project offers an opportunity to document the impacts of geothermal developments on native forest ecosystems and could be used in assessing future developments.

In view of this, the Service recommends that geothermal energy exploration along the Kilauea middle east rift zone be developed incrementally. The Service recommends that exploration and development begin in the northeast corner of the subzone and that the environmental impacts at this site be documented concurrently and evaluated by natural resource agencies. This evaluation of the documented impacts would result in mitigation measures based on known impacts rather than speculation. The development of the geothermal resources in the area would be based on the results of the drilling program and the concurrent environmental studies.

Our office remains available to provide technical assistance.

We appreciate this opportunity to comment.

Sincerely,

Ernest Kosaka

Ernest Kosaka
Project Leader
Office of Environmental Services

cc: The Estate of James Campbell, ATTN: Mr. O. K. Stender
HLFS

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Mr. Ernest Kosaka
Office of Environmental Services
U.S. Department of Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 22 which we received on January 24 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak



THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. Ernest Kosaka
Office of Environmental Services
U. S. Department of Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 22 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY FISH & WILDLIFE SERVICE U.S. DEPARTMENT OF INTERIOR

1. Within the designated geothermal resource zone there are only 3 patches of ohia-a(1) forest. The proposed exploration development map shows that none of the proposed drill sites, or power plants will encroach on any of the ohia-a(1) forest. In the western portion of the subzone, much of the area of planned development can be located on recent and sparsely vegetated lava flows, including some ohia-a(2) forests. Much of the southwest portion of the former Wao Kele O Puna NAR was excluded from the geothermal resource sub-zone. This land use plan should be effective in minimizing impacts on the biological integrity of the native forest ecosystems in this area.

2. The four rare or candidate endangered plants found within the GRS are now shown on Figure 11 of the SUP EIS.

3. The definition of a Category 1 species was the latest definition of which we were aware at the time the SUP EIS was completed. In the most recent listing of endangered and threatened wildlife and plants (Federal Register 50 CFR Part 17, Friday, Sept. 27, 1985, pp. 39526-39527) the definition is: "Taxa for which the Service currently has on file substantial information on biological vulnerability and threat(s) to support the appropriateness of proposing to list them as endangered or threatened species" and "Also included in category 1 are taxa whose status in the recent past is known but that may already have become extinct". The SUP EIS has been modified to include this definition.

4. As indicated in the SUP EIS, Appendix A included only those species which were encountered in the geothermal sub-zone during field surveys. It was indicated in the text (pp. 48-49) that one sighting of *Adenophorus periens* had been made during the USFWS survey of the area, but the precise location of that sighting was not made known by the Service until the Contested Case Hearing in November 1985. This sighting was made in one of the patches of ohia-a(1) forest identified in item (1) above. The species list has been changed to include the *Adenophorus periens*.

5. We concur with your observation that this project offers an opportunity to document any impacts of geothermal development on native forest ecosystems and could be used in assessing future developments. Our development plan is generally consistent with the essence of the recommendations in the last paragraph of your letter. Exploration would be initiated in the Exploration/Development (E/D)



Area 1 in the eastern area of the sub-zone and on the north side of the rift zone. Initial development would occur in E/D areas 1 and/or 2 depending on resource discovery and quality of the resource. The sequence of development is described in Section II of the SUP EIS. Development is expected to occur over a 10-12 year period.

Environmental monitoring will be accomplished to ensure that any impacts of geothermal development activities are detected so that the need for additional or special mitigating measures can be determined.

We greatly appreciate and welcome your offer of technical assistance in our endeavors to develop this natural energy resource in the Kilauea middle east rift in an environmentally acceptable manner. We will request a meeting to discuss your offer at the earliest practical time.

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT SHAFTER, HAWAII 96858

JAN 28 1986

January 21, 1986

Mr. O. K. Stender, Chief
Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Stender:

Thank you for the opportunity to review and comment on the Supplemental EIS to the Revised EIS for Kahauale'a Geothermal Project, Puna District, Hawaii. We offer the following comments:

a. A Department of the Army (DA) permit would not be required for the proposed project exploration/development upland area. However, any future offshore salt water intake structures or deepwater electrical transmission cables from the Big Island to Oahu would require a DA permit.

b. According to the Flood Insurance Study for Hawaii prepared by the Federal Insurance Administration (FIA) for the County of Hawaii, the geothermal project site is located in an area of minimal flooding or Zone C designation. Under the National Flooding Insurance Program, Zone C areas are not considered flood plain areas. Specific use restrictions and floodproofing requirements, therefore, are not applicable to the project.

c. Pages 116-126. In general the section is contusing with potentially conflicting statements. Since the archaeological reconnaissance survey report was cited and quoted often in this section, perhaps it should be included as an appendix similar to the botanical surveys. Both the Holmes and Rosendahl (1985) reports would be useful references.

d. Page 117. The Holmes reference that the project area has always been regarded as remote, inhospitable, etc. It is unclear whether this refers to historic use and/or Hawaiian legend as well.

e. Pages 118, 123. If only one of the trails (historic and/or prehistoric) crosses the entire property, then the other trails and their location



should be identified. The terminal points of the noncontinuous trails should be surveyed for archaeological remains. In addition, since page 123 stated that a greater density of archaeological remains potentially exist along the major trails, they should have been included in the reconnaissance survey.

f. Page 118. At least two (2) bird-hunter shelters (prehistoric, early historic or modern?) and 5-6 cairns were identified; however, it is unclear whether these are the same features as those mentioned on page 121 given tentative burial function.

g. Page 119. The last paragraph is unclear and implies that archaeological remains have been found during surveys southwest and adjacent to the project area. No bibliographic references to these surveys exist. Further, the discussion states that sites similar to those found during previous surveys may be present in the south project area. If so they should be identified as to the use and type of site and be included in the reconnaissance survey. It would have been more appropriate to concentrate on such areas in order to determine more accurately the types and distributions of archaeological remains.

h. Page 120. The "transects" described during the archaeological reconnaissance survey are not transects since they do not cut across or divide the property. Instead, they are sample survey areas representing coverage of a very small portion of the property. The basis for the location of the samples is questionable. Although Transect (sic) 6 was described as being in Kipuka, Figure 23 indicates that it was all contained on the surface of a very recent lava flow (1963). No archaeological remains would be expected in such an area.

i. Page 121. 5-6 cairns found on Transect (sic) 5 were given probable burial function assignations would imply that a greater range of use of the area may have occurred than indicated in the discussion.

j. Page 123. Section 8.b. indicates that an archaeological reconnaissance survey will be performed before any areal clearing. Further mitigative measures should be incorporated into the proposed archaeological research design discussed on page 125.

k. Page 126. Although the EIS states that few archaeological sites are expected because of the extensive lava flows, Figure 24 appears to suggest otherwise. Approximately 25% of the area contains lava flows older than 750 years and at least half of it is older that 350 years. Relatively little of the area is covered by 20th century flows. Therefore, the ground surface appears old enough to support sites representative of most of the era of human habitation in Hawaii.

l. Silica. One of the results from the test well, HGP-A, is silica. It is also likely that silica will also be found with these geothermal wells and should therefore be discussed in the EIS. The discussion should include the amount of silica anticipated, if any, the number of holding ponds required, the disposal of it, and the potential impact on the environment.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

THE ESTATE OF JAMES CAMPBELL

January 28, 1986

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
U. S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 21 which we received on January 28 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Sincerely,

O. K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 6, 1986

Mr. Kisuk Cheung
Chief, Engineering Division
Department of the Army
U. S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858

Dear Mr. Cheung:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 21 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

David H. McCoy

David H. McCoy
for O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY U.S. ARMY ENGINEER DISTRICT, HONOLULU

1. Except for the plant species list, all consultant's reports were summarized to reduce the bulk of the EIS. The State office reviewing this section (pages 116-126) found the summaries to be an accurate reflection of the basic reports. These reports are available in the State Historic Preservation office.

2. The subject report generally refers to the historic use of the project area. The sentence will be modified to clarify the point.

3. All trails, historic and prehistoric, that have been recorded are shown on Figure 22a of the SUP EIS.

4. The presumed location of two bird hunter shelters within the GRS, shown on Figure 22b, are historic and are located in the northeastern and north central portion of the project area. The 5 - 6 cairns, given tentative burial function, are found on the southeast summit of Puu Heiheiahulu, as stated in the SUP EIS and shown on Figure 22b. The two features are entirely separate and distinct.

5. Holmes' report (Holmes 1982:10) cites Dr. Jim Jacobi as noting archaeological sites south of Kalalua crater at the 1200 to 1400 feet elevation. Rosendahl fixes this area as "southwest" of the project area.

   The statement that sites similar to those found during previous surveys "may be present" in the south project area was offered so as not to rule out a possibility. In any event, the area discussed has now been excluded from the geothermal resource subzone.

6. The reconnaissance survey was limited to those areas of the project area that were more reasonably accessible than the interior of the project area and for the reasons cited on page 119 of the draft SUP EIS. The use of the word "transect" is from the report of Dr. Rosendhal, the archaeologist employed to perform the survey. Figure 23 shows the areas or extent of the "survey", even though referred to as "transects."

7. As noted at the beginning of the archaeological impact section of the SUP EIS, the area has always been considered as remote and inhospitable. As such, it appears unlikely that extensive use of the area occurred. This assessment can be validated by the detailed surveys that will be conducted prior to construction activities.



8. The mitigative measures described on pages 123 - 125 are those proposed by Dr. Rosendahl and adopted by the developer. It is believed that these measures are sufficient to locate and protect any significant archaeological sites that may be present.

9. It is recognized that the majority of the project area is covered by relatively old lava flows. However, as noted previously, the generally regarded inhospitable nature of the area and its remoteness from known coastal habitations lead the developer and Dr. Rosendahl to conclude that the area is sparsely populated by surviving archaeological sites of significance. Those sites that are known are identified in the SUP EIS and, as noted, archaeological surveys will be conducted prior to construction activities to ensure significant archaeological sites are properly preserved or recorded as appropriate.

10. As noted in the SUP EIS, the developer plans on disposing of the spent geothermal fluids directly through injection wells rather than through the use of cooling ponds prior to injection. Should silica become a by-product of project operations, it will be disposed of in accordance with county disposal regulations or for commercial purposes if feasible. Please note that one of the local projects to be investigated at the Puna Geothermal Research Center will be the use of the silica in glass making.

# AMERICAN LUNG ASSOCIATION OF HAWAII

JAN 22

## ENVIRONMENTAL IMPACT STATEMENT REVIEW

*. . . an air quality assurance program*

**Project:** Kahauale'a Geothermal Project (Supplemental EIS) **Date:** 1/20/86

1. Tables 11 and 12: The California H2S standard is indicated as being 100 ppbv as a 1-hour average.

   **Comment:** Unless that standard has been recently changed, it is our understanding that it is 30 ppbv.

2. Page 84: "It can be concluded that for a 55 MW plant, downwind concentrations will not exceed 5 ppb beyond the property boundary during power plant operations or stacking when a discrete mean wind direction prevails."

   **Comment:** Such a statement should include a broader caveat, i.e., that it appears to be true based on the modeling results reported and for the specific emission rate, stack parameters, and meteorological conditions that were used in that modeling. The conclusion stated cannot stand by itself since it is based on a specified and apparently limited set of data.

3. Pages 82-84: Air quality impact analysis

   **Comment:** We note that only neutral and stable atmospheric stability categories were reported. Our own analyses of geothermal sources has indicated that high H2S concentrations in flat terrain also occur under slightly unstable conditions. This is not surprising since high groundlevel pollutant concentrations from elevated sources such as stacks are commonly associated with unstable conditions. Maximum groundlevel pollutant concentrations under neutral and stable atmospheric conditions are normally associated with low or groundlevel sources such as highways.

