

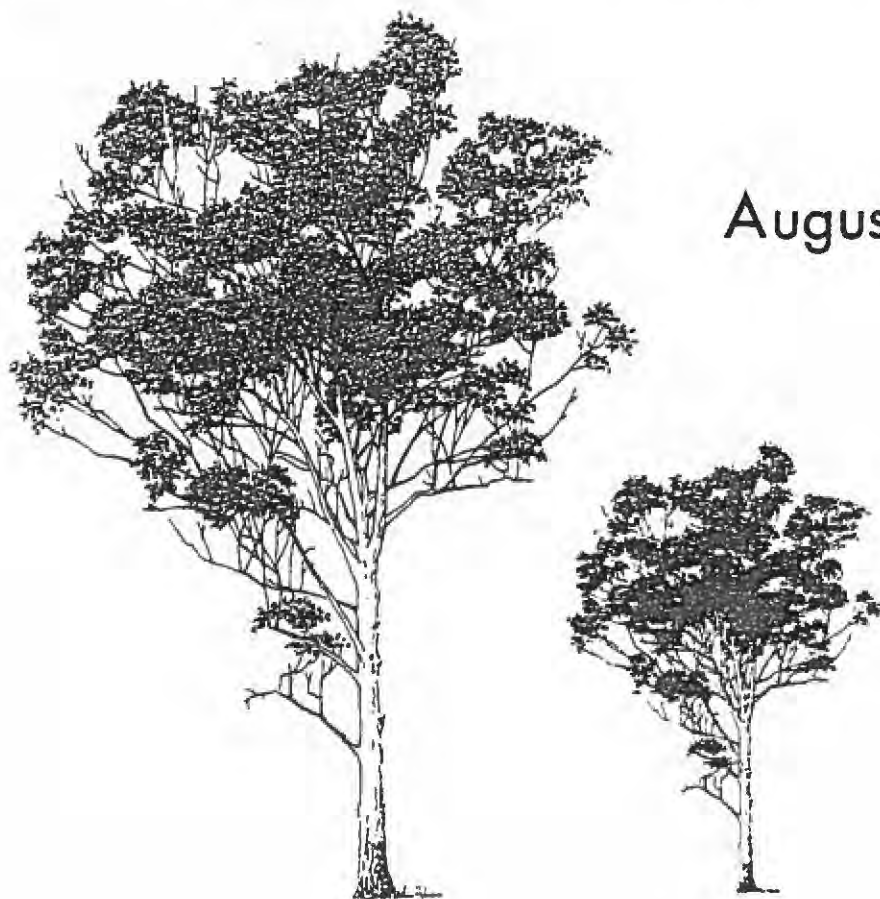
ENVIRONMENTAL IMPACT STATEMENT

for

Eucalyptus Biomass Farm Development

at Pu'u'eo, South Hilo, Hawai'i

August 1981



ENVIRONMENTAL IMPACT STATEMENT
AUGUST 1980

PROJECT: Eucalyptus Biomass Farm Development
at Pu'u'eo, South Hilo, Hawaii

PROPOSING AGENCY: BioEnergy Development Crop.
P.O. Box 1801, Hilo, Hawaii 96720

ACCEPTING AUTHORITY: Board of Land and Natural Resources
State of Hawaii

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SUMMARY

This environmental Impact Statement (EIS) was prepared for submission to the State Office of Environmental Quality Control, pursuant to Chapter 343, HRS. The approving agency is the Board of Land and Natural Resources (BLNR). The BLNR is considering a request by BioEnergy Development Corp. (a subsidiary of C. Brewer and Co. Ltd.) for authorization to undertake eucalyptus biomass farming on 341 acres of Conservation designated land in the Hilo Forest Reserve. The request is identified as: "Conservation District Use Application for Eucalyptus Biomass Farm Development at Pu'u'eo, South Hilo, Hawaii" C. Brewer and Co. Ltd. is the landowner of record.

This EIS was prepared by Juvik and Juvik, Environmental Consultants, whose mailing address is 223 Makani Circle, Hilo, Hawaii 96720.

Proposed Action:

In February, 1978 C. Brewer and Co., Limited submitted to the U.S. Department of Energy's (DOE) a research and development proposal to explore the potential of large-scale eucalyptus plantings in Hawaii for use as biomass fuel. The subsequent approval and funding of that proposal has taken form today in the BioEnergy Development Corporation (BDC), a new C. Brewer Biomass Energy Project. BDC is a planned 5 year, 900-acre demonstration project on the Big Island of Hawaii to determine the economic and technical feasibility of using eucalyptus trees for biomass plantations in Hawaii. During the Period 1978-1980 approximately 300 acres of agriculturally zoned marginal or abandoned cane land were planted in eucalyptus. It is planned to plant an additional 600 acres of eucalyptus over the period 1981-84 in order to fulfill obligations under the DOE funded demonstration biomass project.

BDC would like to meet part of this additional 600 acre commitment by developing a eucalyptus Biomass plantation on 341 acres of Conservation zoned land at Pu'u'eo, South Hilo.

Project Location:

The proposed project area lies between the 1600 and 2400 ft contours on the windward slopes of Mauna Kea, approximately 5 miles above (west) Hilo, Hawaii. The site is at the boundary between mauka cane fields of Mauna Kea Sugar Company and the Hilo Forest Reserve. Disturbed forest, planted eucalyptus forest (established in the 1930s), sugar cane cultivation and a recently established eucalyptus biomass farming project occupy lands immediately adjacent to the proposed project area at Pu'u'eo. Cane haul roads reach the makai boundary of the parcel.

Affected Environment:

Pu'u'eo forest currently supports a vegetative cover dominated by strawberry guava, uluhe fern and scattered 'ohi'a. Exotic, weedy species are dominant in the flora of the project area, although numerous native species also occur at the site. No currently endangered or threatened plant species have been found at the site, however, one species (the native mint Stenogyne scrophularioides) currently "proposed" for federal endangered species status has been found within the project area. The single individual occurs within a natural drainage gulch which will not be disturbed by the proposed action.

Avifauna seen on the project site includes predominately exotic species. Only one native bird species, the 'Elepaio, was observed in the project area. Two federally endangered species, the Hawaiian Hawk (I'o) and Newell's race of the Manx Shearwater (A'o), may utilize the project area periodically.

Probable Impacts and Mitigating Measures

1. Minor soil erosion and compaction will be associated with land clearing and periodic timber harvesting and replanting. Increased runoff and some siltation of minor drainage channels may also occur periodically. These adverse impacts will be minimized with proper soil conservation practices. In addition, the existing vegetation will be left intact along steep-sided stream gulches in the project area to protect unstable slopes and surface water quality.
2. Both native and exotic elements of the existing vegetation will be destroyed by the proposed development, however, the watershed values of the site will be largely maintained by the eucalyptus plantation established over the area. Existing vegetation will be left intact in buffer zones along gulches and above the 2300ft contour. These buffer zones will protect noteworthy native species such as the endemic mint Stenogyne scrophularioides, a plant under consideration for endangered species status.
3. Existing avifauna of the project area will be displaced by the development (except in buffer zones), including a population of the native 'Elepaio. Potential impacts on the Endangered Hawaiian Hawk and Newell's Shearwater are thought to be minimal.
4. The socio-economic impact of the development (and the larger demonstration eucalyptus biomass project of which it is a part) is expected to be positive if the feasibility of large scale biomass development is proven. Dependence on imported fuel oil will be reduced, local jobs will be created and the economic base of the County diversified.

I PROJECT DESCRIPTIONA. PROJECT LOCATION

Eucalyptus biomass farming is proposed for a 341 acre parcel of land located within the Hilo Forest Reserve. The site lies between the 1600 and 2400 ft countours, approximately 5 miles above Hilo on the Island of Hawaii. Figure 1 shows the location of the project area at Pu'u'eo mauka.

B. PROJECT OVERVIEW1. Biomass Potential

Because Hawaii lacks any form of indigenous fossil fuels it imports 100% of its oil to meet 92% of its energy needs. As most of this oil is foreign crude oil, Hawaii is particularly vulnerable to any international political conflicts, such as that which produced the OPEC oil embargo of 1973-1974.

Acknowledgement of this vulnerability by the public, the private sector and government has led to the ongoing, vigorous search for alternative sources of energy for the State. As a consequence several potentially viable replacements for fossil fuels are currently in various stages of research and development. The energy potential from Hawaii's indigenous (non-fossil fuel) energy resources is considered to be high and presently the most promising of these is biomass energy.

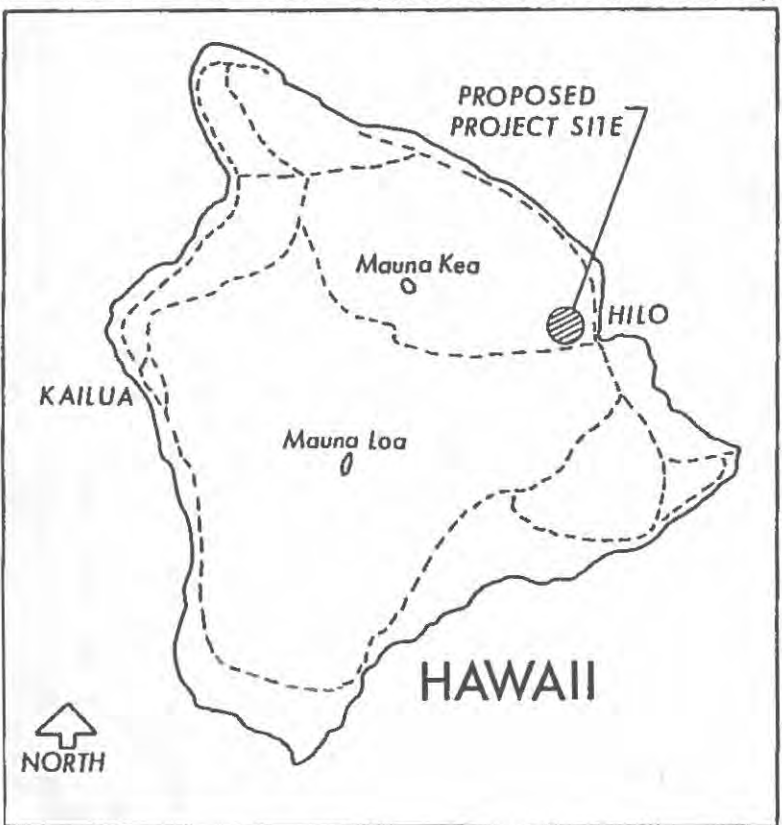
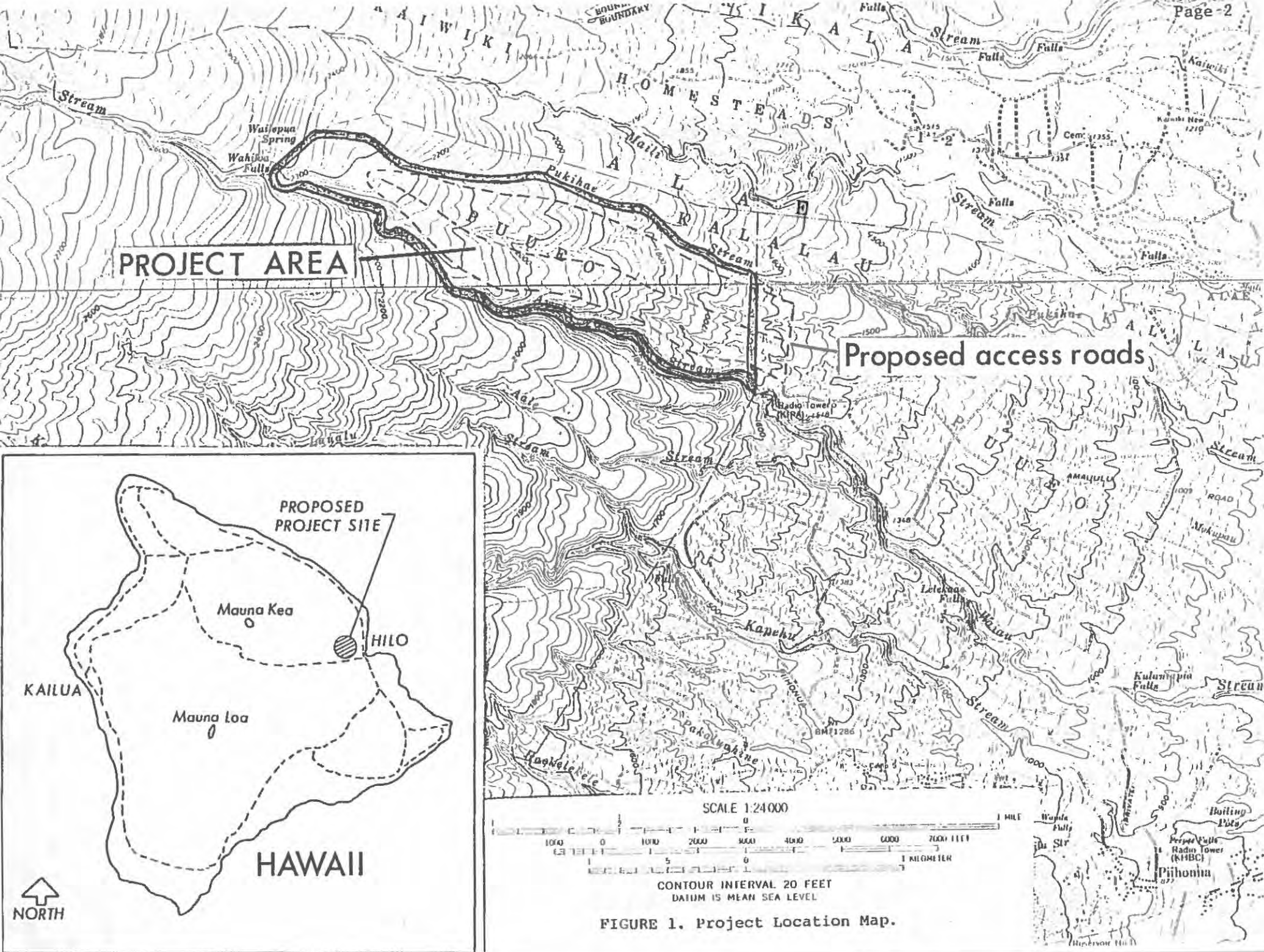


FIGURE 1. Project Location Map.

Biomass energy is often referred to as a form of solar energy because it is stored chemical energy that is primarily derived from the sun through photosynthesis. Simply defined, "biomass" is organic material--growing matter or waste--which can be used to produce energy.

Biomass energy is not a new concept in Hawaii. For many years sugar companies have burned bagasse, the fibrous residue that remains after cane juice extraction, to generate the electricity required for their in-house operations. Today bagasse is the sugar factories' main source of fuel. In addition to electricity generation for their own operations, several raw sugar factories throughout Hawaii presently sell excess electricity to the local utility for resale to the public. It is estimated that 13-14% of the electricity consumed in the state is supplied by these sugar companies.

On the Island of Hawaii approximately 40% of the public's electricity requirements is supplied by raw sugar factories burning mostly bagasse. The Pepeekeo Sugar factory's power plant, run by the Hilo Coast Processing Co. (HCPC), produces steam for its sugar production and in-house electricity generation, as well as electricity generation for sale to the local Hawaii Electric Light Company (HELCO). HCPC is an agricultural cooperative owned 50% by 325 independent farmers and 50% by Mauna Kea Sugar Company.