   One would expect an elevated source in a neutral or stable atmosphere to result in maximum pollutant concentrations if plume impingement occurs on terrain higher than the stack height. The EIS made no mention of this possibility.

4. Page 87: "It can also be concluded that at least up to 110 MW of geothermal power can be produced in the proposed area without violation of the proposed state hydrogen sulfide standard of 30 ppb above background."

   **Comment:** This conclusion seems premature for a number of reasons. First, as noted above, there is no indication that impact analyses were performed under unstable atmospheric conditions or for terrain impingement. Secondly, as noted above, it is based on certain specified parameters, and should therefore include a caveat that it may be true if all the specified conditions of emission rate, meteorology, etc. are met. Thirdly, our own analyses indicate that plants above 55 MW will have difficulty meeting the proposed increment standard under stacking conditions.

   **Comment:** The reference to a state H2S standard of 30 ppb is incorrect. The State Department of Health's Air Advisory Committee has recommended a hydrogen sulfide increment of 25 ppb (manmade sources only) and an ambient standard of 100 ppb (manmade + natural sources). These are both based on 1-hour averaging periods.

5. Page 87: "It should be noted that air diffusion models make conservative estimates whereas actual conditions may be less severe."

   **Comment:** All air diffusion models are not inherently conservative. Some are and some are not. The conservatism in the modeling often results from the conservative data input to the model by the user. The inherent inaccuracies in diffusion models can result in pollutant concentration estimates which are on the high or low side.

6. Pages 90-93: "We conclude that the average level of ambient H2S in and around HGP-A could easily be increased 30-fold (and perhaps more) at current abatement state of the art without hazard to human health." (Siegel, 1985)

   **Comment:** This conclusion should be viewed with great caution as it is taken from a report which has very serious limitations as a public health document. The air sampling methodology was not fully explained in the report. It appeared to be based on grab sampling rather than continuous monitoring. Duration of sampling was not indicated; thus, human exposure in terms of estimated dose could not be determined. Comparisons with 8-hour OSHA threshold limit values (TLV) were made without any indication that the sampling data were also based on 8-hour continuous data. Finally, the evaluation of possible human health effects in the Rotorua area was based on mortality data. Without the benefit of a thorough epidemiological study including as a minimum morbidity data and continuous air monitoring data, one cannot draw the conclusion that a 30-fold increase in H2S levels can be effected "without hazard to human health."

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

American Lung Association
State Office
245 N. Kukui Street
Honolulu, Hawaii 96817

Dear Association:

Subject: <u>Comments Relating to Supplemental EIS to Revised EIS</u>

This is to acknowledge receipt of your comments dated January 20 which we received on January 22 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

American Lung Association
State Office
245 N. Kukui Street
Honolulu, Hawaii 96817

Dear Association:

Subject: <u>Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a</u>

This is with regard to your letter of January 20 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS
ON THE DRAFT SUP EIS TO THE EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY
THE AMERICAN LUNG ASSOCIATION OF HAWAII

1. Tables 11 and 12 have been corrected to show the California $H_2S$ standard as 30ppbv.

2. It was assumed that the data derived from a model exercise would be viewed as applicable for the conditions cited. To clarify, an explanatory sentence is included in the SUP EIS.

3. Calculations using unstable atmospheric conditions produced similar results. The concentrations were lower for unstable conditions with one exception. Using the first case in table 18 with receptor at 1/2 mile downward of a power plant, the calculations are as follows:

| Stability Class | Wind Speed | Eff. Stack Ht. | Est. Conc. |
|---|---|---|---|
| 2 = moderately unstable | 5 mps | 99 m | 3.4 ppb |
| 3 = slightly unstable | 10 mps | 58 m | 4.2 ppb |
| 4 = neutral day | 20 mps | 37 m | 4.2 ppb* |
| 5 = neutral night | 30 mps | 31 m | 2.6 ppb |

*Used in table 18

4. As to terrain impingement, the highest concentration estimates in the Dames and Moore report were all associated with the plume impinging on higher terrain downwind of the source. While this situation certainly can occur during stable conditions <u>in large valleys</u> and result in very high concentrations, <u>we cannot envision</u> that it could happen in the proposed area since there are no such valleys there where the pollutant would be trapped.

Even during stable conditions, which would be required for such episodes, the emissions would still have enough buoyancy to rise well above the ground. E.g. with a wind speed between 1 and 3 mps during stable conditions the effective stack height is over 100 m. Above this speed trapping conditions would generally not occur.

Furthermore, during drainage, the air layers, in which the emissions are diffusing, would rise relatively to the ground as more drainage air is created at the surface.



5. The responses in paragraphs 2, 3 and 4 above are also applicable to the comment in Paragraph 4 of the Lung Association's letter. In addition, meteorological conditions selected for the model, based on all available information, were those that were envisioned to produce maximum ground concentrations on or beyond the property boundaries of the project.

Calculations indicated that maximum concentrations during stacking would be 4 ppb. While perfect reflection from the ground is not likely, calculations for situations with a distinct mean wind and perfect reflection indicate that concentrations would not exceed 25 ppb for a 100MW plant.

6. The reference in the Draft SUP EIS to a State standard for $H_2S$ will be deleted.

7. The statement in the Draft SUP EIS that "all air diffusion models are conservative" will be modified to reflect that the model for this project was conservative.

P.O. Box 428
Pahoa, HI 96778

JAN 23

January 20, 1986

Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Dear Mr. Ono,

I have reviewed the Draft Environmental Impact Statement prepared by Campbell Estate for exploration and development within the Kilauea Middle East Rift Geothermal Resource Subzone. I found the Statement well written, but it is obviously and inherently biased to the goals of the developers. Therefor, it is important that future reviewers consider the following positions and questions.

1. The 100 MW request is far in excess of any current energy demands sought by HELCO. In fact, as evidenced by testimony during previous geothermal hearings, the maximum anticipated energy requirement was only 13 MW.

2. There has been no environmental or socio-economic study considered or prepared that addresses the questions or problems of geothermal development beyond a maximum scenario of 25 MW. This is extremely important when one considers that there are other geothermal development projects now under way in the Puna District and the cumulative effects of all development must be addressed.

3. Though the Statement acknowledges the environmental and ecological concerns and the concerns of adjoining residents and farmers and posits possible remedies, it is my experience that there is often a wide discrepancy between paper solutions and actual practice. It would seem to me then that it would be more reasonable to initially allow only limited development until the suggested solutions are proven reliable.

4. One small discrepancy in the statement that should be corrected is that there are bats located in the upper Kaohe area. Whether these are the particular bats cited in the report I do not know, but they are definitely bats of some kind.

In view of the forgoing, I would suggest the following as a reasonable alternative to the proposed exploration and development plan.

1. Exploration and development should be limited to a maximum of 13 MW during this phase. This size is reasonable given current anticipated energy needs and provides sufficient room to determine the feasibility of the resource and the capabilities of the developers.

2. An additional buffer of at least 2780 feet should be permanently established along the Kaohe Homestead border to the GRS to ensure tqhat the residents and farmers in that area are not disproportionately affected by any development.

3. Because they are the most environmentally sensitive, no exploration or development should be allowed in proposed Pods D and E at this time.

4. Because it is situated closest to developed residential and farm areas, no exploration or development should be allowed in proposed Pod A at this time.

Thank you for the opportunity to comment and input my feeling and concerns on this proposal.

Sincerely,

Karl Kirkendall

Karl Kirkendall

cc: Mr. O.K. Stender
Estate of James Campbell
828 Fort St. Mall Suite 500
Honolulu, HI 96813

*THE ESTATE OF JAMES CAMPBELL*

January 27, 1986

Mr. Karl Kirkendall
P. O. Box 428
Pahoa, Hawaii 96778

Dear Mr. Kirkendall:

Subject: <u>Comments Relating to Supplemental EIS to Revised EIS</u>

This is to acknowledge receipt of your comments dated January 20 which we received on January 23 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak



*THE ESTATE OF JAMES CAMPBELL*

February 4, 1986

Mr. Karl Kirkendall
P. O. Box 428
Pahoa, Hawaii 96778

Dear Mr. Kirkendall:

Subject: <u>Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a</u>

This is with regard to your letter of January 20 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY KARL M. KIRKENDALL

1. The basis for an application for a land use permit to develop and produce up to 100 MW of geothermal electricity is explained in the Project Description, Section II of the SUP EIS. As can be seen, the energy demand to which we are responding is not limited to the Island of Hawaii. The rate of development will depend on the market demand for geothermally produced electrical power and the ability of the HELCO/HECO transmission and distribution system (including the cable) to accept the power.

2. The SUP EIS states in the SUMMARY that the developer "...proposes to explore for and develop 100 megawatts (MW) of geothermal resources to produce electrical power in the Kilauea Middle East Rift Zone Geothermal Resource Subzone (GRS), Puna District, Island of Hawaii". All of the discussion impact analyses, models and studies performed for the SUP EIS have been prepared and conducted on the basis of developing 100 MW of power.

3. The incremental development approach to be followed by this project over a 10-12 year period, together with the environmental protection measures described in the SUP EIS, will serve to minimize the potential for unacceptable impacts on the residents around the project area as well as the wildlife and plants within the project area. Given the number of additional permits, and authorizations that the developer must obtain throughout the life of the project, it is highly likely that the "paper solutions" will be as effective as they are designed to be.

4. The presence of the bats as observed by you will be reported in the Final EIS.

5. The current buffer zone between the GRS and your property boundary was purposefully established by the Board of Land and Natural Resources and in this respect is unique in relation to all other sub-zones established. Geothermal development activities within this sub-zone should not result in unacceptable impacts to adjacent property owners and residents, an objective to which the developers are firmly committed.

6. Per EIS Rules, the alternatives which could feasibly attain the objectives of the action are fully described in the SUP EIS and the Revised Kahauale'a EIS. The alternatives listed in the comment letter are not considered feasible to attain the objectives of the proposed project. As noted in the SUP EIS, the geothermal power will be developed incrementally. The first increment is for 12.5 MW. The proposed project boundaries and the designation



of the Middle East Rift Zone GRS have been established by the BLNR. The distance of the nearest planned well site is approximately one mile from the nearest residence. Also as noted in the SUP EIS, project activities will meet applicable air and noise quality standards. It is estimated that under the worst sound propagation conditions, drilling and power plant operations will not exceed 50 decibels at the one-mile distance.

7. The exploration and development scenario, as described in the SUP EIS, will begin in exploration/development Area A, considered to have the most acceptable geothermal potential in this area of the rift zone, i.e. north of Heiheiahula. Since we must develop the resource where it is located and since the presence of the resource can only be determined by drilling, our development sequence could be altered.

*For the Protection of Hawaii's Native Wildlife*

# HAWAII AUDUBON SOCIETY

P.O. BOX 22832
HONOLULU, HAWAII 96822
P. O. Box 275
Volcano, HI
96785

January 22, 1986

JAN 27 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Re: Comments on the Draft Supplemental Environmental Impact Statement (EIS) to the Revised EIS for the Kahauale'a Geothermal Project, Puna District, Hawaii

Dear Mr. Ono:

Because of a clerical mistake, the original typed letter of comments, dated January 19, 1986, on the draft EIS was not mailed to you. Instead a xerox copy was sent on January 20.

I am enclosing here the original typed letter, with corrections of typographical errors. No substantive change has been made.

I would appreciate it if the original letter would be accepted as a replacement of the xerox copy.

Thank you for your courtesy in this matter.