The Pepeekeo factory power plant produces approximately 23-24% of the Island's electricity, being one of only two sugar companies on the island with a contract to sell "firm power" to HELCO. Other companies sell their excess power when available as "dump power". Pepeekeo uses an estimated 26-40 million KWH of electricity yearly for its own operations and has a contract with HELCO to produce 100 million KWH per year.

Pepeekeo's daily output then ranges between 335,000 and 340,000 KWH--25,000 KWH for the factory and auxiliary power, and 309,000 plus KWH for HELCO. In its contract with HELCO, HCPC has the option to produce not less than 2% less than the contractual amount of 100 million KWH per year. Conversely, HELCO will buy any excess electricity that the power plant can produce. Pepeekeo power plant's generator is rated at 25.8 MW at a power factor of 85%, and its boiler capacity is 330,000 pounds of steam/hr. at 1250 psig and 825 F.

Although bagasse is Pepeekeo's major fuel source to produce steam and generate electricity, oil must be burned when the bagasse supply is insufficient. When the mill stops grinding, the supply of bagasse is affected--first, the stored supply must be relied upon, sometime to the point of depletion and second, no bagasse is being produced to replenish the supply. When this occurs, the power plant must rely largely on fuel oil in order to fulfill the terms

of the HELCO contract. C. Brewer and Company, Limited is currently spending nearly \$2 million annually for this supplemental oil.

Many factors affect the supply of bagasse including any mechanical breakdowns, scheduled weekly shutdowns, harvesting schedules and breakdowns, and the weather. Because of these variables and because the mill's schedule simply does not always coincide with that of the power plant, it is estimated that the maximum rate of power generation the power plant will ever achieve on bagasse as sole fuel source is 90-92%. Alternate fuel sources will always be needed.

One promising source of alternative fuel is wood fibre supplied from fast-growing, commercially-managed forests. Hawaii, with its year-round growing season provides an ideal environment for biomass production. In particular, Australian eucalyptus renowned for its high fuel value and rapid growth rate, grows well on most sites in the State. As energy plantations, eucalyptus tree farms can help relieve Hawaii of its petroleum dependency. Chipping of the trees produced along the Hilo Coast will most likely occur at HCPC, as will testing to obtain the optimum bagasse/wood chip fuel mix. As a research and development project, several energy related possibilities will be investigated for such a mix and for the wood chips alone. Either in a mix or as a pure fuel source, these eucalyptus chips may

first of all aid in alleviating and perhaps eventually eliminating HCPC's need for fuel oil. Secondly, a large and reliable supply may be used to eventually generate more electricity for sale to HELCO. These chips may also prove to be a viable fuel source for other industries.

These and any other possibilities are naturally contingent upon a variety of factors including further technical research and a thorough economic analysis of the situation--fuel costs, marketability, operational and production costs, energy outlook-in 5-7 years when the trees will be harvested. To illustrate this point, the possibility of using the chips to generate more electricity for sale to HELCO can be used. One factor that must be considered before pursuing this would be that the boiler at the Pepeekeo power plant is already operating close to its maximum capacity, necessitating the installation of an entire new generating unit in order to produce a larger amount of electricity. Estimated costs for such a facility are \$1,000/KW or \$1,000,000/MW, thus much research would be required to weigh the economic pros and cons of such a project.

2. BioEnergy Development Corporation

In February, 1978 C. Brewer and Co., Limited submitted to the U.S. Department of Energy (DOE) a research and development proposal to explore the potential of large-scale eucalyptus plantings in Hawaii for use as biomass fuel. The

subsequent approval and funding of that proposal has taken form today in the BioEnergy Development Corporation (BDC), a new C. Brewer Biomass Energy Project. BDC is a planned 5 year, 900-acre demonstration project on the Big Island of Hawaii to determine the economic and technical feasibility of employing eucalyptus trees for biomass plantations in Hawaii and similar subtropical regions. The Dept. of Energy funding will be in annual increments, with a \$335,000 grant for the first fiscal year, Sept. 1978-Sept. 1979. BioEnergy Development Corporation's (C. Brewer) contributions in that first year total \$502,000 in land, equipment and managerial resources. Agencies directly cooperating with BDC include the Institute of Pacific Islands Forestry and the U.S. Dept. of Agriculture.

In attempting to determine the viability of the energy plantation concept in Hawaii, BDC has sought to answer these 8 broad questions:

- 1) How do different sites, cutting cycles, spacing and intensive cultural practices to maximize production affect the growth, yield rotation, length, and profitability of short-rotation eucalyptus?
- 2) What are the relative cost/benefits of growing pure stands of eucalyptus with various fertilizers vs. admixtures of eucalyptus with nitrogen fixing species on different sites?
- 3) Will crop-logging (monitoring growth through chemical and physical measurements throughout the rotation) provide

management guidelines to produce maximum yields?

4) Can genetically superior eucalyptus planting stock be identified and mass produced within a short time frame, through phenotypic selection, in seed orchards?

5) Which provenances of Eucalyptus grandis, E.Saligna, and E.camaldulensis will prove best adapted on planting sites differing greatly in elevation, rainfall, and soil properties?

6) Can existing company equipment be modified at minimal cost for the purpose of close planting and cultivating eucalyptus seedlings, and hauling wood fiber to the generating plant?

7) To what extent are soils and terrain conditions limiting factors, acreage-wise, in the large scale commercial forest biomass production operations on company lands? and,

8) What is the optimum mixture of eucalyptus wood chips and other biomass fuel sources?

A yearly plan of objectives and operations has been devised for each of the five grant years through which BDC will seek the answers to these questions. Research will be conducted in silviculture, engineering and economics and specifics include: spacing, fertilizer and herbicide trials, cost analyses of site preparation and intensive cultivation practices, progeny trials, land use capability appraisals, and evaluations of biomass mixes at the power plant.

Eucalyptus was selected as the biomass crop for the project for several reasons:

- 1) Proven adaptability to a wide range of site conditions, all classified as average to very poor,
 - 2) Fast growth from time of planting--average growth rate is a foot per month,
 - 3) High heat content,
 - 4) Favorable response to fertilizer at time of planting,
 - 5) Coppicing ability--the ability to produce shoots from old stumps, and
 - 6) Indefinite shoots, naked buds and accessory buds.
- Although concentration will be on four species - Eucalyptus saligna, E.grandis, E.globulus, E.camaldulensis - others will be tested as well.

Except for the initial 10,000 trees, all seedlings planted for the project will be propagated at BDC's nursery. A variety of land clearing, planting, weed control, and fertilizing techniques will be examined during the 5-7 year growing time, after which the trees will be harvested, chipped then burned at the power plants of Hilo Coast Processing Co. and Ka'u Sugar Co. for electricity generation. BDC will conduct its operations in two different geographic areas of the island, Hamakua and Ka'u for two reasons. First, these two C. Brewer facilities are readily available to utilize the wood chips and such cooperation between these companies and BDC is anticipated

to be mutually beneficial. HCPC and Ka'u Co. will be aided in moving toward energy self-sufficiency and BDC will have market/testing sites in close proximity to its operations. Second, Hamakua (east coast of Hawaii) and Ka'u (southern point on island) provide two extremely different environment areas, ideal for BDC as a research and development project. Along the Hilo coasts the soil is deep and rain is plentiful while in Ka'u, the soil is very rocky and moisture is not abundant. Operational data gathered in both areas should eventually provide a solid information base on the establishment of terrestrial biomass plantations.

BDC's administrative offices are presently located in the C. Brewer Building in Hilo and its operations office is located in Wainaku. The operations complex is comprised of an office building, a potting shed where seeds are sown and supplies are kept, and two hothouses each 2,100 sq.ft. with the capacity to accommodate 50,000 seedlings. The nursery will produce 400,000 seedlings annually with seed gathered from wild eucalyptus pods.

Economic impacts are evaluated at every level of the project. Cost accounting is strictly adhered to by BDC and economic data recorded to accurately gauge the cost/benefit ratio of large scale biomass energy production. There must be a new energy gain and a net financial savings relative to the cost of fuel oil for the project to be judged successful.

BDC is staffed with a project manager, an accountant, a secretary, an operations supervisor, and agronomist/soil scientist, 2 forestry technicians, 2 nursery workers, 6 field hands and 4 field workers.

3. Current field operations

After two years in operation, BDC has set up standard field practices for all phases of production: nursery, clearing, planting, weed control, and fertilization. These practices are being constantly evaluated for potential reductions in cost and increases in efficiency, yield and employee safety. Mechanization, in particular, is being looked at for future operating improvements.

a) Nursery

Eucalyptus seedlings are grown in plastic dibble tubes called "Ray Leach Cone-tainers" [1]. Raising containerized stock is a convenient, economical way to grow large numbers of seedlings with minimal root damage at time of planting.

The seedlings are removed from the containers shortly before planting and the containers are recycled after sterilization. The potting media used is a 2:1 mix of vermiculite and peat moss. Osmocote (14-14-14), dolomite, and MicroMax (a source of micronutrients) are mixed

1. Trade names mentioned throughout this report are used solely to provide specific information. Mention of a trade name does not imply an endorsement.

thoroughly into the media by hand.

The seedlings are moved from the greenhouse to the hardening area when they are 3 to 4 inches in height, or 4 to 6 weeks after sowing. Depending on the size of the container, the plants are ready for outplanting at 10 weeks to 4 months after sowing, when they are 12-15 inches tall.

Fungicides and insecticides are not necessary in Hawaii for the cultivation of eucalyptus seedlings. Occasionally, aphids or Japanese rose beetles become a problem, and diazinon or malathion are used for control. Damping off only becomes a problem when the plants are watered too frequently, and thus timing of irrigation is sufficient control of this fungal problem.

BioEnergy's nursery consists of two greenhouses capable of holding 50,000 seedlings each, and the outdoor hardening area which has the capacity for 64,000 seedlings. With a rotation of 3 to 4 months, the nursery is capable of producing 450,000 seedlings per year, a number more than adequate to plant 200 acres per year at a 5 x 5 foot spacing.

The nursery staff consists of two hourly paid employees, who carry out all phases of nursery operations. Economic data has been carefully monitored and BDC's current nursery practices will produce eucalyptus seedlings for 336 per thousand.

b) Clearing

The planting sites can be classified into 3 main groups, abandoned cane land: wasteland and forest. Along the Hamakua coast, the abandoned cane land is bulldozed clear of vegetation and harrowed. In Ka'u, the abandoned cane land is simply crushed down with a Krajewski roller to form a mat of vegetation. At both locations, Roundup is applied twice prior to planting, with the first shot at 0.75 gal/A and the second shot at 0/50 gal/A.

The wasteland classification consists of areas either in cane or abandoned long ago. The brush is bulldozed and windrowed, then two applications of Roundup are made prior to planting at the same rates as on abandoned cane land.

In forested areas, any commercially harvestable trees will probably be removed prior to bulldozing and windrowing of the vegetation. Two shots of Roundup will be applied before planting.

Clearing abandoned cane land takes about 3 tractor-hours, or 1 hour each for two tractor passes over the area plus 1 hour for Soil Conservation ditch maintenance work. At \$80 per hour to rent a D-6 tractor, costs will be about \$240 per acre for abandoned cane land.

Wasteland takes about 6 tractor-hours per acre or \$480 per acre. Forested areas are being budgeted at 15 tractor-hours per acre or \$1200 per acre.

c) Planting

The 3 to 4 month-old seedlings from the nursery are outplanted manually at 5 x 5 foot spacings. The 6-person planting crew works in pairs, with one person using a metal or wooden dibble to open a hole, and the other following behind to place a seedling in the hole then covering it.

BioEnergy's 6-person planting crew can plant 600 trees per man-day along the Hamakua coast and 300 trees per man-day in Ka'u where the ground is rocky. At 1742 trees per acre (5 x 5 foot spacing), the 6-person crew can plant 2 acres per day along the Hamakua coast or 1 acre per day in Ka'u. By December 1980, BDC had 298.5 acres under eucalyptus biomass cultivation in both Ka'u and Hamakua (see Table 1).

TABLE 1

BDC lands under eucalyptus cultivation as of December 31, 1980.

Field	Classification	Acres
Ka'u 780	Cane land	15.0
Ka'u 755	Cane land	41.5
Amauulu	Waste land	23.0
Onomea V05A	Cane land	20.3
Onomea V09A	Cane land	2.4
Akaka 54C	Cane land	24.4
Kamae 25A	Cane land	47.7
Kamae 25B	Cane land	28.6
Kamae 26A	Cane land	66.1
Kamae 26B	Cane land	9.0
Kamae 27D	Cane land	20.5

TOTAL 298.5 Acres

Future research will look at increasing the efficiency of planting through improved manual tools or mechanization. BDC is planning to borrow a mechanized transplanter from the Hawaii State Division of Forestry to try along the Hamakua coast.

The advantages and disadvantages of mechanized planting need to be evaluated. Potential problems are the initial cost of investment, the higher costs of tractor rental, and the limitations due to terrain and weather conditions.

d) Weed Control

Weed control begins with two Roundup applications prior to planting. Roundup has no residual effect, so that 2 to 3 months after outplanting, the fields are again filled with weeds competing with the eucalyptus seedlings for sunlight and nutrients.

In the past, sickling was done to prevent shading of the trees, but the effect was very short term, sometimes less than a month. Sickling costs depend on the density of weed growth, but it can run up to \$60 per acre or 15 man-hours per acre.

BioEnergy is currently experimenting with pre-emergent herbicides that can be applied as a preplanting treatment, either separately or combined with the Roundup application. Pre-emergent herbicides will control the seeding grasses and broad leaf weeds for up to 3 to 4 months. The most

promising pre-emergent herbicide tested to date is Simazine.

BioEnergy has also begun testing post-planting herbicide treatments. The rhizomatous grasses are spot-sprayed with Round up, and then after 4 weeks a mixture of Paraquat - Simazine is sprayed over the entire area.

Ongoing weed control research at BDC is a continuous screening of herbicides for pre-emergent and post-emergent activity combined with minor phytotoxicity towards eucalyptus. Future research will include additional herbicide evaluation as well as determining the most effective methods of application. The dangers of Paraquat are recognized, and less dangerous contact poisons will be tested in 1981.

e) Fertilizer and Crop Logging

The trees are fertilized immediately after planting and 6 months later. Metal or wooden dibbles are used to bury 4 ounces of DC-155 (12-24-12) fertilizer about 6 inches away from the tree.

During the first year of establishment, eucalyptus trees receive 104 lbs/acre of nitrogen, 208 lbs/acre of phosphorus, and 104 lbs/acre of potassium.

Crop logging, or monitoring tree growth through plant tissue analysis will be carried out through the entire cropping cycle. Data from the ongoing fertilizer experiments will be used as a guideline for establishing

critical plant nutrient levels.

After the first year of plantation establishment, foliar analysis will be used to determine fertilizing schedules. BioEnergy is testing aerial application of A-f fertilizer (25-0-27) at a rate of 50 lbs/A of nitrogen and 54 lbs/A of potassium.

Ongoing research will to examine the effects of varying levels of nitrogen, phosphorus, and potassium on the growth of eucalyptus seedlings. Future research will focus attention on the possible merits of rock phosphate and liming. Furhter work also needs to be done on crop logging procedure, since the problems of leaf sampling increase proportionately with the height of the trees. Finally, more economical methods of fertilizer application need to be looked at to reduce man-hours required.

f) Harvesting

A computer search on harvesting equipment has been carried out by the Institute of Pacific Islands Forestry, and literature on this subject is being compiled. Also, all major harvesting equipment companies in the United States have been contacted for equipment specifications and recommendations. BDC is looking to the U.S. Forest Service for technical expertise in this area. A visit by an equipment specialist is being examined for 1981 or 1982.

As currently planned harvested logs will be transported to the Pepe'ekeo power plant by conventional logging trucks where the wood will be chipped and stockpiled for use.

C. DEVELOPMENT OF THE PU'U'EO SITE

In order to meet its 900 acre commitment to eucalyptus biomass farming under terms of the DOE funded demonstration project, BDC proposes to clear and plant eucalyptus on a 341 acre parcel at Pu'u'eo mauka within the Hilo Forest Reserve. This land (TMK: 2-6-18:08) is owned by C. Brewer and Co. Ltd. and currently support a disturbed forest of exotic and native species. Development of the parcel for eucalyptus biomass farming will involve clearing of existing vegetation and the construction of three access roads approximately 2 miles in length commencing from the lower boundary of the forest reserve and extending upward looping and connecting in the upper area of the parcel. These roads will take off from existing roads in the adjacent (makai) agricultural zoned lands of 'Amauula (see Figure 1) which have previously been cleared and planted to eucalyptus. The roads will be 12 ft. wide and 18 in. in depth and constructed by an outside contractor with material purchased in Hilo. The AA aggregate will be in the sizes 12-18 in. to fines. Necessary culverts will be installed as required and sized according to Soil Conservation Service recommendations.

Clearing and eucalyptus planting of the project area will be phased over a three to four year period. Eucalyptus planting will commence at the makai boundary of the project area near 'Awehi Stream. It is planned to clear and plant 30 acres in 1982, followed by 110 acres in 1983. The remaining acreage will be cleared and planted in 1984 or later. This schedule is contingent upon federal funding from the DOE to continue the ongoing cooperative project.

II. DESCRIPTION OF THE ENVIRONMENT

A. GENERAL SITE CONDITIONS AND SURROUNDING LAND USES

The proposed project area at Pu'u'eo mauka lies 5 miles above Hilo, in a rural agricultural setting at the boundary between mauka cane fields (Mauna Kea Sugar Company) and the Hilo Forest Reserve. The 341 acre parcel proposed for eucalyptus biomass farming is within a State Conservation District and presently supports a disturbed forest cover dominated by strawberry guava (waiawi), uluhe fern and 'ohi'a. The area is characterized by gently sloping terrain (6-10 %), except where stream channel dissection has given rise to steep sloped gulches such as along 'Awehi and Pukihae Streams on the southern and northern boundaries of the project site respectively (Figure 1). Immediately adjacent to the Pu'u'eo forest parcel on the makai boundary is a recently established (by EDC) eucalyptus plantation on 23 acres of abandoned pasture land. Sugar cane fields also abut the makai boundary of the project area near 'Awehi Stream. Along the southern boundary of the parcel (across 'Awehi Stream) eucalyptus forests planted during the 1930s grow on both State and private lands within the Hilo Forest Reserve. The planted eucalyptus forest extend to approximately the 2000 ft elevation, giving way to mixed exotic native forest above. A narrow belt of land (600-900 ft wide) immediately to the north of the project area (across Pukihae Stream) is also within the Forest Reserve and supports vegetation very similar to that of the subject parcel. Further to the north, beyond Maili Stream, is the Kaiwika Homesteads area, which has been extensively cleared for pasture (see Figure 1).

Above the project site the disturbed character of the forest gradually diminishes with increasing elevation giving way to intact native forest dominated by 'ohi'a and koa on the higher windward slopes of Mauna Kea.

The nearest residential developments to the project site are in the Pi'ihonua area approximately 2.5 miles to the southeast. Additionally, rural residences also occur along the Kaiwiki Homestead Road 1-2 miles east of the makai boundary.

B. GEOLOGY / HYDROLOGY

The eastern slopes of Mauna Kea are underlain by successive lava flows of Pleistocene age. Within the project area the rocks are predominately alkalic basalts classed as upper members of the Hamakua volcanic series (Stearns and MacDonald, 1946). Over much of windward Mauna Kea these upper Hamakua basalts are capped by a deep Pahala Ash layer (named for the type section locality in Ka'u). This ash is also of Pleistocene age and in the Pu'u'e'o mauka area averages about 7-10 ft thick (MacDonald and Abbott, 1970). On the Hamakua coast the gentle slopes of the Mauna Kea shield have been moderately dissected by youthful ("V-shaped") drainage channels which are incised through the Pahala Ash and subjacent basaltic lavas. The project area is bounded on the South by 'Awehi Stream, a major tributary of the Wailuku River, originating on the upper slopes of Mauna Kea (8000 ft level). In the vicinity of the project area the gulch formed by 'Awehi Stream is 100-120 ft deep. By contrast, Pukihae Stream on the northern boundary is much smaller and empties directly into Hilo Bay. Both streams flow year-round.

There are no discharge data available for either 'Awehi or Pukihāe Streams, however, flow rates have been recorded for Honoli'i Stream just to the north of the project area. Honoli'i has a drainage basin area and gulch size similar to 'Awehi stream, and during a twelve year monitoring period, discharge averaged 31 million gallons/day (State of Hawaii, 1970). Discharge rates from 'Awehi Stream are expected to be of a similar order of magnitude.

Because of the generally high porosity of volcanic substrates much of the abundant rainfall on windward Mauna Kea infiltrates directly to the basal lens as ground water (Lau, 1973). However, numerous springs also occur in the project vicinity where there are perching members (e.g. Pahala Ash) to prevent or retard percolation. In size, these perched springs range from near seeps to high volume sources discharging in excess of 1 million gallons/day. Kapehu Spring located approximately 1.5 miles south of the project area has an estimated flow of 2 million gallons/day (State of Hawaii, 1970). No major springs occur within the project area, although Wailepua Spring (flow rate unknown) is located just outside the mauka boundary of the project area and discharges into Pukihāe Stream (Figure 1).

C. SOIL

A soil survey of the project area was undertaken during June 1981 by the U.S. Soil Conservation Service (SCS). A copy of the SCS report is included as Appendix A in this EIS. The following information is extracted from this report and other sources.

In the Pu'u'eo mauka area soils have developed on a deep (7-10 ft) Pahala Ash layer that overlies basaltic bedrock. The soils are silty clay loams of the Akaka series.

The Akaka series consists of deep, moderately well drained silty clay loam soils formed from volcanic ash. They occur at the upper fringe of the sugar-cane land, but primarily within the forested area. Elevations range from 1,000 to 4,500 feet. Mean annual rainfall ranges from 150 to 300 inches. Cloud and fog are prevalent throughout the year.

In a typical profile, the surface layer is dark reddish brown silty clay loam about 15 inches thick. The subsoil is reddish brown to dark reddish brown silty clay loam more than 57 inches thick. The surface layer is strongly acid and the subsoil is strongly acid to medium acid. The subsoil is moderately to strongly smeary. Water moves through the soil rapidly (6 to 20 inches per hour). Roots can penetrate to a depth of over 5 feet.

This soil is usually moist. When allowed to dry, it hardens irreversibly to fine gravel-size aggregates. This soil has low bearing capacity. Heavy equipment will tend to bog down.

Within the project area slopes are dominately 6-10%, but may reach 35-70% (or more) along the steep sided gulches of 'Awehi and Pukihae Streams. Site soil conditions vary with slope conditions:

Akaka silty clay loam, 6 to 10 percent slopes (AkaC).

This is moderately sloping soil. The erosion hazard is slight. Included are small boggy areas. Also included are small areas with up to 15 percent slopes. This soil is suited to grow trees.

Akaka silty clay loam, 10 to 20 percent slopes (AkD).

This soil occurs on moderately steep to rolling topography and is dissected by streams. There are small depressions which remain water-logged for long periods. The erosion hazard is moderate. Small areas are moderately eroded. Included are areas of steeper slope along gulches. This soil is suited to grow trees. Use of machinery and planting should be across the slope or on the contour. The slope angle and low load bearing capacity make the use of machinery somewhat difficult.

Akaka silty clay loam, 35 to 70 percent slopes (rAkF).

This soil occurs on very steep gulch sides. In places, slopes are steeper than 100 percent. Rock outcrop occurs in a few places. The erosion hazard is severe. Disturbance of the natural vegetation and the soil should be avoided.

The potential for timber growing on Akaka soils is generally high (Soil Conservation Service, 1973), and they have been rated "good" for eucalyptus biomass production (Yang, et.al., 1977). In undisturbed conditions Akaka soils of the Hamakua coast support native 'ohia forest.

D. CLIMATE

The project site, located on the windward slopes of Mauna Kea, is exposed to the prevailing north-east trade wind flow throughout the year. Orographic lifting and condensation of moisture laden trade wind air yields abundant, precipitation year-round in the Pu'u'eo mauka area. Although no rain gages are situated at the project site, there are longterm rainfall records available for a U.S. Weather Bureau station at Pi'ihonua located approximately 0.8 miles south of the project area. This station possesses a similar aspect, elevation (1730 ft.) and exposure to prevailing winds as that characterising the project area. Annual rainfall at Pi'ihonua for the 42 year period 1925-1966 ranged between 166 inches (in 1926) and 386 inches (in 1937), with average yearly rainfall for the period equal to 246 inches (State of Hawaii, 1970). In this region of the Hamakua coast there is no strong seasonality in the distribution of precipitation, which, on average is abundant in every month. The driest month at Pi'ihonua is June with a mean rainfall of 13.9 inches, while March is the wettest month with mean rainfall of 26.1 inches. These Pi'ihonua data probably characterise fairly accurately rainfall conditions at comparable elevation in the nearby project area. However, in the general region annual rainfall increases fairly rapidly with increasing elevation, and at the upper boundary of the project (elev. 2400 ft) yearly rainfall is likely to exceed 300 inches (State of Hawaii, 1970). Annual evapotranspiration in the project area is estimated at approximately 55 inches, or less than one-quarter of the annual rainfall (Juvik, Singleton and Clarke, 1978). This results in a large annual moisture surplus (i.e. rainfall minus

evapotranspiration) which is expressed as surface runoff (streamflow) and ground water recharge.

No air temperature data have been collected at the Pu'u'eo mauka site, however, records (1950-1966) are available for Papa'ikou mauka (elev. 1400 ft.), a station located approximately 2 miles north-northwest of the project area. The mean annual temperature at Papa'ikou mauka is 68.2°F. February is the coolest month with a mean temperature of 65.8°F, and September is the warmest at 71.0°F (State of Hawaii, 1970). Because air temperature in Hawaii decreases with increasing elevation at the rate of approximately 3°F per 1000 ft (Price, 1973), actual temperatures within the project area (altitude range 1600-2400 ft.) can be extrapolated to average 1-3°F lower than the values cited above for Papa'ikou mauka.

E. FLORA

A botanical survey of the Pu'u'eo forest was conducted by Botanists Winona Char and Layne Yoshida during the period November 6-9, 1980. Their report is included as Appendix B in this EIS. In order to address the potential problem of seasonal differences in plant species presence, a second, follow-up survey of the flora was undertaken during the period May 24-June 3, 1981 by G. Clarke, Botanist. During the initial November 1980 botanical investigation a total of 85 vascular plant taxa (including species, subspecies and varieties) were recorded within the project area (Appendix B). The follow-up survey in May-June 1981 added a further 30 taxa for a total flora of 115 species and varieties. Table II lists, by family, all vascular plants recorded from the project area. Of this total flora,

TABLE II

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS [1]</u>
<u>PTERIDOPHYTA AND FERN ALLIES</u>		
ADIANTACEAE		
<i>Adiantum capillus-veneris</i> L.	'Iwa'iwa	I
<i>Adiantum cuneatum</i> Langsd. & Fisch.	'Iwa'iwa	X
ASPIDIACEAE		
<i>Athyrium sandwichianum</i> Presl	Ho'i'o	E
<i>Elaphoglossum alatum</i> var. <i>parvisquamum</i> (Skottsb.) Anderson & Crosby	'Ekaha	E
<i>Elaphoglossum hirtum</i> (Swartz) Christensen	'Ekaha	E
ASPLENIACEAE		
<i>Asplenium contiguum</i> Kaulf.		E
<i>Asplenium lobulatum</i> Mett.		E
BLECHNACEAE		
<i>Blechnum orientale</i> L.	Blechnum	X
DAVALLIACEAE		
<i>Nephrolepis cordifolia</i> (L.) Presl	Ni'ani'au, 'okupu-Kupu, narrow sword fern	I
<i>Nephrolepis exaltata</i> (L.) Schott	Pamoho	I
DICKSONIACEAE		
<i>Cibotium chamissoi</i> Kaulf.	Hapu'u 'i'i	E
<i>Cibotium splendens</i> (Gaud.) Krajina	Hapu'u pulu, pepe'e	E
GLECHENIACEAE		
<i>Dicranopteris emarginata</i> (Brack.) Rboinson	Uluhe	I
<i>Hicriopteris pinnata</i> (Kunze) Ching	Uluhe-lau-nui	I
GRAMMITIDACEAE		
<i>Adenophorus hymenophylloides</i> (Kaulf.) H. & G.	Pai, palai-la'au	E
<i>Adenophorus sarmentosus</i> (Brack.) Wilson		E
<i>Adenophorus tamariscinus</i> (Kaulf.) H. & G.	Wahine-noho-mauna	E
<i>Grammitis hookerii</i> (Kaulf.) Copel.	Maku'e-lau-li'i	I
<i>Grammitis tenella</i> Kaulf.	Kolokolo, mahinalua	E

[1] STATUS: I = Indigenous; E = Endemic; X = Exotic; P = Plynesian introduction

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS</u>
<u>HYMENOPHYLLACEAE</u>		
<i>Callistopteris baldwinii</i> (D.C. Eaton) Copel.		E
<i>Mecodium recurvum</i> (Gaud.) Copel.	'Ohi'a ku	E
<i>Sphaerocionium obtusum</i> (H. & A) Copel.	Palai-lau-li'i	E
<i>Vandenboschia davallioides</i> (Gaud.) Copel.	Kilau	E
<u>LINDSAEACEAE</u>		
<i>Sphenomeris chusana</i> (L.) Copel.	Pala'a, pala-pala'a	I
<u>LYCOPODIACEAE</u>		
<i>Lycopodium cernuum</i> L.	Wawae-iole	I
<i>Lycopodium phyllantum</i> H. & A.	Wawae-iole	I
<u>OPHIOGLOSSACEAE</u>		
<i>Ophioglossum pendulum</i> L.	Laukahi, puapua-moa	I
<u>POLYPODIACEAE</u>		
<i>Pleopeltis thunbergiana</i> Kaulf.	'Ekaha-akolea, pakahakaha	I
<u>PSILOTACEAE</u>		
<i>Psilotum complanatum</i> Swartz	Moa, pipi	E
<i>Psilotum nudum</i> (L.) Beauv.	Moa	I
<u>SELAGINELLACEAE</u>		
<i>Selaginella arbuscula</i> (Kaulf.) Spring	Lepелеpe-a-moa	E
<u>THELYPTERIDACEAE</u>		
<i>Christella dentata</i> (Forssk.) Brownsey & Jermy	Downy woodfern	X
<u>MONOCOTYLEDONAE</u>		
<u>ARACEAE</u>		
<i>Colocasia esculenta</i> var. <i>antiquorum</i> (Schott) Hubb. & Rhed.	Taro, Kalo	P
<u>COMMELINACEAE</u>		
<i>Commelina diffusa</i> Burm. f.	Honohono	X