Yours truly,

Mae Evelyn Mull
Mae Evelyn Mull
Member, Board of Directors

Copy sent to:
Mr. O. K. Stender

*For the Protection of Hawaii's Native Wildlife*

# HAWAII AUDUBON SOCIETY

P.O. BOX 22832
HONOLULU, HAWAII 96822
P. O. Box 275
Volcano, HI 96785

January 19, 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Re: Draft Supplemental Environmental Impact Statement (EIS) to the Revised EIS for the Kahauale'a Geothermal Project, Puna District, Hawaii

Dear Mr. Ono:

The draft EIS proposes a level of geothermal development that is not compatible with wise use of the unique natural resources of the Wao Kele O Puna Natural Area Reserve — which is now the project site. The scale of development requested could result in irreversible negative impacts on the native forests and successional habitats of the Kilauea Middle East Rift zone (MER).

This request for geothermal exploration and development of 100 MWe is contrary to the customary planning process for new industry of starting out small-scale and proceeding step-by-step in incremental modes so that negative impacts can be avoided or corrected before the project is full-blown. What would be appropriate now is a plan for geothermal exploration for 13MWe to meet the needs of the Big Island in the next five years.

The Society raises these additional concerns:

1) The draft EIS and the Kahauale'a EIS are inadequate in presenting alternatives to the proposed project. The EIS rules (Title 11-200-17(f)) provide that "the draft EIS shall contain any known alternatives for the action." The rules also require "a rigorous exploration and objective evaluation of the environmental impacts of all reasonable alternative actions . . ." The following alternatives are not treated in the EIS, but they should be, so that decision-makers have this relevant information:

a) a plan for an exploration-only phase to meet the needs of the Big Island.

b) a plan for a lesser scale of development, such as for 13-25 MWe.

c) alternatives sites in the geothermal resources subzones of Kama'ili and Kapoho in lower Puna where geothermal development can be located.

d) an alternative plan in the event a deep water cable between the islands of Hawaii and Oahu turns out to be unworkable.

2) It is misleading for the draft EIS to say (p. 93) that "it appears, based on all studies conducted to date, that adverse short- and/or long-term impacts to the health and welfare of residents, visitors or the wildlife of geothermally active areas are non-existent." Evidence to support such a statement is not presented.

Comparisons of the Puna geothermal production areas with those of New Zealand are not valid when you attempt to extrapolate public health data that were collected with a different base, at different times and for different purposes. No studies or other information are presented to the reviewer to substantiate the claim that adverse impacts to wildlife are non-existent now in Puna or will be non-existent when large-scale geothermal production is on line.

3) The EIS errs when it concludes (p.55): "that no significant interruption of natural successional processes is likely to occur." No substantiating evidence is presented by a qualified ecologist or biologist. The environmental consequences of direct destruction of plant and animal habitats that will accompany the extensive construction of two full networks of roads that will run the full length of the subzone from east to west, as well as vegetation clearing for drilling sites, transmission lines and power plants, are scarcely mentioned and thus do not comply with the EIS rules (Title 11-220-17(g) to (i)).

4) The EIS admits that (p.57) "the invertebrate species inhabiting the project and surrounding areas are not well known,"but no effort was made to survey the native invertebrates living in the project area. This should be done. The EIS also says (p. 57): "It is also likely that the endemic Hawaiian Drosophila exists in the project area and that species differentiation between kipukas and the various ecosystem types may have occurred." Because of their immense importance to genetics research world-wide, geneticists and biologists need to know what undescribed Hawaiian Drosophila species inhabit the project area.

Some Hawaiian invertebrates are on the US List of Endangered Species, like the whole genus of Achatinella tree snails on Oahu. Others have been recommended for endangered species status. It is essential that the native invertebrate fauna be surveyed and evaluated, so that the habitats of newly-discovered or rare species will not be needlessly destroyed.

5) The endemic forest birds living in the Natural Area Reserve/ project area should not be given short shrift (p. 62). It should be acknowledged in the Final EIS that destruction of forest habitats means the demise of 'Elepaio, 'Oma'o, 'Amakihi, 'Apapane and 'I'iwi individuals living there. Contrary to popular thought (pp.64 & 135), these stressed birds just cannot move elsewhere, because the niches in "elsewhere" are already fully occupied with other members of their species earning a living as best they can.

6) It is improper for the EIS to attempt to weaken the endangered species status of the 'Io (Hawaiian Hawk) by emphasizing that it may be appropriate to reevaluate the endangered status of the 'I o (pp. 59-60). The works of the two writers who made this suggestion have not yet been published. No proposal to change the status of the 'I o has been made to the US Office of Endangered species, as far as I know. If a proposal were made to downgrade the 'I o, it certainly would not be supported by local naturalists and biologists who understand the vulnerable position of this island hawk. Its relatively small population, estimated at 1,400 to 2,500 birds, is close to the maximum number that can be supported within a limited habitat. Its total range is the confines of the Big Island. This is small-sized habitat for such a wide-ranging bird as a hawk.

7) The following recommendations on the 'Io made by Andrew J. Berger (in the Puna Geothermal Area Biotic Assessment by Char and Lamoureux, April 1985, p. 115) should be added to the Final EIS and made part of the developer's



plan of operations:

> "Geothermal development would have a negative impact on the nesting areas of the 'I'o [sic]. The 'I'o often uses the same nest or nests in the same locality. Noise from geothermal operations may affect hawk breeding (Char and Kjargaard 1984). Well sites and power plants should be located in open areas such as lava flows or scrub, away from tall trees, if 'I'o are known to nest in the nearby forests. The effects of well emissions on 'I'o are not clear. Monitorin of 'I'o population size and breeding activities around geothermal sites is recommended (Char and Kjargaard 1984)."

8) The EIS states that environmental impacts of the project, such as noise, transmission lines, powerline structures, night lighting of the operating drill sites and emissions of hydrogen sulfide ($H_2S$) and sulfer dioxide ($SO_2$) will be minimal or have insignificant effects on birds or mammals (pp. 63-65). The basis for such unwarranted leaps of faith are some mainland studies of mainland birds. Such conclusions cannot be transferred en masse to endemic Hawaiian birds on the Big Island — and parade as good science.

9) The draft EIS says (p. 143) that "there is no unresolved issue directly concerning the proposed project." Nevertheless, several unresolved questions come to mind. The following problems and means of resolution should be treated in the Final EIS, in accord with the EIS rules (Title 11-200-17(n)).

* Court appeal of the EIS for Kahauale'a geothermal development
* Court appeal of the Kahauale'a geothermal resource subzone
* Court appeal of the KER geothermal subzone, the site of this project
* Contested case hearings on the 100 MWe development proposal and on redesignation of the Protective subzone have been requested by conservation organizations, community groups and residents
* The existence of a geothermal resource in the project area is unknown
* The location of a geothermal resource is unknown
* The extent of a potential geothermal resource is unknown
* The land exchange between the State of Hawaii and the Campbell Estate — which includes the project area — has yet to be accomplished, and is subject to the disapproval of the State Legislature in the current session

Thank you for your consideration of the issues raised here. Please send me a copy of the Final EIS when it is ready. Thank you very much.

Yours truly,

Mae Evelyn Mull

Mae Evelyn Mull
Island of Hawaii Representative and
Member, Board of Directors
Hawaii Audubon Society

copy sent to:
Mr. O. K. Stender
Chief Executive Officer
Estate of James Campbell
800 Fort Street Mall
Honolulu, HI 96813

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Ms. Mae E. Mull
Hawaii Audobon Society
P. O. Box 275
Volcano, Hawaii 96785

Dear Ms. Mull:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 19 which we received on January 24 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Ms. Mae E. Mull
Hawaii Audubon Society
P. O. Box 275
Volcano, Hawaii 96785

Dear Ms. Mull:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 19 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS
ON THE DRAFT SUP EIS TO THE EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY
HAWAII AUDUBON SOCIETY

1. We believe the level of geothermal energy production proposed under our application will not result in the significant negative impacts forecasted by the Audubon Society. This project, to be developed incrementally over a 10-12 year period, will utilize approximately 300 acres of a 26,000 acre parcel of land for dispersed project sites, or about 1% of the total surface area of the land parcel. The quality of the vegetation within this parcel is mixed with only three stands of ohia-a (1) forest. Exotics are present in most of the GRS as well as in areas adjacent to the GRS. Most of the southwest portion of the proposed GRS was excluded from the GRS by decision of the Board. Within the GRS, a portion of the project sites and roads will be constructed on recent and sparsely vegetated lava flows. While we recognize that clearing for sites has the potential to introduce additional exotics, efforts can be made to limit their spread by controlling growth along the edges of the cleared sites.

Emissions and noises from project activities can be controlled to levels that are environmentally acceptable. Environmental monitoring can enable detection of any potential adverse impacts to determine needs for additional and special mitigation measures. Finally, the progress of a geothermal project is "permit controlled" after the land-use permit is issued so that permitting authorities can intervene at anytime during the life of the project to protect the environment and the public interest.

Based on the progress of geothermal development around the world, it is evident that this natural energy resource can be developed and utilized in a responsible and environmentally acceptable manner.

2. We are not aware of a "customary" planning process for new industry. However, our project in which we propose to develop and produce 100 MW of electrical power has always been planned as an incremental process extending over 10-12 years beginning with exploration and proceeding to development and production, incrementally, as the market for geothermal energy is identified.

There is sufficient time between the exploration and development of the intial wells and power plants and subsequent wells and power plants as shown on the project schedule (Figure 6), for regulatory and permitting authorities to monitor and assess the environmental impacts of the project as it progresses and to take corrective actions if required. As stated in the SUP EIS,



additional permits are required throughout the life of the project such as (1) permits to drill each well and (2) authority to construct and authority-to-operate permits for each power plant prior to initiating construction and operation. Qualified biologists and archaelogists will survey all construction areas prior to construction. A plan of operations must be submitted to and approved by the BLNR prior to commencing drilling operations. These measures are designed to ensure that the project moves forward step by step and that project activities are performed in an environmentally acceptable manner.

3. Both the Kahauale'a EIS and SUP EIS contain a full discussion of the alternatives to the proposed project "...which could feasibly attain the objectives of the action...." The alternatives suggested do not, in the view of the applicant, represent alternatives that feasibly attain the objectives of the proposed project because of the financial risks and constraints that would be placed on the applicant by the suggested alternatives. The potential for economical development of the project area would not be assured and would therefore affect investment support for the project. Consideration of alternative sites (Kamaili and Kapoho) "where geothermal development can be located" is not a feasible alternative for the applicant and there is no assurance that all geothermal development needed for the county and state would be allowed to be concentrated only in these areas. Since no project beyond 25 MW has been proposed to the residents living within and adjacent to these two areas, there would undoubtedly be objections to your proposal. In addition, the utility company should not depend on geothermal generated energy from a single or concentrated area of an active rift zone due to the potential for disruption of power due to lava flows. As noted previously, the level of development will be controlled by market conditions (including the market supplied by means of the cable) and the ability of utility companies to absorb the power generated through existing or planned transmission and distribution systems. If the cable is not installed, the rate of development of geothermal energy will be decreased.

4. As noted in the SUP EIS, project generated air emissions will be controlled to meet applicable air quality standards. The Department of Health is presently in the process of formulating and promulgating geothermal rules for wells, power plants and other geothermal facilities. For all geothermal wells, power plants and other geothermal facilities, the Best Available Control Technologies (BACT) will be required, as a minimum, to control air emissions. The air quality and health surveys conducted to date in Hawaii, the mainland U.S. and New Zealand, would suggest

that the incidence of health problems associated with geothermal activities are no greater in these areas than non-geothermal areas.

Based on the foregoing and the progress of geothermal developments around the world, it is our opinion that geothermal development will not have unacceptable impacts on the health and welfare of nearby residents, or on the environment. Nevertheless, to preclude misunderstanding this statement will be deleted from the Final SUP EIS.

5. The health data collection methods used in New Zealand are described in the SUP EIS. The time of data collection, purpose and base are not considered to have any effect on the results of the data or of the author's comparison between the two areas since he described the basis for comparison.

The fact that wildlife exist in Puna District at present, given the ambient levels of volcanically produced air pollutants, serves as an indicator that geothermally active areas can be and are inhabitable by wildlife. The air and noise quality controls and other environmental protection measures that will be employed will ensure the continued compatibility of the project area and the wildlife inhabiting the area.

6. The statements on page 55 regarding the lack of interruption to successional processes were developed by Dr. Charles Lamoureaux, noted Hawaiian botanist and ecologist.

The statement made in the SUP EIS in its entirety states, "again, the area involved in relation to the total area in the subzone is so small that no significant interruption of natural successional process is likely to occur. The substantiating evidence presented was that only very small areas of any given successional stage would be disturbed by project activities, and that the vast majority of each successional stage in the subzone would remain intact. Moreover, the major portion of the land area in which vegetation diversity exists has already been excluded from the subzone."

7. The total land area to be cleared, the total length of roads to be constructed and all other proposed land uses are clearly identified in Section II, page 17, Table 1, as required by Title 11-200-17(g) to (i). The potential impacts of clearing in a forest area were discussed in the EIS, Section 5 and in the SUP EIS Section III.



8. As noted in the SUP EIS, biological surveys of construction areas will be conducted prior to construction. Organisms inhabiting those areas will be identified at that time and proper protective measures taken if appropriate.

To our knowledge, no EIS ever prepared for Hawaii was required to survey and evaluate the native invertebrates. Such a survey covering the entire subzone would be overly burdensome since it would require many person-years and excessive costs to complete. It would however be workable (and the developer intends) to survey the specific sites to be used for project development activities and facilities when such sites are selected to be used.

9. As noted in the SUP EIS, the amount of land to be cleared for project purposes represents about 1 percent of the total land parcel in which the GRS is located. As such, there will be minimal habitat removal. There is no evidence, given the small land area to be cleared, that the project "... means the demise ..." of the endemic, non-endangered or introduced birds of the area. For comparison purposes, these same birds reside in the Volcanoes National Park where many acres have been cleared for park use, i.e. buildings, roads, houses, etc. Further, there is no evidence that "... the niches in 'elsewhere' ..." are fully occupied. The evidence appears to indicate that there is sufficient habitat for all species. (See SUP EIS page 61 and Scott, et al. (in press).

10. The statements regarding the status of the 'I'o were taken from Scott, et al. (in press) and Griffin (1984) as noted in the SUP EIS. Both of Griffin's papers have been published. Both individuals are noted authorities on the 'I'o and have been studying this species in recent years in Hawaii.

11. As noted in the SUP EIS, biological surveys of construction areas will be performed prior to construction. Should 'I'o nesting areas be found, proper protection measures will be taken. Available evidence by qualified ornithologists regarding the effects of noise on wildlife indicates that birds become habituated to noises in the environment that they learn pose no harm to them. Also, as noted in the SUP EIS, project activities will comply with applicable air and noise control standards.

12. Scientific biological studies by qualified ornithologists (See Berger, 1985 and references thereto) indicate that bird behavioral and characteristics study results can be transferred from one location to another.

13. Court appeals: The statement that the judicial appeals of the decisions of the Board of Land and Natural Resources to the courts is an unresolved issue is not valid. The decisions of the Land Board have a legal presumption of validity and remain as enforceable orders unless and until overturned by legal decisions of the courts having jurisdiction. Chapter 91-14(c) states that:

> "(c) The proceedings for review shall not stay enforcement of the agency decisions; but the reviewing court may order a stay if the following criteria have been met:
>
> (1) There is likelihood that the subject person will prevail on the merits of an appeal from the administrative proceeding to the court;
> (2) Irreparable damage to the subject person will result if a stay is not ordered;
> (3) No irreparable damage to the public will result from the stay order; and
> (4) Public interest will be served by the stay order."

The courts reviewing the appeals may stay the decisions of the Land Board pending the outcome of the appeals. The courts in which all the appeals have been filed have not granted any orders to stay these decisions and therefore the decisions remain valid.

Moreover, traditionally, as supported by Hawaii Supreme Court cases, the decisions of administrative agencies have a strong legal presumption of validity. In Re Hawaii Electric Light Co. Inc., 60 Haw. 625 (1979); Aio v. Hamada, 66 Haw. 401 (1983). Therefore, although a final decision has not been rendered by the courts, there is no uncertainty that the decisions of the Land Board are valid and will remain so unless and until overturned by the courts. Whether these legal appeals will overturn the present Land Board decisions are entirely speculative and no firm conclusions can be drawn on whether the appeals will succeed.

Contested Case: The contested hearing to be held on the CDUA for geothermal development is not considered an unresolved issue for the purpose of the SUP EIS.

Location and extent of resource unknown: We concur with the statement, but do not agree that it represents an unresolved issue in the SUP EIS since the sole objective of the exploration phase of the project is to determine the location and extent of geothermal resources in the GRS.



As to the existence of a resource, the preponderance of evidence indicates, as is noted in Section IIB of the draft SUP EIS that geothermal resources exist throughout the Kilauea East Rift Zone.

Land exchange between the State and the Estate of James Campbell: The exchange was effected on December 20, 1985 and is subject to the veto of the State Legislature. It is not an unresolved issue.

P.O. Box 388
Mt. View, HI 96771
Jan. 20, 1986

Mr. Ok Stender
Chief Executive Officer
The Estate of James Campbell
828 Fort Street Mall, Suite 500
Honolulu, HI 96813

Dear Mr. Stender,

Please find enclosed my comments on the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a geothermal Project.

Thank you for your considerations and time.

Sincerely,

Diane Ley

P. O. Box 388
Mt. View, HI 96771
January 20, 1986

Mr. Susumo Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, HI 96809

Dear Mr. Ono,

Subject: The Draft Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

After reviewing this document, I have found numerous areas which I feel were inadequately addressed by the applicant.

This Supplemental Environmental Impact Statement (SEIS) is extremely vague in its description of the developers' overall plans for the area. While applying for a permit to explore and develop 100 megawatts (MW) of geothermal energy, their current plans outline a project that also fits the previously submitted plans for 250 MW of development at Kahauale'a. Both proposals consist of the same number of well sites and equal amounts of acreages expected to be required for overall surface area and geothermal fluid transmission lines. What is the actual scope of this project?

Frequently this SEIS leaves unanswered questions as to whether various uncovered topics are dealt with in the original Kahauale'a EIS or one might ask has the developer simply chosen not to address certain areas of concern? Due to the complexity of this geothermal development project and the vast volume of new information which has been gained the developers, State administators, and the general public over the past three years, an entirely new and comprehensive EIS should have been prepared.

Regarding emissions, the SEIS failed to discuss probability of acid rain formation, which would be a direct result of hydrogen sulfide emissions from the proposed project.

The developers discuss mitigating H2S emissions from cooling ponds by use of neutralizing chemicals; however, no mention is made of specific chemicals, the number of these types of ponds or their expected total acreage, nor estimated pounds per hour of H2S which would escape directly into the atmosphere.

On page 89 coal and oil fired plants are compared to geothermal operations, there is the implication here that because geothermal development produces fewer sulfur and nitrogen oxides it is somehow a cleaner type of power source. This is simply a case of twisted facts. One cannot compare the three in this manner.

The SEIS fails to provide a clear picture of the State Department of Health's 1984 health survey of a portion of the Puna District. This survey was only conducted in two very limited areas of Puna. The upper portion of Kilauea Volcano where significantly more volcanic emittants are found was not included in the survey. Yet this document uses the DOH health survey to inadequately support its contention that ..."adverse short- and/or long-term impacts to the health and welfare of residents, visitors or the wildlife of geothermally active areas are nonexistent."

The SEIS fails to address impacts which might occur to water catchment systems in the Puna District.

The concerns of the Kaohe Homestead residents and landowners appear to be ignored when the developer addressed noise impacts of the proposed project.

The SEIS addresses noise impacts on avian species during the "preparation of the project", but fails to address the stress that would be thrust upon the native species over the life span of the project.

The SEIS has no studies to assert their claims that the Newell Shearwater and the Dark-rumped Petrel do not nest or breed in the project area. In fact, James Jacobi has testified before this Board that he believes that it is a likely nesting area for the Newell Shearwater.

Any on-site water catchment systems may provide an ideal breeding ground for mosquitoes, which are known vectors of avian malaria. This concern was not addressed in the preparation of this draft.

Once again the developers continue to argue that if birds do not like the geothermal emissions that they will simply move away from the source of pollutants. What still needs to be addressed is the fact that the majority of habitats are normally supporting an optimal number of birds and any additional population is likely to upset the balances within a niche.

All sections regarding visual impacts failed to address plumes that would arise from cooling towers and well sites.

No consideration was given to the use of buffer zones around areas of high quality forest. A distance of 600 yards might be appropriate between power plants and sensitive habitats. Additionally, buffer zones of 100 yards could be provided for all other cleared areas.

The SEIS does not clearly explain the monitoring program for emission damage to vegetation adjoining the developed areas. Who will do this monitoring? What guidelines have been sucessfully followed in other geothermal areas or similar industrial operations, and what government division would oversee enforcement?

This document refers to an "environmentally compatable method" of weed control. What is their definition of such a method?

This project proposes to use rock fill from an area known as 'I'ilewa cinder pit. There is no further discussion as to the quality of the vegetation within the 'I'ilewa area. This needs to be addressed because any fill from the site could be a potential carrier of exotic plant material.

The SEIS makes various ridiculous claims about protecting the proposed facilities from lava flows, ground cracking, subsidence, and other associated geological hazards. The developers are failing to address the potential losses that might arise from brown-outs and/or black-outs, which may occur. These losses would not only be suffered by the developers, but also other businesses and the public, to date this issue has yet to be spoken to.

The sections regarding socio-economics are inadequate because no study has been done on a 100 MW scenario; furthermore, it is my understanding that no one within the consulting company of D"M Inc. is a qualified sociologist.

Table 1 regarding estimated surface acreage fails to explain what some 20 acres will be used for. The Board should know what all of the developers' plans are.

The SEIS failed to address the issue of waste heat applications. While it might be improbable to gain permits to allow other industrial uses of conservation lands, aside from geothermal activities, the developers might also seek a lease of the adjoining State-owned agricultural lands to the east of the project area. These lands would offer a potential where by the developers might increase the project's efficiency from 10 to 20 to even 40% by making use of the waste heat.

Under the section titled "Irreversible and Irretrievable Commitment of Resources" there is no mention of resource depletion and associated impacts on Pele practioners nor the Kilauea Volcano's magma source. Additionally the loss of a unique Hawaiian forest mosaic and accompaning fauna.

Alternative Scenario section fails to mention pending court cases when refering to the prospect of returning to Kahauale'a for geothermal activities. This section also does not discuss the various size scenarios available for both exploration and development of the resource. These options might include the Board's original Decision and Order on the Kahauale'a project, or any combination of exploration and possible development of 13 MW or 25 MW.

Section V regarding Policies and plans for the area failed to include any mention of the current Natural Area Reserve status. The SEIS somehow comes to the conclusion that this area "...demonstably appears to lie in an area of significant geothermal potential." However, there have been no wells drilled in the proposed sites, and no resistivity or electromagnetic tests done to confirm their statements.

Finally, regarding Unresolved Issues what are the developers plans if the cable to Oahu proves to be unfeasible? This question was not addressed. All pending lawsuits on the Kahauale'a Project, including the developer's appeal of this Board's Decision and Order, were likewise not covered.

Thank you for your time and consideration in this matter.