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL</u>	<u>COMMON NAME</u>	<u>STATUS</u>
CYPERACEAE		
Carex pluvia R.W. Krauss		X
Cyperus brevifolius L.	Kyllinga, Kili 'o'opu	X
Cyperus haspan L.		X
Cyperus polystachyus Rottb.		X
Eleocharis obtusa var. gigantea (Clarke) Fern.	Kohekohe, pipi-wai	I
Machaerina mariscoides (Gaud.) Kern	Uki, 'ah-nui	I
GRAMINEAE		
Andropogon virginicus L.	Broomsedge	X
Andropogon affinis Chase	narrow leaved carpet grass	X
Axonopus compressus (Sw.) Beauv.	Broad-leaved carpetgrass	X
Brachiaria mutica (Forsk.) Stapf	Californiagrass, paragrass	X
Coix lachryma-jobi L.	Job's tears, kukae- kolea	X
Microlaena stipoides (Labill.) R.Br.	Puu Lehua, meadow rice grass	X
Oplismenus hirtellus (L.) Beauv.	Basketgrass, hono- hono-kukui	X
Panicum repens L.	Quackgrass	X
Paspalum conjugatum Berg.	Hilo grass, mau'u- Hilo	X
Paspalum orbiculare Forst. f.	Ricegrass, mau'u- laiki	X
Pennisetum clandestinum Hochst. ex Chiov	Kikuyugrass	X
Sacciolepis indica (L.) Chase	Glenwoodgrass	X
Setaria glauca (L.) Beauv.	Yellow foxtail	X
Setaria palmifolia (Koen.) Stapf	Palmgrass	X
JUNCACEAE		
Juncus tenuis Willd.		X
LILIACEAE		
Astelia menziesiana Sm.	Pa'iniu	E
Cordyline terminalis (L.) Kunth	Ti, ki	P
Silax sandwicensis Kunth	Hoi-kuahiwi, aka- 'awa	E
MUSACEAE		
Musa X paradisiaca L.	Mai'a, banana	P

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS</u>
<u>ORCHIDACEAE</u>		
Arundina bambusaefolia (Roxb.) Lindl.	Bamboo orchid	X
Epidendrum sp.	Epidendrum	X
<u>PANDANACEAE</u>		
Freycinetia arborea Gaud.	'Ie'ie	E
<u>ZINGIBERACEAE</u>		
Hedychium flavescens Carey	Yellow ginger, 'awapuhi melemele	X
<u>DICOTYLEDONAE</u>		
<u>AQUIFOLIACEAE</u>		
Ilex anomala H. & A.	Kawa'u	E
<u>ARALIACEAE</u>		
Cheirodendron trigynum (Gaud.) Heller	'Olapa	E
<u>BIGNONIACEAE</u>		
Spathodea campanulata Beauv.	African tulip	X
<u>CARYOPHYLLACEAE</u>		
Drymaria cordata (L.) Willd.	Drymaria, pipili	X
<u>CELASTRACEAE</u>		
Perrottetia sandwicensis Gray var sandwicensis	Olomea	E
<u>COMPOSITAE</u>		
Ageratum conyzoides L.	Ageratum, maile- hohono	X
Erechtites valerianaefolia (Wolf) DC.		X
Eupatorium riparium Regel	Pamakani	X
Hypochoeris radicata L.	Hairy cat's ear	X
Pluchea odorata (L.) Cass.	Pluchea	X
Youngia japonica (L.) D.C.	Oriental hawksbeard	X
<u>CONVOLVULACEAE</u>		
Ipomea tuboides Deg. & van Ooststr.	Hawaiian moon flower	E

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS</u>
ERICACEAE		
Vaccinium calycinum Sm.	'Ohelo-kau-la'au	E
Vaccinium sp.	'Ohelo	E
EUPHORBIACEAE		
Antidesma platyphyllum Mann var. platyphyllum	Hame, Mehame	E
GUTTIFERAE		
Hypericum mutilum L.	St. Johnswort	X
LABIATAE		
Stenogyne scrophularioides Benth. var. aff. scrophularioides		E
LEGUMINOSAE		
Acacia koa Gray	Koa	E
LOBELIACEAE		
Clermontia parviflora Gaud.	Papa'a-hekili	E
Cyanea sp.	'Oha	E
LOGANIACEAE		
Buddleja asiatica Lour.	Dogtail, huelo- 'ilio	X
LYTHRACEAE		
Cuphea carthagenensis (Jacq.) MacBride	Cuphea, Puakamoli	X
MALVACEAE		
Malvaviscus arboreus Cav.	Turk's cap	X
MELASTOMATAACEAE		
Melastoma malabathricum L.	Malabar melastome	X
MELIACEAE		
Toona ciliata M. Roem.	Toon	X

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS</u>
MYRTACEAE		
<i>Eucalyptus citriodora</i> Hook.	Lemon-scented gum	X
<i>Eucalyptus robusta</i> Sm.	Swamp mahogany	X
<i>Eugenia jambos</i> L.	Rose apple, ohia loki	X
<i>Metrosideros collina</i> ssp. <i>polymorpha</i> (Gaud.) Rock	'Ohi'a-lehua, lehua	E
<i>Psidium cattleianum</i> Sabine	Strawberry guava	X
<i>Psidium cattleianum</i> f. <i>lucidum</i> Deg.	Waiawi, yellow strawberry guava	X
<i>Psidium guajava</i> L.	Guava, Kuawa	X
ONAGRACEAE		
<i>Ludwigia octivalvis</i> (Jacq.) Raven	Primrose willow, kamole	X
<i>Ludwigia palustris</i> (L.) Ell.	Water purslane	X
OXALIDACEAE		
<i>Oxalis corniculata</i> L.	Yellow wood sorrel	X
PASSIFLORACEAE		
<i>Passiflora edulis</i> f. <i>flavicarpa</i> Deg.	Yellow lilikoi	X
<i>Passiflora edulis</i> Sims f. <i>edulis</i>	Purple granadilla, lilikoi	X
<i>Passiflora ligularis</i> Juss.	Sweet granadilla, lemiai	X
PIPERACIAE		
<i>Peperomia hawaiiensis</i> C.D.C.	'Ala'ala-wai-nui kane	E
<i>Peperomia macreana</i> CDC	'Ala'ala-wai-nui kane	E
<i>Peperomia tetraphylla</i> (Forst. f.) H. & A.	'Ala'ala-wai-nui kane	I
POBYGONACEAE		
<i>Polygonum</i> sp.		X
ROSACEAE		
<i>Rubus rosaefolius</i> Sm.	Thimbleberry, 'ola'a	X

TABLE II (continued)

VASCULAR PLANTS FROM PU'U'EO FOREST

<u>BOTANICAL NAME</u>	<u>COMMON NAME</u>	<u>STATUS</u>
RUBIACEAE		
Coprosma sp.	Pilo	E
Psychotria hawaiiensis (Cray) Fosberg var. hawaiiensis	Kopiko	E
RUTACEAE		
Pelea volcanica Gray var. volcanica	'Alani	E
SOLANACEAE		
Physalis peruviana L.	Poha	X
TILIACEAE		
Heliocharpus popayaensis HBK.	White moho	X
UMBRELLIFERAE		
Centella asiatica (L.) Urban	Asiatic pennywort, pohekula	X
URTICACEAE		
Pipturis sp.	Mamaki	E
Urera sandyicensis Wedd. var. sandvi- censis	Opuhe	E
VERBENACEAE		
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi, oi	X

58 taxa (50.4%) are exotic forms, that is, plants introduced to the archipelago (either accidentally or intentionally) subsequent to European contact (1778); 39 taxa (33.9%) are plants endemic to Hawaii; and 15 taxa (13.0%) are indigenous, occurring naturally both in Hawaii and other parts of the world. A final 3 species (2.6%) in the total are of Polynesian (pre-european) introduction.

None of the plants listed in Table II are currently designated as endangered or threatened species under the U.S. Endangered Species Act of 1973 (Federal Register, 1980). However, two taxa encountered within the project area, Cyanea sp. and Stenogyne scrophularioides warrant further discussion in relationship to federal endangered species legislation.

There are approximately 80 species of endemic Cyanea (Family Lobeliaceae) in the Hawaiian Islands, of which 31 species and varieties have been "proposed" by the U.S. Department of Interior as likely candidate species for future endangered species status, subject to ongoing review and documentation. In November 1980, Char and Yoshida found several small seedlings belonging to the genus Cyanea growing ephemerally in the rocky bottom of a small drainage tributary of Pukihae Stream, within the project area (location shown in Figure 2). These plants could not be classified to the species level because of their immature growth stage. This area was thoroughly re-investigated by Clarke in June 1981 in an effort to find the population and clarify their taxonomic status. The Cyanea sp. were no longer present at their previous stream bed location and it is hypothesized that the seedlings were dislodged from the site during intervening high, winter

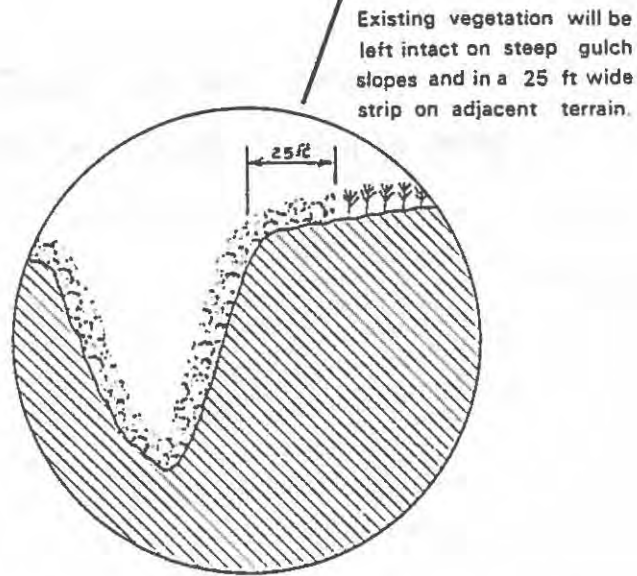
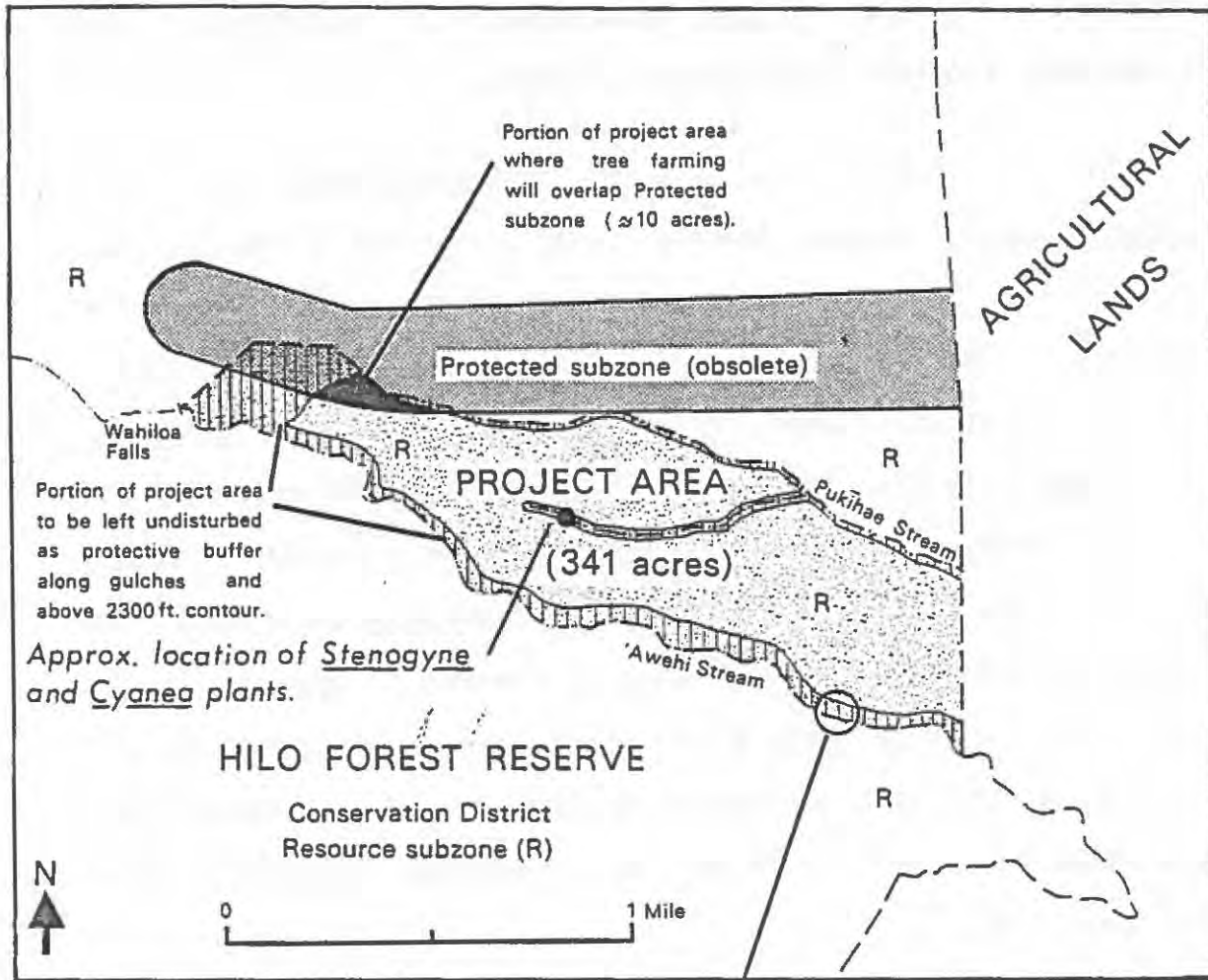


FIGURE 2. Land use classification and land management plan.

streamflow. No other Cyanea populations or individuals were encountered elsewhere within the project area.

The native Hawaiian mint Stenogyne scrophularioides var. aff. scrophularioides (Family Labiatae) has also been listed by the Department of Interior as a species currently under review for possible endangered species designation (Federal Register, 1980). Within the project area a single individual of Stenogyne scrophularioides var. aff. scrophularioides was found on the bank of the same Pukihae tributary from which Cyanea was reported (location shown in Figure 2). On June 3, 1981 the Stenogyne had a basal stem diameter of 3/8 inch, and was growing to a height of approximately 5 feet. The creeping stems of the plant spread sparsely over an area 20ft square. The plant appeared to be in fair condition although some pig damage was evident. This was the only specimen encountered within the project area.