Diane Ley

Diane Ley

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Ms. Diane Ley
P. O. Box 388
Mountain View, Hawaii 96771

Dear Ms. Ley:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 20 which we received on January 22 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Ms. Diane Ley
P. O. Box 388
Mountain View, Hawaii 96771

Dear Ms. Ley:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 20 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY DIANE LEY

1. We feel the SUP EIS adequately describes the scope of the proposed project. As noted in the SUP EIS SUMMARY, the developer "...proposes to explore for and develop 100 MW of geothermal resources to produce electrical power in the Kilauea Middle East Rift Zone Geothermal Resource Subzone (GRS), Puna District, Island of Hawaii." Also, as noted in the SUP EIS (Section IIF) the proposed project is reduced in scope from that proposed in the Kahauale'a EIS. The length of access roads is reduced from 8.3 to 3.8 miles, the number of exploration wells is reduced from 20 to 12, the number of development wells is reduced from 72 to 23, the number of planned injection wells is reduced from 17 to 8, the upper level of production is reduced from 250 MW to 100 MW and power plant sizes have been reduced from the maximum of 110 MW to 55 MW. Information included in the SUP EIS describes the potential environmental impacts and the mitigation measures that will be taken to minimize adverse environmental impacts of the proposed 100 MW project.

2. As noted in Section IC of the SUP EIS, the scope of the SUP EIS is limited primarily to presenting information on "(1) changes in the environmental setting described in the EIS that are the result of relocating the project activities to the adjoining land areas; (2) additional baseline data collected in the area since preparation of the EIS; (3) the effects, if any, of changed environmental baseline data and the relocation of the project site on both the environmental impacts predicted for the project and the measures planned to reduce or prevent those impacts as described in the EIS; and (4) information on revised development plans for the proposed project." All information that is not directly affected by the shift of the project to the Middle East Rift Zone GRS is applicable to the SUP EIS and is incorporated in the SUP EIS by reference, by authority of the BLNR and Title 11, Chapter 200 Environmental Impact Statement Rules.

3. As noted in the SUP EIS, project operations will meet applicable air quality standards. The types of equipment that can be used to ensure maintenance of air quality standards is described in the SUP EIS and Kahauale'a EIS. Further, Appendix E to the Kahauale'a EIS fully describes the relationship of sulfuric acid and emissions from geothermal development operations. The information contained therein is applicable to the SUP EIS.

4. It may be feasible to inject fluid directly without diverting to a cooling pond. Cooling ponds, if used, would emit a negligible amount of $H_2S$ since up to 98% of



the $H_2S$ in the fluid would separate into the steam phase and the remaining would carry over into the brine phase. The composition of the fluid to be injected normally has a high pH, above 7. In this state some of the $H_2S$ becomes ionized (HS- or S2-) and would not emit from the pond.

5. It is generally accepted that geothermal operations are cleaner than oil or coal power generating operations. Therefore, we felt the comparison is useful.

6. As noted in the SUP EIS, project generated air emissions will be controlled to meet applicable air quality standards. The Department of Health is presently in the process of formulating and promulgating geothermal rules for wells, power plants and other geothermal facilities. For all geothermal wells, power plants and other geothermal facilities, the Best Available Control Technologies (BACT) will be required, as a minimum, to control air emissions. The air quality and health surveys conducted to date in Hawaii, the mainland U.S. and New Zealand, would suggest geothermal activities are no greater in these areas than non-geothermal areas.

Based on the foregoing and the progress of geothermal developments around the world, it is our opinion that geothermal development will not have unacceptable impacts on the health and welfare of nearby residents, or on the environment. Nevertheless, to preclude misunderstanding this statement will be deleted from the Final SUP EIS.

7. There is not expected to be any impact on water catchment systems adjacent to the project site because $H_2S$ emissions will be limited to environmentally acceptable levels. This statement will be added to the SUP EIS.

8. The developer has committed in the SUP EIS to comply with the County guidelines on noise levels which would apply at the boundary of residential property. Except in those infrequent cases where venting of a well is unavoidable, all project activities will be in compliance, i.e., maximum daytime levels of 55 dBA and night time levels of 45 dBA.

9. Noise impacts were addressed in the EIS and SUP EIS. There is no evidence to suggest there would be stress on avian species from the level of noise that will be generated from proposed operations. As stated in the SUP EIS, several studies conducted on the mainland U.S. as well as in Hawaii, have shown that normal noise levels in the range expected for the proposed project (i.e., 82 dBA within 100 feet of the drilling rig) should have little effect on the birds of the area and that the birds become habituated to noises in the environment that they learn pose no harm to them (Berger, 1985).

10. We are not aware of any evidence or any factual information that establishes that Newell's Shearwater or Dark-Rumped Petrel nest or breed in the project area. As a consequence, we stand by our statement in the SUP EIS.

11. It is true that any on-site water catchment system used in the project site could provide a breeding ground for mosquitoes. There is also standing water over pahoehoe lava in areas north of the GRS. Natural sites for oviposition by mosquitoes includes "hapu'u stumps, treeholes, and ground pools." The Final SUP EIS will include this potential impact.

12. We can find no evidence in Hawaii that the "majority of habitats are normally supporting an optimal number of birds and any additional populations" (due to your predicted exodus from a geothermal project site) "is likely to upset the balances within a niche." Moreover, the normal operating noise levels from project activities (drilling and power plant operations) will be generally steady noises at low levels so that impacts on birds would be expected to be limited to a localized area within a 1/2 mile radius of a drilling site at which the noise level from the drilling rig would be expected to be less than 55 decibels, the equivalent of light automobile traffic.

13. Plumes associated with geothermal operations were addressed in Appendix G of the EIS. Plumes in the Geysers can rise several hundred feet under certain weather conditions, i.e., on cold, clear days. Similar plumes would not be expected in Hawaii. Steam plumes that may be seen from time to time are not considered to be of a disruptive visual impact.

14. The project as here proposed will avoid the most sensitive areas, the ohia-a(l) forests. No power plant sites are proposed within several hundred yards of these forests. The width of a proposed buffer zone for roads or power lines would depend on the nature of the terrain, but on recent lava flows, where many of these structures are located, a buffer zone of perhaps 10 to 20 yards should be adequate to prevent damage to sensitive areas.

15. Based on available evidence, it appears that abated emissions do not damage vegetation, and in some instances may encourage growth. The monitoring program to be conducted is the responsibility of the developer, although it is likely that we will contract the monitoring to specialty consultants. The monitoring program will include air and noise quality to ensure that applicable standards are being met and possibly soil and leaf tissue analyses if it appears that surrounding vegetation is being degraded by project activities.



16. "Environmentally compatible" methods of weed control could include mechanical methods (hand pulling, cutting, etc.), spot applications of approved herbicides, and approved biological control methods.

17. The vegetation at 'I'ilewa cinder pit includes a mixture of native and introduced species. To the best of our knowledge all the plants found there also occur generally throughout the subzone on appropriate substrates.

18. There is always the potential that some volcanic events could disrupt power supply from any geothermal generating system in the Kilauea east rift zone (or any other rift zone in Hawaii in which geothermal energy is being developed) in spite of the measures taken to prevent such an occurrence. There is also the potential, as is demonstrated occasionally, that the existing electrical generating systems in Hawaii can be disrupted. The utility companies have the responsibility to establish reliable systems including plans, equipment and procedures to switch to backup or reserve systems. The dispersion of geothermal operations not only within a project site but in widely separated areas of the rift zone is one measure that can be taken to minimize the chances that a significant amount of geothermal power would not be disrupted during one event. We believe the potential for this occurrence is a risk that is preferable to the risk of not developing Hawaii's geothermal resources and remaining vulnerable to blackouts and brownouts of longer duration if oil supplies are disrupted.

19. The socioeconomic analysis performed for the SUP EIS is for the total development of 100 MW of geothermally produced power. Estimates of population increases, income levels, housing requirements, etc. are given for the full development. Ms. Duk Hee Murabayashi, principal of DHM Inc., has a B.A. in sociology from Ewha Women's University and an M.A. in sociology from the University of California.

20. There are no current planned uses for the "miscellaneous use" category in Table 1 of the SUP EIS. All of the acreages indicated for the project development are estimates. All uses of the property will be directly related to the activities that are an inherent part of geothermal development operations as described in Chapter 183, DLNR Administrative Rules.

21. The developer is interested in utilizing any waste heat from electrical generation operations that may be useable. There are no plans at this time to utilize adjacent agiculture lands for waste heat applications.

22. There is no evidence that the unique Hawaiian forest mosaic and accompanying fauna will be lost because of this project. Some individual plants and animals will be destroyed, but, as the SUP EIS indicates, there is no evidence that large parts of any given unit in the mosaic will be destroyed, and the overall effects on the ecosystems therein were judged to be not significant.

23. Court appeals: The statement that the judicial appeals of the decisions of the Board of Land and Natural Resources to the courts is an unresolved issue is not valid. The decisions of the Land Board have a legal presumption of validity and remain as enforceable orders unless and until overturned by legal decisions of the courts having jurisdiction. Chapter 91-14(c) states that:

> "(c) The proceedings for review shall not stay enforcement of the agency decisions; but the reviewing court may order a stay if the following criteria have been met:
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> (1) There is likelihood that the subject person will prevail on the merits of an appeal from the administrative proceeding to the court;
> (2) Irreparable damage to the subject person will result if a stay is not ordered;
> (3) No irreparable damage to the public will result from the stay order; and
> (4) Public interest will be served by the stay order."

The courts reviewing the appeals may stay the decisions of the Land Board pending the outcome of the appeals. The courts in which all the appeals have been filed have not granted any orders to stay these decisions and therefore the decisions remain valid.

Moreover, traditionally, as supported by Hawaii Supreme Court cases, the decisions of administrative agencies have a strong legal presumption of validity. In Re Hawaii Electric Light Co. Inc., 60 Haw. 625 (1979); Alo v. Hamada, 66 Haw. 401 (1983). Therefore, although a final decision has not been rendered by the courts, there is no uncertainty that the decisions of the Land Board are valid and will remain so unless and until overturned by the courts. Whether these legal appeals will overturn the present Land Board decisions are entirely speculative and no firm conclusions can be drawn on whether the appeals will succeed.

Contested Case: The contested hearing to be held on the CDUA for geothermal development is not considered an unresolved issue for the purpose of the SUP EIS.



Location and extent of resource unknown: We concur with the statement, but do not agree that it represents an unresolved issue in the SUP EIS since the sole objective of the exploration phase of the project is to determine the location and extent of geothermal resources in the GRS.

As to the existence of a resource, the preponderance of evidence indicates, as is noted in Section IIB of the draft SUP EIS that geothermal resources exist throughout the Kilauea East Rift Zone.

Land exchange between the State and the Estate of James Campbell: The exchange was effected on December 20, 1985 and is subject to the veto of the State Legislature. It is not an unresolved issue.

24. Both the Kahauale'a EIS and SUP EIS contain a full discussion of the alternatives to the proposed project "...which could feasibly attain the objectives of the action...." The alternatives suggested do not, in the view of the applicant, represent alternatives that feasibly attain the objectives of the proposed project because of the financial risks and constraints that would be placed on the applicant by the suggested alternatives. The potential for economical development of the project area would not be assured and would therefore affect investment support for the project. As noted previously, the level of development will be controlled by market conditions (including the market supplied by means of the cable) and the ability of utility companies to absorb the power generated through existing or planned transmission and distribution systems. If the cable is not installed, the rate of development of geothermal energy will be decreased.

25. The Natural Area Reserve is an element of the land exchange proposed by the State in which the Natural Area is terminated in conjunction with executing the land exchange. This has been included in Section 5 of the SUP EIS. As to the existence of a resource, the preponderance of evidence indicates, as is noted in Section IIB of the draft SUP EIS that geothermal resources exist throughout the Kilauea East Rift Zone.

26. The SUP EIS describes the environmental impacts and mitigation measures that will be taken to minimize adverse environmental impacts for the 100 MW geothermal development project. As is stated in the SUMMARY to the draft SUP EIS, the first increment of the 100 MW development project proposed in this action is 12.5 MW as shown on Figure 6 (Development Schedule) of the draft SUP EIS. Any development beyond this level would be subject to administrative scrutiny and review.