F. VEGETATION

The vegetation of the project area is highly disturbed (i.e. modified from its presumed natural state), reflecting the impact of both direct and indirect past human disturbance. Although Pu'u'eo forest is currently included within a conservation zoned forest reserve/watershed district, such designation did not pertain earlier in the century when the forest reserve and the project area were exploited for limited cattle grazing, selective timber cutting and exotic tree planting (eucalyptus). A water diversion ditch was constructed along the southern boundary of the property. In recent years the project area has not been utilized other than for its

watershed value. Additionally, pig hunting is allowed and encouraged within the area. At present a matrix of dense waiawi (Psidium cattleianum) thickets (canopy height 25-30 ft.) and patches of uluhe fern (Dicranopteris emarginata) form the major vegetation type in the project area. Within this dominant vegetation type few other plant species are able to establish themselves in abundance. Larger trees such as 'ohi'a (Metrosideros collina polymorpha) and planted eucalyptus (Eucalyptus robusta) are found scattered throughout the area along with some koa (Acacia koa). Tree stocking is not sufficient to produce a closed canopy and there were very few trees with large trunk diameter (>3 ft).

Because of the dense understory of waiawi and uluhe, other elements in the shrub and herbaceous layer are not well developed. However, the following species are fairly common throughout the project area: hapu'u 'i'i (Cibotium chamissoi), 'olapa (Chierodendron trigynum), 'alani (Pelea volcanica), hame (Antidesma platyphyllum), Papa'a hekili (Clarromontia paraiflora), thimbleberry (Rubus rosaefolius), palmgrass (Setaria palmifolia), and yellow foxtail (Setaria glauca).

Small patches of California grass (Brachiaria mutica), form a distinctive, though limited vegetation type in forest openings scattered throughout the project area.

The gulches of 'Awehi and Pukihae Streams (and the minor tributary of Pukihae), although dominated by uluhe, do support some of the more noteworthy native plants. In addition to the Cyanea and Stenogyne discussed earlier a patch of Hawaiian moon flower (Ipomea

tuboides) was observed on the banks of 'Awehi Stream.

G. VERTABRATE FAUNA

1. Amphibians and reptiles

The herpetofauna of the Hawaiian Islands consists entirely of recently introduced species. There are no native or endemic forms, nor are any of the various introduced frogs, toads, lizards, snakes or turtles considered to be threatened or endangered species. Within the project area frogs (Rana sp.) and their tadpoles were observed along 'Awehi Stream. The South American "cane toad" (Bufo marinus) is also known to inhabit the general area.

2. Birds

A survey of the avifauna at the project site (and adjacent areas) was conducted by zoologist Matthew D. Hess during the period September 29 through November 9, 1980. A copy of this report is included as Appendix C in this EIS. The following discussion is excerpted from the report. Information was also obtained by field observations during May-June 1981, and a review of the relevant ornithological literature.

The September-November 1980 Bird survey was undertaken using two different sampling methods: i) birds were censused using a systematic, circular plot technique involving 50 sample points on 12 transects covering the project site and

adjacent areas (see Appendix C, Figure 1 page 13); and ii) random searching of the area for incidental sightings of endangered bird species.

The combined systematic and random sampling of the avifauna involved 54 man-hours of direct field observations.

During the survey 10 bird species were encountered (Table III), including 9 exotic species and the endemic 'Elepaio (Chasiempis sandwichensis). Table III also presents statistical estimates of species densities within the project area based on the results of the systematic circular plot sampling. The Japanese White-eye (Zosterops japonica japonica) had the highest estimated density (67.01 birds/100 acres), followed by the 'Elepaio (Chasiempis sandwichensis) with 12.89 birds/100 acres. Other species present had densities ranging from less than 1 to near 6 birds/100 acres. In general the project area was found to be poor in resources for native birds, either for food, shelter or breeding, and the area does not resemble in any context what could be viewed as prime habitat for endemic or endangered bird species. The highest elevation in the project area (2,400 ft.) is approximately 500 feet (altitude) lower than the predominantly native forest where endangered birds are thought to occur. However, these results can not be taken to infer that there are no endangered bird species utilizing the project area, since habitats in these elevations may be differentially utilized in other seasons of the year. A

brief follow-up reconnaissance survey of avifauna was conducted and again in May, 1981, the Japanese White-eye and Elepaio were the most frequently observed species. No new species, beyond those recorded previously (Table III) were encountered in the follow-up survey.

TABLE III. Birds Recorded From Pu'u'eo Mauka During September-November 1980.

SPECIES	Status	Individuals sighted	Estimated Density		95% Confidence Levels Population Density Esti- In Project Area (341 ac)	
			Birds/ 100 Acres	Birds/ 341 Acres	Lower	Upper
House Sparrow (<u>Passer domesticus</u>)	X	23	4.90	16.71	10.57	24.22
N. American Cardinal (<u>Richmondean cardinalis</u>)	X	53	4.33	14.77	11.06	19.000
Japanese White Eye (<u>Zosterops japonica japonica</u>)	X	232	67.01	228.51	200.05	258.86
Elepaio (<u>Chasiempis sandwichensis</u>)	E	40	12.89	43.94	31.38	58.62
Spotted Munia (Rice Bird) (<u>Lonchura punctulata</u>)	X	13	4.03	13.73	7.28	22.21
Red-billed Leiothrix (<u>Leiothrix lutea</u>)	X	7	0.45	1.54	0.61	2.89
House Finch (<u>Carpodacus mexicanus frontalis</u>)	X	5	0.66	2.24	0.70	4.64
Laughing Thrush (<u>Garrulax sp.</u>)	X	2	0.16	0.55	0.05	1.55
Kalij Pheasant (<u>Lochura leucomelana</u>)	X	1	0.03	0.09	0.000037	0.36
Helemeted Guinea Fowl (<u>Numida meleagris galeata</u>)	X	2	5.73	19.53	1.84	55.98

X = Exotic; E = Endemic

Statistical estimates generated from circular plot sampling (see text and Appendix C)

Although not observed within the project area during the surveys two additional bird species with threatened or endangered status must be considered in relation to the proposed development.

The Hawaiian Hawk (Buteo solitarius) or I'o is a federally endangered species found only on the island of Hawaii. The bird ranges widely between sealevel and the 8,500 ft elevation on both Mauna Loa and Mauna Kea (Berger, 1972). The species is frequently seen soaring over agricultural and forest lands along the Hamakua coast and even over urban areas of adjacent Hilo. The Hawk feeds opportunistically on a variety of both native and exotic insects, birds and small mammals (Berger 1972). Hawks may occur periodically within the project area, however, no evidence was found of hawk nesting nor other specialized use of the Pu'u'eo mauka area by this species.

Newell's race of the Manx Shearwater (Puffinus puffinus newelli), or A'o is a seabird endemic to the Hawaiian archipelago. It is designated as a "threatened subspecies" under the U.S. Endangered Species Act (1973). The A'o nests on steep-sided uluhe covered slopes between the months of June and November (Berger, 1972). As a ground nesting species it is particularly vulnerable to introduced predators (rats, mongoose, etc.). It is thought to have originally nested on all the main Hawaiian Islands, however,

Munro (1944) concluded that introduced predators had exterminated the birds from Hawaii, Maui and Molokai. More recently the bird has been found on the Island of Hawaii. Kepler, Jeffrey and Scott (1979), have summarised the recent sightings of this species on the Hamakua coast.

During a 1977 survey of Hamakua coast forest birds A'o were heard calling along 'Awehi stream at an elevation of 1640 ft (near the lower boundary of the project area). A'o were also heard calling at Hakalau Stream approximately 8 miles to the north of the project area, and at two locations in the Kohala Mountains. Several sightings of A'o have also been reported between Papa'ikou and Laupahoehoe, where birds have been attracted to the lights of night-harvesting sugar cane equipment. Kepler, et al., (1979) concluded:

The records, however, do suggest that A'o colonies exist within the Hamakua and Kohala forests, but that these colonies are very dispersed and probably contain few individuals...

There are thousands of hectares of steep, muddy uluhe-covered stream banks within the forest on a windward slopes of Mauna Kea. Much of the ohia forest has died and is covered of additional hectares. Within this area pig densities are relatively low, and mongooses, dogs, cats, and rats are rarely seen, in contrast to forested areas at both higher and lower elevations. We suggest that A'o colonies will be found in this area and in the Kohalas. However, they will be exceedingly difficult to find, and locating them will require luck, hard work, and clues provided by pig hunters and others familiar with the remote forested areas. The location of a possible colony at Makaopuhi Crater (Banko, unpublished manuscript) suggests that pit craters might be reasonable locations in which to search for additional colonies.

During the September-November 1980 bird survey (Appendix C) two evenings were spent in the project area (6:30 - 9:30 pm) looking and listening for nocturnal species such as the A'o, Pue'o (Hawaiian short-eared owl: Asio flammeus sandwichensis), and the Hawaiian Hoary Bat (see following section). Two additional evenings during late May 1981 were also spent listening for A'o along 'Awehi stream. No A'o vocalizations or sightings were recorded during these observation periods. However, this can not rule out the periodic presence of A'o within the project area, or the possibility that the species may nest on the steep, uluhe clad gulches of 'Awehi Stream.

3. MAMMALS

A list of the mammal species potentially occurring within the project area and surrounding agricultural lands is presented in Table IV.

Hawaii's only native land mammal, an endemic race of the North American Hoary Bat (Lasiurus cinereus semotus), may occur within the project area, although it was not seen during the nocturnal avian survey. This species is widely distributed along the Hamakua coast, and is sometimes observed in urban areas of adjacent Hilo. The species also occurs on Kauai and

TABLE IV

Checklist of Mammals Potentially Occuring In The Pu'u'eo Mauka
Area

Common/Scientific name	Hawaiian Name	Status [2]
Hawaiian Hoary Bat <u>Lasiurus cinereus semotus</u>	O Pe'a Pe'a	E
Black Rat [1] <u>Rattus rattus</u>	Iole	X
House Mouse <u>Mus musculus</u>	Iole li'ili'i	X
Feral Dog <u>Canis familiaris</u>	Ilio	X
Indian Mongoose <u>Herpestes auropunctatus</u>	Ilio mana Kule	X
Feral Cat <u>Felis catus</u>	Popoki	X
Feral Pig <u>Sus scrofa</u>	Pua'a	X

Source : Tomich (1969)

[1] The Polynesian Rat (Rattus exulans) may also occur in the project area although it has generally been excluded from areas disturbed by man due to competition with the more aggressive Rattus rattus.

[2] E = endemic subspecies; X = exotic species introduced by man in Polynesian or modern period.

has been seen occasionally on other islands in the archipelago (Tomich, 1975).

With respect to impact on the local ecosystem, the feral pig (Sus scrofa) is probably the most significant mammalian species present in the project area. Pig trails, vegetation destruction and soil disturbances are evident throughout the project area. Pig hunting is encouraged and actively pursued in Pu'u'eo mauka and adjacent forest lands.

H. ARCHAEOLOGICAL/HISTORICAL

An archaeological survey of the project area was conducted by Paul H. Rosendahl, Ph.D., Inc., Consulting Archeologist, on May 27-28, 1981. Dr. Rosendahl and a team of three field archaeologists spent 64 man-hours in a walk-through, reconnaissance survey of the project area searching for surface archaeological features. The following information is excerpted from Dr Rosendahl's survey report which appears as Appendix D in this EIS.

Despite the dense vegetation cover that made it difficult to traverse the survey area--often it was impossible to see more than ten meters ahead--the method utilized to carry out the survey was relatively simple. Beginning at the southeast corner of the area, near 'Awehi Stream, the initial inspection of the survey was made on May 27 by proceeding inland along the main hunter trail adjacent to the abandoned ditch. At irregular intervals, secondary hunter trails and feral pig runs that branched off were followed and the proximate land inspected. In this fashion, the portion of the survey area nearer 'Awehi Stream was explored to the approximate location of the 2200-foot elevation limit. At one point--estimated to be about the 2000-foot elevation--the survey team dropped down to the stream bed of Awehi Stream and inspected the side of the stream area for several hundred meters.

Survey work on May 28 began by heading inland along the same main trail from the southeast corner of the survey areas, but proceeded by bearing further to the north, cutting through the central portion of the survey area. The unnamed tributary of Pukihae Stream was crossed and a trail continued to be broken on into the northwest corner portion of the survey area. The survey team gradually turned and began heading seaward, in the area near Pukihae Stream.

The total number of acres inspected during the reconnaissance cannot be estimated with any degree of accuracy, but it is felt that the two days spent traversing the survey area from the sea-ward to the approximate inland limits, and through both the southern and northern portions of the survey area, comprised a good sampling of the project area. Any more formal sampling strategy would have required considerably greater expenditure of man-hours, and most likely would not have produced significantly different results.

No archaeological remains of any kind were found within the site of the proposed Eucalyptus Biomass Farm during the two days of reconnaissance survey field work. A check of records on file in the Hawaii County Planning Department in Hilo failed to reveal the presence of any previously recorded or known archaeological sites within or immediately adjacent to the survey area. Based on the completely negative results of the reconnaissance survey, it is concluded that no further archaeological work of any kind is necessary or justified, and it is recommended that full

archaeological clearance be granted.

There are no historical buildings or other structures of any kind within the project area. The only man-made feature present on the property (beside hunting trails) is an old sugar plantation diversion ditch which extends for approximately one-half mile along the north edge of 'Awehi Stream. This ditch was constructed around the turn of the century to divert water for cane fluming to Wainaku Mill (closed in 1975), and to provide potable water for mauka cane camps. The ditch has been out of service for almost a decade, is partially collapsed in many places and overgrown by waiawi.

I. EXISTING SOCIO-ECONOMIC CONDITIONS AND INFRASTRUCTURE

At present the project area is not economically utilized except to the extent that watershed values of the site may offer some protection to makai agricultural lands from flooding or erosion.

With the exception of the abandoned water diversion ditch there are no existing structures at the site, nor are utilities available.

'Amauulu Road, a privately owned (Mauna Kea Sugar Co.) gravel base cane haul road extends from sealed country roads in the Pu'u'eo area to the makai boundary of the project site (see Figure 1).

III THE RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS,
POLICIES AND CONTROLS FOR THE AFFECTED AREA

The 341 acre Pu'u'eo area (TMK 2-6-18:08) proposed for eucalyptus biomass farming is within the Hilo Forest Reserve, and is designated a Conservation District by the State Land Use Commission. The present Regulation 4, administered by the Department of Land and Natural Resources provides for land use within the Conservation District, sub-zones, uses, appeals, enforcement and penalty, pursuant to Chapter 183-41 HRS, as amended, and identifies the 341 acre area as occupying two sub-zones, Protective (P) and Resource (R). Most of the parcel is in the Resource subzone of the Conservation District (see Figure 2), and the growing and harvesting of forest products is a conditionally permitted use in this subzone. According to Department of Land and Natural Resources maps (Figure 2) a small portion of the project area (approx. 25-30 acres) is included within the Protected subzone of the Conservation district. This Protected subzone was declared in earlier years to insure the quality of potable, surface water sources utilized by mauka cane camps in the 'Amaula - Wainaku area. Today these camps have either been abandoned or are now serviced by County well-water. Surface water sources in this area of the Hilo Forest Reserve are no longer utilized for domestic supply.

In addition, it appears that cartographic errors may have been incorporated in the delineation of this Protected subzone, since the subzone boundaries do not conform to the major drainage

alignments in the area (see Figure 2). In any event, this Protected subzone designation now appears obsolete. Because the existing forest will not be cleared from a buffer zone along 'Awehi and Pukihae Stream, or above 2500 ft. elevation, very little of the Protected subzone (less than 10 acres) would be affected by the biomass project (Figure 2).

IV THE PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT AND MITIGATION MEASURES PROPOSED

The impacts of the proposed eucalyptus biomass farming on the site environment, surrounding lands, and general socio-economic conditions are discussed below along with measures proposed to mitigate adverse environmental impact.

A. IMPACT ON SOIL AND WATER RESOURCES

The project area lies within a high rainfall zone, and steep sided gulches with permently flowing streams border the site. Clearing of the site for eucalyptus planting could be expected to increase the soil erosion hazard, and any modifications to the existing drainage system could pose a threat of downstream flooding, erosion or water quality deterioration (e.g. siltation), unless adequate soil and water conservation measures are adopted.

In order to protect the soil and water resources of the project area the steep sided gulches of 'Awehi and Pukihae Streams (and the Pukihae tributary) will not be cleared or distrubed. In addition a 25ft wide vegetation buffer will also be left in place on the gentle sloping terrain immediately adjacent to the gulch tops to insure that clearing and grading operations do not inadvertently disturb potentially unstable gulch slopes (see Figure 2). That portion of the project area above the 2300 ft contour (approximately 25-30 acres) will also be left as a natural vegetation buffer protecting the area makai of Wailepua Springs (just outside the project boundary) and

Wahiloa Falls. It is important to emphasize that clearing and tree planting of the project area will proceed incrementally over a 3-5 year period (see page 20), so that at no time will the entire site be devoid of vegetative cover. Likewise subsequent timber harvesting and replanting will proceed incrementally and the project area will be characterized by a mosaic of different aged eucalyptus stands. Complete canopy closure of the rapidly growing eucalyptus seedlings is achieved in 9-12 months, substantially reducing the soil erosion hazard.

Either tree or herbaceous non competitive legumes (such as Albizia falcataria or Vicia desvcarpa) may be interplanted with the eucalyptus, both for ground cover erosion control and nitrogen fixation. Studies as to the benefits of such interplanting are as yet inconclusive (BioEnergy Development Corp. 1980). In order to minimize soil compaction and the short term erosion hazard during the actual clearing and grading phase specialized filed equipment will be utilized. A D-6 low ground pressure crawler tractor or comparable unit with swamp shoes or track growers 36" in width, for improved flotation, will be used to clear and windrow vegetative material across the slope. Natural drainage features of the site will not be obstructed and windows will be positioned to inhance any conservation ditches recommended by the Soil Conservation Service as agreed to in a cooperative work plan required to obtain a grading permit under County Ordinance.

A month to six weeks after land clearing the area will be sprayed with the herbicide Roundup, a systemic herbicide which is taken in through foliage and roots. Regrowth is allowed for another 5-6 weeks before another application of Roundup is applied. The use of Roundup and other herbicides and pesticides for plant, insect and animal control causes short-term contamination of the soil. All agricultural chemical usage is strictly regulated by policies of the U.S. Department of Agriculture and only certain approved chemicals may be used at approved application rates. While this in itself does not provide total safeguard against any adverse environmental effects, it does minimize the chances of it occurring. It is anticipated that planned weed control will be most needed during the first year of tree growth, after which time shading from tree limbs and fallen leaves would provide a natural control.

Planting of eucalyptus seedlings will begin approximately two weeks after the second spraying of Roundup and will be done by hand. Tools called dibblers are used by the planters to create a hole into which the seedling is placed. Planting by hand should have no adverse impacts on the soil.

Harvesting may involve two methods of tree felling. A unit called a feller buncher is proposed for trees under 18" in diameter and located on suitable ground. It consists of a large loader with a tree-shear attached to the front. The unit pulls up to a tree, clamps it, then shears it off. Because BDC's trees are not expected to be much larger than 10" or 11" in diameter at the time of harvest, the feller-buncher can accumulate several trees before laying the load

down in a pile.

The second method of felling trees would be to use chain saws for trees in areas not suitable for the feller-buncher.

Transporting the felled trees to be loaded onto waiting trucks may be accomplished through two means. A skidder or brush hog, either tracked or wheeled, can pick up a load of trees with its grapple and drag them out. If the area is not suitable for skidders then a high-line or cable-skidder can be used. For cable skidding, a portable tower is used from which cables are laid out over the logging area. The logs are attached to the cables and then pulled back to the tower area.

As ground disturbance will occur harvesting time, BDC in cooperation with SCS will develop a harvesting plan prior to any logging. Some compaction and erosion may result from heavy equipment usage. Also, should skidders be used to drag the trees out, some erosion, compaction and displacement of soil will occur. Cable-skidding would cause less ground disturbance. The eucalyptus and the legumes to be interspersed both have the ability to coppice thus the stumps left after cutting and subsequent shoots will aid in controlling erosion by reducing the time that the soil is exposed to direct rainfall. The mat of leaves, the cover crop, if planted, and other vegetation left in the field will also help to minimize erosion.

The effect of BDC's field operations on water quality and availability is expected to be minimal. As no impoundments, irrigation or stream diversions are planned for either Ka'u or

Hamakua, there should be no effect on water availability should there be any downstream users. During periods where little or no vegetative cover exists in the fields, some increased runoff, sedimentation and turbidity may occur in the few streams that immediately bound the project area, however, the proposed vegetation buffer zones within and along gulches should minimize this adverse environmental impact. Other potentials for water quality degradation may exist, for example, localized algae bloom on streams caused by runoff from nitrogen fertilizers, and stream and water table contamination from any chemical runoff or absorption. However as previous, more intensive usage of agricultural chemicals and fertilizers for adjacent sugarcane cultivation resulted in no such problems, it is anticipated that no deleterious effects on water quality will be caused by BDC's operations. Again chemical usage is strictly controlled by USDA regulations with only approved chemicals permitted and only at recommended application rates.

B. IMPACT ON AIR QUALITY

The proposed biomass farming and woodchip combustion is not expected to have any adverse, longterm effect on regional air quality, however, temporary, localized and generally minor negative impacts may occur during the development and operation of this project. Fugitive dust associated with land clearing and timber harvesting is expected to be slight due to the continuously wet ground conditions in the project area. Smoke from prescribed burning would result in temporary localized air pollution, however, little or no burning is anticipated in any of the clearing or harvesting phases at Pu'u'eo mauka so the threat to air quality is expected to be minimal. Should any occasional burning be required, agricultural burning permits would be sought in compliance with State Department of Health regulations.

Windblown dust from driving on haul roads, and vehicle and field equipment exhaust will contribute to minor temporary air pollution which is unavoidable, but generally remote from residential areas.

When the wood chips are burned at the Pepe'ekeo Sugar Factory several particulate emissions control systems are available for air pollution abatement.

Wood chip energy will be used to lessen dependence on imported fuel oil at the Pepe'ekeo factory. As wood chips are comparatively low in sulfur, burning this material would result in fewer sulfur oxides being emitted into the atmosphere.

C. IMPACT ON NOISE

Noise pollution should not be a significant factor in the proposed operation as the project area is situated away from residential areas. Adjacent forest and canefields will serve as a noise buffer. Logging trucks transporting trees to the Pepee'okeo power plant will be a periodic source of noise along haul roads and public highways. All relevant State and Federal noise abatement regulations will be followed.

D. IMPACT ON NATIVE FLORA AND VEGETATION

Pu'u'eo mauka does not support a unique, distinctive or intact native forest ecosystem, rather exotic plant species predominate in the project area. Clearing of the site and replanting with eucalyptus will result in the removal of a number of native plants inhabiting the area, except in the gulch and mauka buffer zones (see Figure 2) where the existing vegetation will be left undisturbed. No currently endangered plant species occur within the project area. However, two species under consideration for possible endangered species status are reported from the site. One individual of the native mint Stenogyne scrophularioides and possibly a few individuals of Cyanea sp. occur in the small tributary gulch of Pukihae Stream (see Figure 2). These habitats and plants will not be disturbed by the proposed development as gulch vegetation (and a 25 ft wide buffer zone on either side) will be left intact.

Of additional environmental concern is the extent to which the proposed development might compromise the ecological integrity of adjacent ecosystems within the Hilo Forest Reserve. The impact of the development in this regard is expected to be minimal for the following reasons:

1. Undisturbed native forest does not occur immediately adjacent to the project area, rather these adjacent forests are either planted eucalyptus forest or disturbed forest similar to that of the project area.
2. The aggressive exotic waiawi currently dominant in the project area will be replaced by eucalyptus which does not rapidly invade native forest.
3. The natural buffer zones of 'Awehi and Pukihae Streams and the mauka buffer zone above 2500 ft will help to minimize the impact of the project on surround plant communities (either native or exotic).
4. Weed control programs (herbicide application) and the natural suppression of weed species under closed canopy eucalyptus forest will restrict the area as a seed source for weedy species.

A further, long-range consideration of the project's impact on native forest relates to the fact that it is part of a larger, joint BDC - USDA research and development demonstration project to determine the economic and technical feasibility of employing eucalyptus biomass plantations for energy production in Hawaii. Should this demonstration phase prove successful there is the implication of large scale (thousands of acres) eucalyptus planting in the future to meet growing local energy needs and lessen dependence on imported oil. Such an eventuality could increase pressure in the future for the conversion of native forest lands to biomass plantations. However, existing State and Federal regulations, as well as strict EIS requirements on a case by case basis, seem adequate to insure that any future development proposals would be unlikely to proceed if shown to seriously compromise the integrity of native ecosystems, or the critical habitats of endangered species. The Pu'u'eo mauka parcel, although within the Hilo Forest Reserve, does not support (or abut) an intact native forest ecosystem. As such, its development for eucalyptus biomass farming would not represent a precedent for future large scale native forest conversion.

E. IMPACT ON NATIVE FAUNA

Only a single species of native bird, the 'Elepaio (Chasiempis sandwichensis) is know to be resident within the project area. During September-November 1980 the total population of this species within the subject parcel was estimated to range between 31-59 individuals (see Table III). The 'Elepaio is one of the most common species in the remaining native avifauna, and is still widely distributed on the

island of Hawaii and other islands of the archipelago. Most 'Elepaio will be unavoidably displaced by the proposed development, although reduced populations of this species are likely to maintain themselves in the various vegetation buffer zones provided for in the project.

The impact of the proposed development on the endangered Hawaiian Hawk (Buteo solitarius) is thought to be minimal. The Hawk is known to hunt over both native forest and agricultural lands on the Hamakua coast. The project area will ultimately be characterized by a mosaic of different aged eucalyptus stands, and as a potential hunting ground for this avian predator will probably be no better or worse than the existing waiawi-uluhe dominant vegetation.

The A'o, or Newell's Shearwater (Puffinus puffinus newelli), a federally designated threatened subspecies of the Manx Shearwater has on two occasions (in 1977) been heard calling along 'Awehi Stream. Whether this secretive species may currently nest in the area is unknown. The bird feeds at sea during the day, departing before dawn and returning after dusk. Nesting burrows appear generally restricted to steep-sided uluhe clad gulches. These factors make detection of the species difficult. Any impact on the A'o resulting from the proposed development is expected to be minimal because the gulch vegetation along both 'Awehi and Pukihae Streams will be left intact. If A'o are currently nesting in the area, they are doing so in spite of the fact that eucalyptus forest already dominate the southern edge of 'Awehi Stream, and sugar cane fields also abut the gulch. It is perhaps significant that the eucalyptus biomass field operations, unlike sugar cane harvesting, will not involve night-time field

activities. Thus, night time noise, light, and vibration associated with field equipment will not be a disturbance factor for any possible A'o breeding colonies in the area. Should A'o breeding sites be discovered in the future in gulches bordering the project area, it would be a relatively easy matter to adjust field work schedules to minimize disturbance adjacent to such sites during the breeding season.

F. SOCIAL/ECONOMIC IMPACT OF THE PROJECT

The proposed eucalyptus biomass farming at Pu'u'eo mauka is part of a larger 5 year joint co-operative program between BDC and the USDA to development 900 acres (in Ka'u and Hamakua) as a biomass demonstration project. During 1979 and 1980, 300 acres of marginal sugar cane land and pasture have been planted to eucalyptus with no visible impact on the islands social infrastructure, except that jobs have been generated. BDC budgetary expenses in 1980 were \$555,875 including 240,288 in salaries, wages and payrole benefits for 19 employees. The proposed expansion of eucalyptus farming at Pu'u'eo mauka will provide for continuing employment of BDC staff over the next three years and facilitate continuation of the Joint BDC-USDA biomass demonstration program.

More significant by far is the possible outcome of a larger commercially viable bioenergy resource development that could grow out of the present research and development project. The following section considers the benefits and costs of biomass energy development on the Hamakua coast at large and is not limited to the impact on the proposed project site at Pu'u'eo.

1. Potential social benefits
 - a) An indigenous energy source

Because Hawaii imports 92 per cent of its energy needs from foreign crude oil sources, Hawaii is particularly vulnerable to the recurrence of an oil crisis or to any similar international political ramification. In addition, the geographical isolation of Hawaii from continental U.S. negates many advantages which other states have. There is no electric power grid with adjacent regions or states; there are no oil or gas pipelines connected to other localities. For these reasons Hawaii should pursue the development of indigenous energy resources. An indigenous power source, such as biomass energy conversion, would substitute for oil thereby possibly reducing costs of energy and reducing economic uncertainty.

- b) Economic growth: more jobs, more state revenue

The extent to which the commercial forest resource development would contribute to the economic growth of the County of Hawaii and create jobs and income for the residents of the Hamakua district largely depends on the level of the development effort. It is entirely possible that the forest industry can be developed for three types of final products: commercial lumber, wood chips for pulp, and biomass fuel for energy conversion. All three products, however, will require land clearing, planting, harvesting, chipping, and transportation activities. Because forest production is a labor intensive industry, it offers greater opportunities both in the initial development stage and

after the full development of the industry.

Direct economic benefits would be gained by those who are employed in land clearing, planting, harvesting, etc. Benefits would also be gained by owners of forest lands, by state and local governments in various revenues, and by the customers of Hawaii electric and light companies through lower cost of power. Indirect stimulation of employment and income from such sectors as transportation and construction would be particularly helpful in broadening the narrow economic base of the island's economy.

2. Potential social costs

Any expanded forest resource development project will invariably require increased expenditures for infrastructure requirements. This public expenditure may, at least initially, offset any increase in public revenue realized from the development.

V PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The probable adverse environmental effects of the proposed eucalyptus development project are identified in Section IV along with mitigation measures proposed. These unavoidable adverse effects are summarized below.

1. Some soil compaction and soil erosion will be associated with clearing and harvesting operations in the project area. Temporary increased siltation of minor drainage tributaries will also be unavoidable during these field operations. After initial tree planting, however, disturbance associated with harvesting in any specific area will occur only at 5-7 year intervals.
2. Although the project area is dominated by an exotic flora and fauna, native plants and animals present in the area will be destroyed or displaced by land clearing and eucalyptus replanting, except in those buffer zones where the existing biota will be left undisturbed.
3. Short term temporary air, water, and noise pollution will result from vehicle and field equipment use, hauling of trees to Pepe'ekeo Sugar Factory, and the use of prescribed herbicides, and fertilizers.

VI ALTERNATIVES TO THE PROPOSED ACTION

A. NO ACTION

A no-action alternative would place in jeopardy the continuation of the ongoing, joint BDC-USDA eucalyptus biomass demonstration project, as only 300 of the programmed 900 acres are as yet developed. The subject parcel at Pu'u'eo mauka is planned to provide for about half of the remaining 600 acres to be planted over the next three years. A no-action alternative would remove one important option (eucalyptus biomass) in the quest for alternative energy development and make it more difficult to achieve goals established by the State and County Government to increase energy self sufficiency for Hawaii.