Sierra Club
moku loa group
Hawai'i Chapter
P.O. Box 1137, Hilo, HI 96720

JAN 21

Mr. Susumo Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

January 16, 1986

The Sierra Club has the following comments and questions regarding the draft Supplemental Environmental Impact Statement to the Revised EIS on the Kahaualea Geothermal Project. (Dated December 23, 1985).

1). The Club feels that a completely new EIS is in order. The original Campbell EIS is still in litigation regarding its insufficiencies and errors. This document is not discussing Kahaualea. It is a new environment, with different impacts and consequences of industrial activity.

2). The scope of this SEIS is questionable. Discrepancies are apparent when reading the CDUA transmittal letter from D.K. Stender to Susumo Ono dated August 20, 1985. Stender discusses the 100mw application "[A]s an upper limit for the first increment of development,..." This begs the question "What is the full development in terms of size, timetable and impact?" Is it an attempt to resurrect the discredited 250mw plan?

3). Rod moss, representing the developers, in questioning by the Board at the CDUA hearing on January 13, 1986, admitted that well sites could be drilled outside the five "pod" areas delineated on the maps as "A" through "E". Once again, as with the old controversial plan, Decision makers and the public are given no specific sites to evaluate and a project of indeterminate scale and impacts.

4). There is no geophysical, geochemical or resistivity study done for this project. The Board correctly ordered Campbell/True-MidPacific to do these studies for the Kahaualea project and that condition should apply in this new subzone.

5). There is no indication that the preparers of this SEIS



had obeyed the Board's of May 7,1984, which directed Campbell to prepare an acceptable exploration plan which took into account eruptive activity like the current one at Puu O'O. The assertions on page 103 do not take into account lava ridges over 300 feet high like to ones on top of the proposed well grid uprift. 15 to 40 feet thick lava flows were not uncommon and statements of elevating pipelines and well structures sound absurd.

A graben one kilometer long, 80 feet wide and 10 feet deep opened up in the Puu Kauka area in December 1983. What mitigation is there for facilities so close to the rift?

6). Sierra Club estimates that over 96 of the proposed well sites would have been buried, one power plant would have been obliterated under 60 feet of lava, and that two or more of the power plants would have been shut down from the three year old eruptive activity had the project been in place.

Wells serving the shut down power plants would have been free vented, with toxic geothermal fluids and gasses spewing into the National Park and surrounding areas. Millions of invested dollars cound have been lost, including those from businesses and people depending on the lost electricity. Is there any indication that the presently configured Campbell project would not suffer the same fate?

7). The salinity of the geothermal brines as a percent of sea water has increased from 5% to 50% at HGP-A's well. (HNEI legislative test. 1985). There is no discussion in this SEIS whether this could happen in the Kilauea Middle East Rift Subzone(KMER), and affect the ground water resource close to the coast.

8). Two conditions placed on the original Campbell project by the Board permitted only a limited exploration area of 800 acres in which they could drill only 8 wells or 4 successful ones. We urge that these conditions be applied here also. The Club heard testimony of Kaohe Homesteads residents Karl and Melissa Kirkendall(CDUA hearing 1/13/86) and concurr, at this time, that only the pod "C" area be explored.

9). HGP-A can achieve one third to one half lb. per hour emission rates of H2S, and as a result are good neighbors. Will Campbell commit themselves to similar 'best efforts"? Will the economy of scale make the new Dow Chemmical system cost effective and economical?

10). Retrofitting abatement technology is always more costly than if the equipment was installed originaly, both from an engineering standpoint and an environmental one. The Club feels that the current proposed H2S standards are too lax(having been discarded in California) and that the current California emission standard is what Hawaii geothermal plants should be meeting.
Incorporated into the SEIS comments is a memo to the Dept. of Health's Air Advisory Committee, dated 7/31/85. (S.C. Attachment 1). The 5 lbs. per hour emission of H2S per power plant should b used to control pollution.

11). Cumulative effects of emissions are inadequately discussed in this SEIS. Incorporated in the SEIS comments is the Lake County Air Pollution New Source Review Analysis for Natomas Energy Company's 25mw Power Plant, pp.61-63 (S.C. Attachment 2). Of particular concern is item #5 which states that project permitting should not be done piecemeal and that the entire project be considered for their cumulative impacts.

12). The section on Rotorua H2S is misleading (pp.89,SEIS). Is Saigel a qualified doctor of medicine or an epidemiologist? Did he consider that people could have selected themselves to live in that foul smelling environment? The energy development of Puna will bring new pollutants with it, impacting sensitive populations previously here, such as retirees, and people with chronic lung problems who were forced to flee from urban areas.
There is also the presumption that the geothermal wells will bring up exactly the same thing that is present in the Rotorua atmosphere.

13). Is Best Available Control Technology(BACT) now defined by the turbine bypass steam flow systems and the H2S gas incineration systems at use at HGP-A?

14). H2S abatement systems like the Stretford technology involve toxic chemicals. Why is there no discussion of this in the SEIS? Some of the chemicals can be carried out of the plant via the plume. Incorporated into our comments are three news articles.
S.C. # 3 - Poison Fears At Geysers Stirs Probe, Santa Rosa Press Democrat, December 23,1984.
S.C.# 4 - Workers AT Geysers Say Saftey Lax, Santa Rosa Press Democrat, January 27,1985.
S.C.# 5 - State Cites State Owned Plant As Unsafe, Santa Rosa Press Democrat, September 27,1985.



15). There is no discussion in the SEIS of toxic mud wastes generated by the drilling and problems with its safe disposal. Are the disposal sites on or off the property? Increased traffic with accidents is another cost county residents will be exposed to. Incorporated into our SEIS comments are 6 news articles.
S.C. # 6- Vist To Geothermal Spill Site Spurs Ire, S.R. Press Democrat, January 26,1985.
S.C. # 7- Arsenic Tainted Water Leaks From Truck, S.R. Press Democrat, February 8, 1985.
S.C. # 8- Waste Firm Violates Use Permit, Lake County Record Bee, March 19,1985.
S.C. # 9- Highway 101 Spill-Geysers Traffic Poses Threat, S.R. Press Democrat, June 4, 1985.
S.C. #10- CHP Cites Geothermal Company, Lake County Record Bee, December 20,1985.
S.C. #11- Hazardous Material Traffic Big Threat In North County, S.R. Press Democrat, Dec. 12,1985.

16). SEIS statements on Radon fail to address the lengths of the half-life, toxicity and potential health hazards related to radon and radon daughter exposure. A report prepared for the Kahaualea EIS but not included is incorportated into our comments. It is Wayne Westlake's EIS Inadequacy Radiological Issues Report, dated November 1982. (S.C. Attachment #12).

17). In view of the geothermal proposals for 100mw to 250mw, and with State scenarios contemplating 500mw, we feel that now is an appropriate time to ask for a condition on all exploration and development permits which would set aside funds for an Environmental Permits Monitoring Officer on the Big Island, who would periodically inspect all permit conditions.
This need has been discussed in the Legislative Reference Bureau Report #1, 1985, entitled The Feasibility of Environmental Reorganization for Hawaii. Pages 47-50 are submitted as S.C. Attachment 13 as part it its comments.

18). Vigilance in geothermal monitoring is a must in Hawaii's sensitive environment. Inspection and monitoring problems have cropped up in the Geysers development. We would like two attachments as part of our comments.
S.C. #14- PG&E Balks at Creek Monitoring on Cobb Mtn, Clear Lake Observer, March 14, 1985.
S.C. #15- Firms Must Pay For Own Steam Watch, Lake County Record Bee, July 21, 1985.

19). Sierra Club feels that this is an appropriate time to ask for a condition on permits which would fund a geothermal "SuperFund". It would be developed in order to financially address and correct immediately any environmenal or public health catastrophe. A good example would be the Minnesota fund to deal with problems arising from uranium mining and processing.

20). No socio-economic impact study was done for this SEIS. Necessary for an adequate EIS is a discussion of the impacts of 100mw(250mw?) in this island if the speculative electric cable is unfeasible.

21). Sierra Club feels that the magnitude of this project is too big. Incorporated into our comments is the article, Rethinking Geothermal Energy's Contribution to Community Development, by Sociologist Dr. Penelope Canan. S.C. Attachment #16. The issues of scale (25mw) and need are well thought out.

22). If the developer is relying so heavily on the speculative cable, will they agree not to develop if the cable is not built? Figure 6 opposite page 22 has a timetable for the geothermal facilities, a similar one should be provided for the cable.

23). What is the projected reliability of the cable? That answer would have a direct bearing on environmental impacts arising from this project. Unabated well venting would happen every time the power plant went off-line.

24). With the Puna Geothermal Research Facility being built with $325,000, and so much direct/waste heat research going on, what plans does Campbell have for utilizing this resource?

25). Where did the SEIS preparers get the power demand estimate of 50mw base load for the Big Island(pg.22)?

26). State figures indicate only 33% of the imported petroleum is utilized for generating electricity. What actual $ savings will be realized by geothermal generation of 13mw, 25mw, 50mw, and 100mw?

27). The section discussing alternatives to the propsal lacks any assessment of 13mw, 25mw, and 50mw of geothermal development.



28). There is no discussion of what the sound levels would be at nearest residences during times of unabated well venting.(page 100). Nor how often this type of noise is likey to occur over the life of the project. As a condition of this project, the petitioners should conduct noise measurments on site and submit for approval a noise monitoring program(this includes generating noises to test meteorolgical conditions).

29). What will the noise levels of the heavy truck traffic be on the access roads, such as the Pahoa dump road? What frequency of impact will be generated over the life of the project?

30). The visual analysis done for Figures 25-28 are for well rigs only. The previous contested case hearings revealed that plumes are a vital component in the visual impact and analysis. This error should be corrected.

31). There is no discussion of the power transmission lines and the types of impact they would have. Sierra Club incorporates in its comments a news article of some health problems.
S.C. Attachment #17- Transmission Lines Pose Problems Clear Lake Observer, April 26,1984. and Cancer, Suicide and Power Lines San Francisco Chronicle April 21, 1984.

Thank you for the opportunity to comment on this SEIS.

Nelson Ho

Nelson Ho
For Moku Loa Conservation Comm.

Sierra Club comment letter attachments are listed on the following separate sheets. Copies of the attachments are available at OEQC and DLNR.

LIST OF ATTACHMENTS TO
SIERRA CLUB MOKU LOA GROUP
LETTER OF JANUARY 16, 1986

1. Memo from Sierra Club to Department of Health Air Advisory Committee, July 31, 1985.

2. R. L. Reynolds, D. L. Saderlund and R. L. Kauper Report, Lake County Air Pollution Control District New Source Review Analysis for Authority to Construct Permits for Natomas Energey Company Bear Canyon Full Field Development Project Including a 25MW Geothermal Power Plant, February 8, 1985. (Note pages 61-63 only attached.)

3. Santa Rosa Press Democrat, December 23, 1984. "Poison Fears at Geysers stirs probe."

4. Santa Rosa Press Democrat, January 27, 1985. Workers at Geysers say saftey lax."

5. Santa Rosa Press Democrat, September 27, 1985. "State cites state-owned steam plant as unsafe."

6. Santa Rosa Press Democrat, January 26, 1985. "Visit to geothermal spill site spurs ire against Lake firm."

7. Santa Rosa Press Democrat, "February 8, 1985. "Arsonic-tainted water leaks from overturned truck."

8. Lake County Record Bee, March 19, 1985. "Waste firm violates use permit."

9. Santa Rosa Press Democrat, June 4, 1985. "101 spill Geysers' traffic poses threat."

10. Lake County Record Bee, December 20, 1985. "CHP cites geothermal company."

11. Santa Rosa Press Democrat, December 12, 1985. "Hazardous material traffic big threat in North County."

12. W. K. Westlake Kahauale'a Geothermal Project EIS Inadequacy Radiological Issues Report.

13. Legislative Reference Bureau Report No. 1-1985, The Feasibility of Environmental Reorganization for Hawaii, Chapter 6, pages 47-50.

14. Clear Mountain Observer, March 14, 1985. "PG&E balks at creek monitoring on Cobb."

15. Lake County Record Bee, July 21, 1985. "Firms must pay for own steam watch."

16. P. Canan. Rethinking Geothermal Energy's Contribution to Community Development.

17. Clear Lake Observer, April 26, 1984. "Transmission lines pose problems."

THE ESTATE OF JAMES CAMPBELL

January 27, 1986

Mr. Nelson Ho
Sierra Club
P. O. Box 1137
Hilo, Hawaii 96720

Dear Mr. Ho:

Subject: Comments Relating to Supplemental EIS to Revised EIS

This is to acknowledge receipt of your comments dated January 16 which we received on January 21 relating to the Supplemental Environmental Impact Statement to the Revised EIS on the Kahauale'a Geothermal Project.

Your comments have been noted and will be addressed.

Most sincerely,

O.K. Stender
Chief Executive Officer

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

THE ESTATE OF JAMES CAMPBELL

February 4, 1986

Mr. Nelson Ho
Sierra Club
P. O. Box 1137
Hilo, Hawaii 96720

Dear Mr. Ho:

Subject: Comments Relating to Draft Supplemental Environmental Impact Statement to the EIS for Kahauale'a

This is with regard to your letter of January 16 commenting on our Draft Supplemental Environmental Impact Statement to the EIS on the Kahauale'a Geothermal Project. In accordance with the Department of Health's "Environmental Impact Statement Rules," Title 11, Chapter 200, attached please find our detailed response to each of your questions and comments.

We appreciate your interest and effort in assisting us in the preparation of this document.

Sincerely,

O. K. Stender
Chief Executive Officer

Attachment

OKS:sak

Suite 500, 828 Fort Street Mall, Honolulu, Hawaii 96813 (808) 536-1961

RESPONSES TO COMMENTS AND RECOMMENDATIONS ON THE DRAFT SUP EIS TO THE EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT SUBMITTED BY SIERRA CLUB (MOKU LOA GROUP)

1. The requirement and authority for a Supplemental EIS to the EIS for Kahauale'a is described in Section IB of the SUP EIS. The objective and scope of the SUP EIS is described in Section IC of the SUP EIS. We feel a SUP EIS is appropriate for a project that is relocated to adjoining property. All data in the EIS pertaining to geothermal development that is not directly related to a specific site is applicable to the project as proposed in the SUP EIS.

   The statement that the environmental impact statement for Kahauale'a is in litigation and as a consequence, is presumptively inadequate is without foundation. The Board of Land and Natural Resources accepted the EIS as legally adequate in August of 1982. That decision has not been overturned by any court and the acceptance of, the EIS by the Land Board as an administrative agency has the strong presumption of legal validity (see In Re Hawaii Electric Light Co. Inc., 60 Haw. 625 (1979); Alo v. Hamada, 66 Haw. 401 (1983)). The apparent assertion that the filing of a suit to overturn the Land Board's decision is enough to warrant the conclusion that the EIS is inadequate places too much importance on the act of filing a suit. The filing of a suit challenging the adequacy of an EIS constitutes a ministerial acceptance by the court of the suit. There is no review by the accepting court as to the likelihood of the suit prevailing on its merits. Also, no determination is made by the reviewing court other than that the challenge to the EIS is correct in its form and that the filing fee is paid.

   Therefore, the implication that the EIS for Kahauale'a should be treated as invalid because of a challenge filed in court is erroneous.

2. The SUP EIS describes the environmental impacts and mitigation measures that will be taken to minimize adverse environmental impacts for the 100 MW geothermal development project. As is stated in the SUMMARY to the draft SUP EIS, the first increment of the 100 MW development project proposed in this action is 12.5 MW as shown on Figure 6 (Development Schedule) of the draft SUP EIS. Any development beyond this level would be subject to separate approval.

3. The environmental setting for the proposed project is described in the SUP EIS. We feel this information provides adequate knowledge for decision makers and the public about the project area. The project description, Section II of the SUP EIS, together with estimates of the

impacts of project operations, similarly provides the decision makers and the public with the basis on which to evaluate the project. The project as proposed is for 100MW of development. The potential impacts for that scale of development are described in the EIS and SUP EIS. In addition, upon determination of specific sites based on drilling results, site specific environmental information on those sites will be provided as supporting information during the administrative permit process for each well site and power plant. This process will allow the permitting authority to validate that site specific data is consistent with the baseline data and to determine that there is no finding of significance that should be protected or preserved at the site.

4. One of the principal ojectives of the State laws on development of geothermal energy is to identify areas with geothermal potential. A committee of scientists under a State study, concluded that the entire Kilauea east rift zone had a goethermal potential and defined the boundaries parallel to the rift zone in which probabilities for the presence of a resource were indicated. The GRS in which the proposed project development would occur is within most of the 90% probability zone for this section of the Kilauea east rift zone.

5. Volcanic hazards of the Kilauea east rift zone were discussed in the EIS, in the contested hearing on the CDUA, and in the contested hearing on hazards as a result of the Puu O'o eruption, and again in the SUP EIS. There is also a discussion of volcanic hazards in the State's report on designating geothermal resource subzones in the Kilauea east rift zone. We feel that all aspects of the potential hazards of developing geothermal energy in Hawaii's volcanic rift zone have been fully presented.

6. The above response is also applicable to comments in paragraph 6 of your letter.

7. The salinity of the geothermal fluid in the rift zone has always been expected to be sea water. We would also expect the fluid in the middle east rift zone to have a similar saline content. The depth of geothermal reservoirs (4000-6000 ft. below sea level) is such that ground water resources close to the coast would not be affected by the change in salinity of the geothermal fluid provided from the rift zone.

8. We believe our project description adequately explains the basis for the exploration and development plan presented and the environmental impacts thereof.



9. The developer has committed to use the best available control technology to meet the standards on air quality that are imposed in the State.

10. The statement that California's $H_2S$ emission standard has been discarded by California is misleading when taken out of context. California has not abandoned its ambient air standard for $H_2S$ of 30 parts per billion.

The history of California's emission standard is related to the importance of maintaining the ambient air standard and minimizing the violations of that ambient standard. The emission standard is importantly related to the ambient standard because the amount in weight (emission standard) of $H_2S$ put into the atmosphere by each separate powerplant determines the probability of cumulatively combining to be below the ambient standard (the amount of $H_2S$ cumulatively emitted by the power plants as mixed with air to form the mixed concentration of $H_2S$ and air being breathed in the receptor area).

California did not have any ambient standard or emission standard for $H_2S$ until the combined level of megawatts of electricity being produced by all power plants in the Geysers area exceeded 600 megawatts. As the amount of electrical power approached that level without any abatement for $H_2S$ being undertaken, it became necessary to begin abatement to maintain a reasonable level of air quality and avoidance of citizen complaints.

After the ambient $H_2S$ standard was adopted in California, the emission standard became important to the success of maintaining that ambient standard and to avoiding unreasonable "exceeds." Therefore, as the number of power plants increased in the Geysers, the total amount of $H_2S$ being emitted by the increasing number of plants had to be maintained at the same level to keep the ambient concentration below the ambient standard. As a consequence, the amount of $H_2S$ emitted by each plant had to be less to maintain the same ambient standard.

Presently, the total amount of power being produced in the Geysers is in excess of 1400 megawatts. This level of power generated has caused the emission standard to become more stringent. The ambient standard has not changed and remains the important standard to protect the public from exposure to $H_2S$.

The situation in the Puna area is not anywhere comparable to the amount of power plants on line at the Geysers. The HGP-A plant is the only power plant in operation and produces only 3 megawatts of power. The Geysers started out at 200 grams per megawatt hour as the emission standard at 600 megawatts of power being generated. Your proposal that 5 pounds per hour as the emission standard in Hawaii is overly stringent in a situation that facts have not shown that it is required in order to maintain the ambient standard proposed by the Department of Health at 25 parts per billion above the ambient level.

11. We have submitted an application for a single land use permit to discover, develop geothermal resources of sufficient quantity to produce 100 MW of electricity. All other permits required subsequently are operating type permits which are required throughout the life of the project.

The total estimates of the potential impacts of a project at this level of activity are described in the EIS/SUP EIS. Emissions are limited by standards and regulations specifically to preclude adverse impacts on a short or long term (cumulative) basis. Environmental monitoring is the means by which the effectiveness of the standards or mitigating measures can be assessed. For example, California has maintained their ambient air standard for $H_2S$ during an 8-10 year period when geothermal development has grown from 600 MW of electrical power production to over 1,400 MW of power generation. As the production has increased, $H_2S$ emission limits have been reduced on a per-megawatt-hour of production basis to prevent cumulative adverse impacts.

We believe the EIS/SUP EIS adequately addresses the total estimated potential impacts of a 100 MW project.

12. We believe the statement on pg. 89 of the SUP EIS is a fair statement of the results indicated by Dr. Siegel's study of the high, natural atmospheric concentrations of $H_2S$ and $SO_2$ in the Rotorua area of New Zealand and the apparent absence of any indication of short or long term adverse impacts of such levels in comparison with areas which have no geothermal activity and no detectable $H_2S$. The data on health statistics was provided by the Research Officer, National Health Statistics Center, New Zealand Department of Health.

13. Best Available Control Technology (BACT) is defined on a case-by-case basis. The characteristics of the geothermal fluid and the available technology are evaluated to determine the most appropriate system for a given set of conditions.



14. The Stretford system is entirely separate from the cooling tower, and as a consequence, chemicals used in the Stretford process can not be carried out of the plant by way of a cooling tower plume. The Stretford System and other abatement systems are discussed in the EIS.

15. It is planned to drill with air. In cases where drilling mud is used, residues will be disposed of in accordance with county guidelines or ordinances.

16. Radon was discussed in the EIS. Radon and radon daughter products were discussed in the contested case hearing to which you were a party. Additional information on radon and radon daughter products has been included in the SUP EIS.

17. The establishment of an environmental permits monitoring officer is a matter to be decided by the state and county governments.

18. Environmental monitoring of geothermal project operations is a responsibility of the developer. Reports on the results of this monitoring are made periodically to designated permitting authority and regulatory agencies.

19. Current state regulations on geothermal development require indemnity and performance bonds and liability insurance by the developer.

20. As required by HRS Title 11-200-17(e)(3), (g) and (h), an analysis of the socioeconomic impacts of the proposed project is given in Section III D 7a and b of the SUP EIS. The analysis conducted was based on existing information and data collected by various federal and state agencies. The analysis given in the SUP EIS pertains to the development of 100 MW of geothermally produced electricity to supply the utility companies to replace oil fired electrical generation systems. If the cable is not installed, power would be developed to the level that could be absorbed by the local utility.

21. As indicated in the SUP EIS, the proposed development will be accomplished incrementally. The total level of development that will occur over the life of the project will, as noted in the SUP EIS, be determined by the market demand for geothermally produced electrical power and the ability of the HELCO/HECO distribution and transmission system to accept the power. The initial market that can be supplied from our project within approximately 3 years is estimated to be 12.5 MW.

22. As noted in the Summary to the SUPP/EIS, the developers' objectives are first to develop geothermal energy to meet the needs of the Big Island and secondly to supply power to Oahu via underwater cable. As noted in the SUP EIS the final level of development will be determined by the market demand for geothermally produced electrical power and the ability of the HELCO/HECO transmission and distribution system to accept the power. Therefore, the developer would endeavor to meet any alternate energy demand that may exist. A schedule will be added to the SUP EIS showing the cable development program in relation to geothermal development.