B. ALTERNATIVE LOCATIONS FOR EUCALYPTUS BIOMASS FARMING

Other areas of marginal cane land and wasteland under the ownership or control of BDC (and its parent Company C. Brewer Ltd.) are already being developed into demonstration and experimental eucalyptus plantations. It is a BDC objective to get as much of this marginal land as possible into productive tree farming use over the years ahead. During 1979-80, 11 land parcels in both Ka'u and Hamakua, ranging in size from 2.4 - 66.1 acres (totalling 293.5 acres; see Table I) were planted to eucalyptus. However, the definition of "marginal cane land" can change with the fluctuating economics of the sugar industry, and current high sugar prices coupled with plans for a large scale ethanol plant on the Hamakua coast have increased pressure to maintain "marginal" fields in cane production for the foreseeable future. These events have restricted the available alternative

locations for expanding eucalyptus biomass farming. No other BDC controlled land parcels possess the combination of positive attributes which make the Pu'u'eo mauka site so ideal for eucalyptus biomass farming. These positive attributes include:

1. large size of parcel
2. idle land brought into productive use
3. adjacent to ongoing eucalyptus biomass farming operations
4. proximity to the Pepe'ekeo power plant
5. no conflict with other agricultural interests (i.e. does not involve removing cane land from production).
6. under general zoning restrictions the proposed activity (tree farming) is a conditionally permitted use of lands within the Conservation District.
7. unique or endangered native Hawaiian ecosystems/species are not significantly threatened.

VII THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

The proposal for eucalyptus biomass farming on 341 acres at Pu'u'eo mauka, because it is part of a demonstration project, can be considered a local short-term use of our environment. However if the demonstration phase proves successful then sustained yield eucalyptus biomass farming of the parcel would continue into the future enhancing the longterm productivity of the area. Since the eucalyptus biomass farming will also generally maintain the watershed values of the subject area the proposed action does not represent a significant trade-forf of short term exploitation at the expense of long-term productivity and environmental quality.

VIII IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Land, federal funds, human labor, herbicides and fertilizers, heavy equipment, construction materials (e.g. for roads) and fuel will be committed to the project. Energy commitments will be retrievable through the sustained yield of eucalyptus biomass at the site. Use of the site for commercial forestry will continue for as long as eucalyptus biomass is a viable energy source in Hawaii.

IX OTHER INTERESTS AND CONSIDERATIONS THOUGHT
TO OFFSET ADVERSE ENVIRONMENTAL EFFECTS

The goal of the proposed action as part of a project to demonstrate the feasibility of eucalyptus biomass farming, conforms with stated Federal, State and Hawaii County government objectives of developing alternative energy resources that would reduce dependence on fossil fuel imports, thus encouraging greater energy self-sufficiency. Additionally, a viable eucalyptus biomass industry on the Island of Hawaii would increase employment opportunities and reduce economic uncertainty. These potential benefits are considered to offset the relatively minor adverse environmental effects of the proposed action.

X LIST OF NECESSARY APPROVALS

1. Conservation District Use Permit - Department of Land and Natural Resources
2. Grading Permit - County of Hawaii

The project area does not fall within a Special Management Area (SMA), so requirements established under Chapter 205-A, HRS, and Rule 9 of the Hawaii County Planning Commission are not Applicable (see Appendix E).

XI AGENCIES ORGANIZATIONS AND PERSONS CONSULTED IN THE
PREPARATION OF THIS EIS

The following persons, firms and agencies were contacted for professional services and/or specialized advise on the various aspects of this EIS:

Paul H. Rosendahl, Ph.D. Archaeologist	Archaeological Reconnaissance survey
Matthew D. Hess, Zoologist	Bird Survey
Winona Char, Layne Yoshida and Garvin Clarke, Botanists	Flora/Vegetation survey
Y.K. Hahn, Ph.D. Economist	Socio-economic impact
Jerry Williams, Conservationist U.S. Soil Conservation Service	Soil survey
Sydney Fuke, Director Planning Department, County of Hawaii	General comments
State of Hawaii Dept. of Land and Natural Resources	Environmental concerns and guidelines for EIS preparation, status of Protected subzone.

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APPENDIX A: SOIL SURVEY



United States
Department of
Agriculture

Soil
Conservation
Service

P. O. Box 1089
Kamuela, HI 96743

6/26/81
BDC 2-6-18:8
1 copy for
you
2 in file
it
more
JWB

SUBJECT:

DATE: 6-25-81

TO: Mr. Thomas Crabb, Project Manager
Bioenergy Development Corporation
P. O. Box 1801
Hilo, Hawaii 96720

Mr. Crabb:

The soil survey report requested by Bioenergy Development Corporation for T.M.K. 2-6-18:8 in Amaulu Mauka is enclosed. Three copies have been prepared for your use. Additional copies can be supplied if you need them.

Please contact this office if you have any questions regarding the report. We trust it provided you with the information you need.

Jerry Williams

Jerry Williams, Conservationist
U.S.D.A., S.C.S.
P. O. Box 1089
Kamuela, Hawaii 96743

Encl.



SOIL SURVEY
AMAUULU MAUKA
BIOENERGY DEVELOPMENT CORPORATION

Prepared by Soil Conservation Service
June 1981

This soil survey is for the 341-acre parcel zoned Conservation and the land below the Forest Reserve boundary currently used for biomass tree planting.

Elevations range from about 1,500 to 2,300 feet. Annual rainfall ranges from 250 to 275 inches. The mean annual soil temperature is estimated between 66°F. and 68°F. Fog and cloud cover are common.

The area within the conservation zone is densely covered with rainforest-type vegetation including tree fern, ohia, uluhe and other ferns. Eucalyptus robusta and a dense growth of waiwe occur in the area just above the Forest Reserve boundary. The soils are almost entirely those of the Akaka series. Dominant slopes are 6 to 10 percent, with steeper slopes along the gulches.

The area currently used for biomass tree planting consists of Akaka and Kaiwiki soils. Slopes are dominantly 3 to 8 percent.

Akaka and Kaiwiki are deep soils. They are formed in volcanic ash under high rainfall. The Akaka soils are somewhat poorly drained and the Kaiwiki soils are well drained. Both Akaka and Kaiwiki soils are suitable for growing a wide variety of trees. They have low bearing capacity and machinery tend to bog down under wet conditions.



UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

cooperating with
Mauna Kea

Conservation District

OUR SOIL * OUR STRENGTH

Owner _____
Operator BioEnergy Development Corp.

Plan No. _____ Date June 1981
Scale 1"=1,200' Acres 341+

Approximate

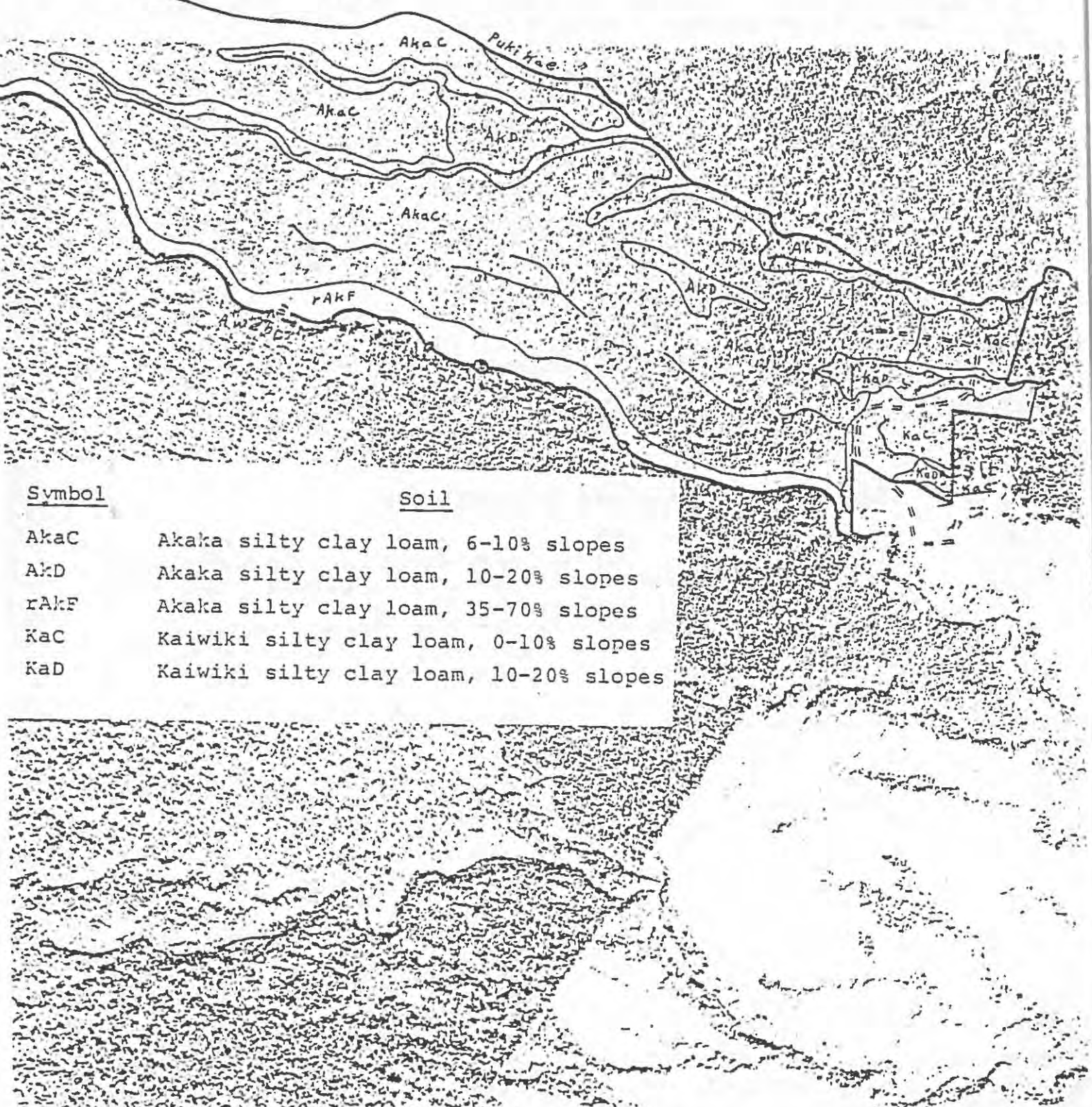
Hawaii

County

Hawaii

State

Photo No. _____



Symbol

Soil

- AkaC Akaka silty clay loam, 6-10% slopes
- AkD Akaka silty clay loam, 10-20% slopes
- rAkF Akaka silty clay loam, 35-70% slopes
- KaC Kaiwiki silty clay loam, 0-10% slopes
- KaD Kaiwiki silty clay loam, 10-20% slopes

DESCRIPTION OF SOILS

Akaka Series

The Akaka series consists of deep, moderately well drained silty clay loam soils formed from volcanic ash. They occur at the upper fringe of the sugarcane land, but primarily within the forested area. Elevations range from 1,000 to 4,500 feet. Mean annual rainfall ranges from 150 to 300 inches. Cloud and fog are prevalent throughout the year.

In a typical profile, the surface layer is dark reddish brown silty clay loam about 15 inches thick. The subsoil is reddish brown to dark reddish brown silty clay loam more than 57 inches thick. The surface layer is strongly acid and the subsoil is strongly acid to medium acid. The subsoil is moderately to strongly smeary. Water moves through the soil rapidly (6 to 20 inches per hour). Roots can penetrate to a depth of over 5 feet.

This soil is usually moist. When allowed to dry, it hardens irreversibly to fine gravel-size aggregates. This soil has low bearing capacity. Heavy equipment will tend to bog down.

Akaka soils are suited to growing a wide variety of trees.

AkAC Akaka silty clay loam, 6 to 10 percent slopes.

This is moderately sloping soil. The erosion hazard is slight. Included are small boggy areas. Also included are small areas with up to 15 percent slopes. This soil is suited to grow trees.

AkD Akaka silty clay loam, 10 to 20 percent slopes.

This soil occurs on moderately steep to rolling topography and is dissected by streams. There are small depressions which remain waterlogged for long periods. The erosion hazard is moderate. Small areas are moderately eroded. Included are areas of steeper slope along gulches. This soil is suited to grow trees. Use of machinery and planting should be across the slope or on the contour. Slope and low bearing capacity make use of machinery somewhat difficult.

rAkF Akaka silty clay loam, 35 to 70 percent slopes.

This soil occurs on very steep gulch sides. In places, slopes are steeper than 100 percent. Rock outcrop occurs in a few places. The erosion hazard is severe. Disturbance of the natural vegetation and the soil should be avoided.

Kaiwiki Series

The Kaiwiki series consists of deep, well drained silty clay loam soils formed from volcanic ash. Elevations range from 800 to 1,500 feet. Mean annual rainfall ranges from 150 to 200 inches.

In a typical profile, the surface layer is dark brown silty clay loam about 15 inches thick. The subsoil is dark brown and dark reddish brown silty clay loam about 48 inches thick. The surface layer is very strongly acid and medium acid. The subsoil is medium acid to strongly acid. Water moves through the soil rapidly (6 to 20 inches per hour). Roots can penetrate to a depth of over 5 feet.

The soil is usually moist. When allowed to dry, it hardens irreversibly to fine gravel-size aggregates. This soil has low bearing capacity. Heavy equipment will tend to bog down.

Kaiwiki soils are suited to growing a wide variety of trees.

KaC Kaiwiki silty clay loam, 0 to 10 percent slopes.

In most places this soil is gently sloping with dominant slopes of 3 to 8 percent. The soil is dissected by narrow drainageways. The erosion hazard is slight. This soil is suited to growing trees.

KaD Kaiwiki silty clay loam, 10 to 20 percent slopes.

This is a moderately steep soil. The erosion hazard is moderate. Included are steeper slopes along gulches. This soil is suited to growing trees, but use of equipment is somewhat difficult.

APPENDIX B: FLORISTIC SURVEY

FLORISTIC ASSESSMENT
IN THE
PUUEO FOREST RESERVE

November, 1980

Winona Char
Layne Yoshida

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INTRODUCTION

An environmental assessment of the vegetation of the study area was conducted during November 1980. The major portion of the field work was conducted from November 6 to November 9 by Winona Char and Layne Yoshida.

The study site consists of approximately 300 acres in the Puueo Forest Reserve and is bounded on the south by 'Awehi' Stream and on the north by 'Pukihae' Stream. The elevation of the study site is between 1600 and 2400 ft. A trail that parallels 'Awehi' Stream was used to gain access to the southern boundary of the study site, while two minor unnamed streams were used as access trails to the central portion of the study area. There were no recognizable trails to be found on the eastern boundary and access was gained by cutting a trail paralleling 'Pukihae' Stream.

Since the main objective of this study was to provide an assessment of the vegetation in the area, notes were only made on the dominant vegetation types and species present. No attempt was made to estimate the percentage cover of each species within the study site.

METHODOLOGY

Prior to fieldwork, topographic maps were examined for possible access routes and trails. A walk-through survey method covering the most acreage was employed. Notes were made on the vegetation types and on the different species (taxa) encountered. Any vegetative associations appearing to be different were searched for unique or rare taxa.