23. The cable final design has not yet been selected. Reliability is a major consideration of any design being considered. It is not true that there would be unabated open venting if power plants went off-line. Wells can be throttled back, diverted to other plants and redundant systems, or shut-in. The ambient air standard would have to be maintained regardless of operating conditions.

24. The developer would attempt to fully utilize the useable heat in the resource to generate electricity and for any other applications that may be appropriate and authorized.

25. The power demand estimates in the SUP EIS are assumptions based on discussions with HELCO/HECO personnel, knowledge of base load requirements, previous alternate energy studies and the applicant's best estimate of future power demand conditions.

26. The actual dollar savings to be realized by the geothermal generation of electrical power will be dependent upon negotiations between the geothermal developers and the electric utilities. The first major advantage to the state which translates into savings would be the retention in the State of a portion of the revenue including royalties derived from the sale of geothermal resources. Secondly, the price of locally produced energy would not escalate on the scale set by OPEC countries when supplies become less abundant than now. There may not be any direct cost savings initially and as long as an oil surplus exists.

27. In accordance with EIS rules, the alternatives which could feasibly attain the objectives of the action are fully described in the SUP EIS and the Revised Kahauale'a EIS. The alternatives listed in the comments letter are not considered feasible to attain the objectives of the proposed project.



28. As noted in the SUP EIS, project-generated noise levels will meet Hawaii County noise guidelines and applicable state standards. Estimated decibel (dBA) noise levels from geothermal operations are shown in Table A attached hereto.

The developer in consultation with the accoustical consultant recognizes that the rural areas of Puna are subjectively judged to be "quiet" to "very quiet". In addition, the developer is aware of level of noise created by the various project activities. Using various meteorological conditions which influence the propogation of sound, estimates were made to enable determination that project activities could be accomplished while remaining within the Hawaii County guidelines for noise levels at nearest residential receptors. Therefore, it does not appear that field noise measurements would serve any useful purpose. Experience of residents living within a mile of the commercial well sites in the HGP-A area indicate that drilling noises can be quieted to acceptable levels.

29. Trucks used to supply the drill rigs and required during construction of roads, power plants, etc. will be typical vehicles as now used on the island for construction and delivery. Such trucks typically generate 75 to 90 decibles (dBA) at 50 feet. A rough estimate of noise levels at distances to about 500 feet can be made by assuming a 6 dBA noise reduction for each doubling of the distance, e.g. 84 dBA at 100 feet; 78 dBA at 200 feet; 72 dBA at 400 feet, etc.

30. Plumes from cooling towers in Hawaii are expected to have minimal visual impacts as discussed in the EIS. (Plumes associated with geothermal cooling towers in the geysers can rise to considerable altitudes on cold, clear days.)

31. Power transmission lines are discussed in the EIS.

TABLE A

ESTIMATED DECIBEL (dBA) NOISE LEVELS FROM GEOTHERMAL OPERATIONS

| SOURCE | SOUND PROPAGATION CONDITION | 100 FEET | DISTANCE 1/2 MILE | 1 MILE |
|---|---|---|---|---|
| Drill Rig | 4 | | Inaudible | Inaudible |
| | 3 | | 44 | 36 |
| | 2 | 82 | 50 | 42 |
| | 1 | | 53-55 | 47-50 |
| Power Plant | 4 | | Inaudible | Inaudible |
| | 3 | | 34 | 26 |
| | 2 | 72 | 40 | 32 |
| | 1 | | 43-45 | 37-40 |
| Free Venting of Well | 4 | | 38 | Inaudible |
| | 3 | 122 | 74 | 64 |
| | 2 | | 84 | 76 |
| | 1 | | ---* | ---* |

NOTES: Sound Propagation Condition No. 4 - Receptor is upwind of noise source. Conditions No. 1 through 3 - Receptor is downwind of source. Condition No. 3 - Winds greater than 10 mph or some attenuation from trees. Condition No. 2 - No attenuation from topography or trees. Condition No. 1 - Same as No. 2, but on occasion unstable focusing may occur in some locations causing fluctuating noise levels.

* Free Venting of well will not occur during Condition No. 1, e.g. when wind is less than 2 mph and thermal inversions exist.

* Levels from venting through a rock muffler will be between those for Drill Rig and Power Plant.

# COMMENT/RESPONSE LETTERS

# WITH NO COMMENTS

JAN 28 1986

2756
STP 8.1147

January 23, 1986

**MEMORANDUM**

TO: The Honorable Susumu Ono, Chairperson
Board of Land and Natural Resources

FROM: Director of Transportation

SUBJECT: Draft Supplemental EIS
Kahauale'a Geothermal Project
Puna District, Hawaii

A review of the subject EIS revealed that the proposed project will not adversely impact upon our plans or facilities.

We appreciate this opportunity to provide comments.

Wayne J. Yamasaki

SC/DT:ko

cc: HWY, HWY-PA, STP (dt)
The Estate of James Campbell
Mr. O.K. Stender

JAN 10

JAN -2 1986

(P)1903.5

Honorable Susumu Ono
Chairman
Department of Land and
Natural Resources
State of Hawaii
Honolulu, Hawaii

Dear Mr. Ono:

Subject: Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project

We have reviewed the subject document and have no comments to offer.

Very truly yours,

HIDEO MURAKAMI
State Comptroller

CT:rmr
cc: Mr. O. K. Stender

University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

JAN 22

17 January 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

SUBJECT: Draft Supplemental Environmental Impact Statement to the Revised Environmental Impact Statement for the Kahaualea Geothermal Project, Puna, Hawaii, December 1985

We have reviewed the subject DSEIS and have no comment to offer. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi
Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: O.K. Stender, True/Mid Pacific



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GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF SOCIAL SERVICES AND HOUSING
HAWAII HOUSING AUTHORITY
P. O. BOX 17907
HONOLULU, HAWAII 96817

RUSSELL N. FUKUMOTO
EXECUTIVE DIRECTOR

IN REPLY REFER TO:

January 15, 1986

MEMORANDUM

TO: The Honorable Susumo Ono, Chairman
Board of Land and Natural Resources

FROM: Russell N. Fukumoto, Executive Director

SUBJECT: Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project

The Authority has reviewed the subject supplemental EIS and has no comments to offer relative to the proposed action.

Thank you for allowing us the opportunity to comment on this matter.

RUSSELL N. FUKUMOTO
Executive Director

Attachment

cc: Mr. O. K. Stender

Dante K. Carpenter
Mayor

Eugene N. Tiwanak
Managing Director

**DEPARTMENT OF PARKS & RECREATION**
COUNTY OF HAWAII

Patricia G. Engelhard
Director

Ronald Okamura
Deputy Director

JAN 13

January 8, 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
State of Hawaii
P. O. Box 621
Honolulu, HI 96809

Subject: Supplemental EIS for Kahauale'a
Geothermal Project, Puna, Hawaii

We have reviewed the supplemental report and have no comments or objections to offer.

Thank you for the opportunity to review the document.

Pat Engelhard
Patricia Engelhard
Director

PE:GH:al

cc: Mr. O. K. ~~Stender~~

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD, HONOLULU, HAWAII 96816-4495

JAN 10
[stamp: ... of James Campb...]

JAN 9 1985

HIPMG

Susumo Ono, Chairman
Board of Land & Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Gentlemen:

Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project

Thank you for providing us the opportunity to review the above subject project.

We have completed our review and have no comments to offer at this time.

Yours truly,

SIGN.

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contr & Engr Officer

Enclosure

cc: Mr. O. K. Stender, Chief Executive Officer

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DEPARTMENT OF THE NAVY
HEADQUARTERS
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860-5020

IN REPLY REFER TO:
9510
Ser 002B/2366
10 DEC 1985

RECEIVED
2 1985
The Estate of James Campbell

Mr. Susumo Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

SUPPLEMENTAL EIS TO THE REVISED EIS FOR THE
KAHAUALE'A GEOTHERMAL PROJECT

The Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project has been reviewed and we have no comments to offer. Since we have no further use for the EIS, the EIS is being returned to the Office of Environmental Quality Control, by copy of this letter.

Thank you for the opportunity to review the EIS.

Sincerely,

HENRY J. RINNERT
Captain, CEC, U.S. Navy
Facilities Engineer
By direction of the Commander

Enclosure

Copy to:
Mr. O. K. Stender, Chief Executive Officer
True/Mid-Pacific Geothermal Inc.
800 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Office of Environmental Quality Control

United States Department of the Interior

NATIONAL PARK SERVICE
PACIFIC AREA OFFICE
300 Ala Moana Blvd., Box 50165
Room 6305
Honolulu, Hawaii 96850

IN REPLY REFER TO:

N40(PAAR)
xL7617

JAN 8

January 7, 1986

Mr. Susumu Ono, Chairperson
Board of Land and Natural Resources
State of Hawaii
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

We have reviewed the Supplemental EIS to the Revised EIS for the Kahaualea Geothermal Project in Puna, Hawaii. If the land exchange, geothermal development zones, and mitigating measures shown here are done as outlined in this Supplemental EIS, these will effectively resolve all objections the National Park Service had to the earlier proposal for geothermal development on Kahaualea lands.

Thank you for the opportunity to comment. I especially appreciate the problem solving, flexible attitude your Department has had in dealing with this matter. You and Campbell Estate officials have effectively responded to our earlier objections.

Very sincerely,

/S/ BRYAN HARRY

Bryan Harry
Director, Pacific Area

cc:
Mr. O. K. Stender

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. BOX 50004
HONOLULU, HAWAII
96850

January 21, 1986

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Dear Mr. Ono:

Subject: Supplemental EIS to the Revised EIS - Kahauale'a Geothermal Project
Puna District, Hawaii

We reviewed the subject document and have no comments to make.

Thank you for the opportunity to review the document.

Sincerely,

FRANCIS C.H. LUM
State Conservationist

cc:
Mr. O. K. Stender, Chief Executive Officer
~~True/Mid-Pacific Geothermal, Inc.~~ The Estate of James Campbell
~~888 Fort Street Mall, Suite 600~~ 828 Fort Street Mall, Suite 500
Honolulu, HI 96813

HEADQUARTERS
U. S. NAVAL BASE
BOX 110
Pearl Harbor, Hawaii 96860-5020

JAN 10

9510
Ser 002B/2366
10 DEC 1985

Mr. Susumo Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

SUPPLEMENTAL EIS TO THE REVISED EIS FOR THE KAHAUALE'A GEOTHERMAL PROJECT

The Supplemental EIS to the Revised EIS for the Kahaualo'a Geothermal Project has been reviewed and we have no comments to offer. Since we have no further use for the EIS, the EIS is being returned to the Office of Environmental Quality Control, by copy of this letter.

Thank you for the opportunity to review the EIS.

Sincerely,

Captain, CEC, U. S. Navy

Enclosure

Copy to:
Mr. O. K. Stender, Chief Executive Officer
True/Mid-Pacific Geothermal Inc.
800 Fort Street Mall, Suite 500
Honolulu, Hawaii 96813

Office of Environmental Quality Control

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U.S. Department of Transportation
United States Coast Guard

Commander (dpl)
Fourteenth Coast Guard District

Prince Kalanianaole Federal Building
300 Ala Moana Blvd.
Honolulu, Hawaii 96850
Phone: (808) 546-2861

16475.2/2-86
Serial No. 6/062
January 10, 1986

RECEIVED
JAN 13

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Re: Supplemental EIS to the Revised EIS for the Kahauale'a Geothermal Project

Dear Mr. Ono:

The Fourteenth Coast Guard District has reviewed the subject document and has no comment on it at this time. Thank you for the opportunity to review it.

Sincerely,

Jay Silberman
Environmental Protection Specialist
District Planning Office
Fourteenth Coast Guard District
By direction of the District Commander

Copy: The Estate of James Campbell