Collections were made of plants which could not be positively identified in the field and were later determined in the laboratory at the University of Hawaii Herbarium. Voucher specimens of some of the plants collected have been deposited at the U. H. Herbarium.

DISCUSSION

The vegetation in the study area is highly disturbed (adjoining areas were once used for grazing cattle) and the dominant taxa throughout much of the area are waiawi (*Psidium cattleianum*), an exotic, and uluhe (*Dicranopteris emarginata*), a native fern. The vegetation types encountered during this survey are similar to other areas of highly disturbed vegetation at the same elevations along the Hamakua coast.

A matrix of closed waiawi scrub and uluhe patches form the major vegetation types within the study area. In these types of vegetation only a few other species are able to establish themselves. Larger trees such as 'ohi'a (*Metrosideros collina* ssp *polymorpha*), *Eucalyptus* (planted) can be found scattered throughout the area, along with some koa (*Acacia koa*). Several minor vegetation types in the area include small patches of California grass (*Brachiaria mutica*) and stands of *Eucalyptus* (mostly *Eucalyptus robusta*). Besides 'ohi'a and koa other native species found throughout the study area are hapu'u 'i'i (*Cibotium chamissoi*) hame or mehame (*Antidesma platyphyllum*) and kopiko (*Psychotria hawaiiensis*). Papa'a hekili (*Clermontia parviflora*), a native member of the Lobelia family, becomes occasional at elevations above 2000 ft.

Several taxa encountered during the survey could not be identified to the species level because they were either immature or without flowers. The only one which has a high probability of being on the Proposed Federal Register of Endangered Species is the *Cyanea* sp., Several individuals of this taxon were located along the small stream that passes through the central portion of the study site. The plant appears to grow only in dense shade along the steep stream bank.

SUMMARY

Only the 'Awehi' Stream area appears to have been botanized in the past and in searching the herbaria at the University of Hawaii, Manoa and Bishop Museum no rare or endangered taxa from the study area were located.

During the course of this survey no rare or endangered species were found and the vegetation types within this 300 acre area are not unique. The planned development of this area will not cause any significant damage to the total island population of any of the species involved.

CHECKLIST OF VASCULAR PLANTS
'AWEHI, HAWAI'I

As the primary objective of this survey was to prepare an environmental assessment of the study area, rather than to make an exhaustive search solely for plant species, the list is not considered to be complete.

Plant families are listed alphabetically within each of three groups: Pteridophyta (ferns) and fern allies, Monocotyledonae, and Dicotyledonae. For each species the following information is provided:

1. Scientific name with the author of that name
2. Common name or Hawaiian name, when known
3. Status of the species
 - E = endemic to the Hawaiian Islands, i.e. occurring naturally nowhere else in the world
 - I = indigenous, i.e. native to the Hawaiian Islands but also occurring naturally (without the aid of man) elsewhere
 - X = exotic, i.e. plants of accidental or deliberate introduction after the Western discovery of the Hawaiian Islands
 - P = Polynesian introduction; it includes those plants brought by the Polynesian immigrants prior to Captain Cook's discovery of the Hawaiian Islands.

Taxonomy and nomenclature of the pteridophytes follows Wagner's unpublished "Checklist of Hawaiian Pteridophytes" except where more commonly accepted names or more recently published names are listed. Taxonomy and nomenclature of the flowering plants (Monocotyledonae and Dicotyledonae) follows St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or with St. John (1973).

PTERIDOPHYTA AND FERN ALLIES

ADIANTACEAE		
Adiantum capillus-veneris L.	'Iwa'iwa	I
ASPIDIACEAE		
Athyrium sandwichianum Presl	Ho'i'o	E
Elaphoglossum alatum var. parvisquamatum (Skotts.) Anderson & Crosby	'Ekaha	E
Elaphoglossum hirtum (Swartz) Christensen	'Ekaha	E
ASPLENIACEAE		
Asplenium contiguum Kaulf.		E
Asplenium lobulatum Mett.		E
BLECHNACEAE		
Blechnum orientale L.	Blechnum	X
DAVALLIACEAE		
Nephrolepis cordifolia (L.) Presl	Ni'ani'au, 'okupukupu, narrow sword fern	I
Nephrolepis exaltata (L.) Schott	Pamoho	I
DICKSONIACEAE		
Cibotium chamissoi Kaulf.	Hapu'u 'i'i	E
Cibotium splendens (Gaud.) Krajina	Hapu'u pulu, pepe'e	E
GLECHENIACEAE		
Dicranopteris emarginata (Brack.) Robinson	Uluhe	I
Hicriopteris pinnata (Kunze) Ching	Uluhe-lau-nui	I
GRAMMITIDACEAE		
Adenophorus hymenophylloides (Kaulf.) H. & G.	Pai, palai-la'au	E
Adenophorus sarmentosus (Brack.) Wilson		E
Adenophorus tamariscinus (Kaulf.) H. & G.	Wahine-noho-mauna	E
Grammitis hookerii (Kaulf.) Copel.	Maku'e-lau-li'i	I
Grammitis tenella Kaulf.	Kolokolo, mahinalua	E
HYMENOPHYLLACEAE		
Callistopteris baldwinii (D. C. Eaton) Copel.		E
Mecodium recurvum (Gaud.) Copel.	'Ohi'a ku	E
Sphaerocionium obtusum (H. & A) Copel.	Palai-lau-li'i	E

LINDSAEACEAE		
Sphenomeris chusana (L.) Copel.	Pala'a, pala-pala'a	I
LYCOPODIACEAE		
Lycopodium cernuum L.	Wawae-iole	I
Lycopodium phyllantum H. & A.	Wawae-iole	I
OPHIOGLOSSACEAE		
Ophioglossum pendulum L.	Laukahi, puapua-moa	I
POLYPODIACEAE		
Pleopeltis thunbergiana Kaulf.	'Ekaha-akolea, pakahakaha	I
PSILOTACEAE		
Psilotum complanatum Swartz	Moa, pipi	E
Psilotum nudum (L.) Beauv.	Moa	I
SELAGINELLACEAE		
Selaginella arbuscula (Kaulf.) Spring	Lepelepe-a-moa	E
THELYPTERIDACEAE		
Christella dentata (Forssk.) Brownsey & Jermy	Downy woodfern	X
<u>MONOCOTYLEDONAE</u>		
ARACEAE		
Colocasia esculenta var. antiquorum (Schott) Hubb. & Rhed.	Taro, kalo	P
COMMELINACEAE		
Commelina diffusa Burm. f.	Honohono	X
CYPERACEAE		
Cyperus haspan L.		X
Cyperus polystachyus Rottb.		X
Eleocharis obtusa var. gigantea (Clarke) Fern.	Kohekohe, pipi-wai	I
GRAMINEAE		
Axonopus compressus (Sw.) Beauv.	Broad-leaved carpetgrass	X
Brachiaria mutica (Forsk.) Stapf	Californiagrass, paragrass	X
Coix lachryma-jobi L.	Job's tears, kukae-kolea	X
Oplismenus hirtellus (L.) Beauv.	Basketgrass, hono-hono-kukui	X

GRAMINEAE (continued)		
<i>Panicum repens</i> L.	Quackgrass	X
<i>Paspalum conjugatum</i> Berg.	Hilo grass, mau'u-	
	Hilo	X
<i>Paspalum orbiculare</i> Forst. f.	Ricegrass, mau'u-	
	laiki	X
<i>Sacciolepis indica</i> (L.) Chase	Glenwoodgrass	X
<i>Setaria glauca</i> (L.) Beauv.	Yellow foxtail	X
<i>Setaria palmifolia</i> (Koen.) Stapf	Palmgrass	X
LILIACEAE		
<i>Astelia menziesiana</i> Sm.	Pa'iniu	E
<i>Smilax sandwicensis</i> Kunth	Hoi-kuahiwi, aka-	
	'awa	E
MUSACEAE		
<i>Musa X paradisiaca</i> L.	Mai'a, banana	P
ORCHIDACEAE		
<i>Arundina bambusaefolia</i> (Roxb.) Lindl.	Bamboo orchid	X
<i>Epidendrum</i> sp.	Epidendrum	X
PANDANACEAE		
<i>Freycinetia arborea</i> Gaud.	'Ie'ie	E
ZINGIBERACEAE		
<i>Hedychium flavescens</i> Carey	Yellow ginger, 'awapuhi melemele	X
<u>DICOTYLEDONAE</u>		
AQUIFOLIACEAE		
<i>Ilex anomala</i> H. & A.	Kawa'u	E
ARALIACEAE		
<i>Cheirodendron trigynum</i> (Gaud.) Heller	'Olapa	E
BIGNONIACEAE		
<i>Spathodea campanulata</i> Beauv.	African tulip	X
CARYOPHYLLACEAE		
<i>Drymaria cordata</i> (L.) Willd.	Drymaria, pipili	X
COMPOSITAE		
<i>Ageratum conyzoides</i> L.	Ageratum, maile- hohono	X
<i>Erechtites valerianaefolia</i> (Wolf) DC.		X
<i>Eupatorium riparium</i> Regel	Pamakani	X
<i>Pluchea odorata</i> (L.) Cass.	Pluchea	X

ERICACEAE		
Vaccinium calycinum Sm.	'Ohelo-kau-la'au	E
Vaccinium sp.	'Ohelo	E
EUPHORBIACEAE		
Antidesma platyphyllum Mann var. platyphyllum	Hame, mehame	E
LEGUMINOSAE		
Acacia koa Gray	Koa	E
LOBELIACEAE		
Clermontia parviflora Gaud.	Papa'a-hekili	E
Cyanea sp.	'Oha	E
LYTHRACEAE		
Cuphea carthagenensis (Jacq.) MacBride	Cuphea, puakamoli	X
MELASTOMATACEAE		
Melastoma malabathricum L.	Malabar melastome	X
MELIACEAE		
Toona ciliata M. Roem.	Toon	X
MYRTACEAE		
Eucalyptus citriodora Hook.	Lemon-scented gum	X
Eucalyptus robusta Sm.	Swamp mahogany	X
Metrosideros collina ssp. polymorpha (Gaud.) Rock	'Ohi'a-lehua, lehua	E
Psidium cattleianum Sabine	Strawberry guava	X
Psidium cattleianum f. lucidum Deg.	Waiawi, yellow strawberry guava	X
ONAGRACEAE		
Ludwigia octivalvis (Jacq.) Raven	Primrose willow, kamole	X
Ludwigia palustris (L.) Ell.	Water purslane	X
PASSIFLORACEAE		
Passiflora edulis f. flavicarpa Deg.	Yellow lilikoi	X
PIPERACEAE		
Peperomia tetraphylla (Forst. f.) H. & A.	'Ala'ala-wai-nui kane	I
Peperomia sp.	'Ala'ala-wai-nui kane	E
ROSACEAE		
Rubus rosaefolius Sm.	Thimbleberry, 'ola'a	X

RUBIACEAE			
Coprosma sp.	Pilo		E
Psychotria hawaiiensis (Gray)			
Fosberg var. hawaiiensis	Kopiko		E
RUTACEAE			
Pelea volcanica Gray var. volcanica	'Alani		E
TILIACEAE			
Heliocarpus popayaensis HBK.	White moho		X
UMBRELLIFERAE			
Centella asiatica (L.) Urban	Asiatic pennywort,		
	pohekula		X
VERBENACEAE			
Stachytarpheta jamaicensis (L.)			
Vahl	Jamaica vervain,		
	owi, oi		X

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APPENDIX C: AVIAN SURVEY

AVIAN ASSESSMENT SURVEY
for
BioEnergy Development Corporation

By Matthew D. Hess
Bachelor of Science in Zoology

Avian Disease Laboratory
Hawaii Volcanoes National Park

University of Hawaii Research Corporation

1980 Earthwatch Teams Assistant

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INTRODUCTION

A biomass energy organization is proposing the clear cut logging of an area involving 341 acres which is in an area known to have endermic Hawaiian birds. At the request of BioEnergy Development Corporation, the author, Matthew Hess was contracted to undertake an avian assessment survey. The primary objective in this Avian survey of a small geographic area of 341 acres, called Puueo, in the Hilo district on the island of Hawaii, was to establish the presence of any endangered bird species. In addition, quantitative data on all the bird species present was found collected, to give a view of the species diversity and density. In this 54 man-hour study beginning September 29, 1980 and ending November 9, 1980, attention was directed toward the detection of endemic and endangered bird species.

HISTORICAL REVIEW

HABITAT

A number of factors have led to the degeneration of this area's native forest, which now has a direct bearing on the resources available for the native and endangered bird species. The native trees found were widely scattered Koa, Hapuu, and Ohia in largely the same abundance as the scattered exotic Eucalyptus. The succession of the thick guava tree stands results in mostly older Ohia and Koa trees with little apparent regeneration. The geographic elevation is between 1600 ft. and 2400 ft., where at the highest elevation the guava is still consistently dense. In the elevations above, a vegetation gradier begins that gradually becomes more continuous with the predominantly native forest at approximately 3000 ft. (1) The rainfall is variable throughout the year, but this is considered a wet, low elevation forest with from 250 to 300 in. average rainfall annually. (2)

In this low elevation the night biting mosquito, Culex, is known to thrive, therefore this is now a habitat with vectors for such avian diseases as malaria and fowl pox. The native bird species and many of the endangered birds have little genetic resistance to these exotic diseases and this is believed to be another factor why many endemic species, with former ranges here, now are found in higher elevations. (3)

Experimental evidence has demonstrated the high susceptibility of existing endemic species to avian malaria, an exotic disease. (Charles Van Riper III, personal communication) In a preliminary study to determine this drepanid distribution near Hilo, an abrupt lower edge of population density occurred at about the 2000 ft. level, the approximate upper level of the Culex mosquitos' breeding belt. (4) However, this avian malaria vector has now been known to breed in localized areas as high as 6000 ft. (5)

An endangered species presently known to occur in these elevations is the Hawaiian Hawk. (Curtis Griffin, personal communication) The other endemic Hawaiian drepanids found on Hawaii are believed to occur only in the forest elevations above 600 - 900 m, approximately 2000 ft. as a lower edge.(6) The Hawaiian Owl and the Elepaio are other endemic species known to occur in these elevations.(7)

Endangered species, as any endemic species, may, frequent the area by day if their elevational ranges are close enough. They may also use these elevations at different months of the year, migrating vertically or laterally. Therefore, practically all endangered species are treated as possibly occurring in the area, even though most are not proable to be found here.

The U. S. Fish and Wildlife Service investigation of the Hilo districts has not yet been published for reference. Refer to Table 1 for the individual endangered species accounts of the known elevational ranges and habitat descriptions, derived largely from Berger(8) and Munro(9).

STUDY METHODS

Census Method

Selection of a particular census method took many hours of consideration. The first method chosen not only gives a fair accuracy of the species diversity at the time of this survey, but also a more thorough view of the species density and relative abundances in this area. The variable circular-plot technique used by Dr. Michael Scott of the Hawaii Fish and Wildlife Service and the U. S. Forest Service Ornithologists was selected to generate the data. (10) Several line transects, parallel to the contour were set with flagging tape. This technique was used on four mornings, from dawn till about 10:30 a.m., during the period of maximum bird activity and singing in order that observations at later stations were not biased as activity gradually decreased.

The starting and ending stations on each of the 4 days were different, and the transects ran in opposite directions, and from different elevations each day so that any bias was eliminated. Since a large influence in bird activity and singing was the weather, each morning the survey was conducted, was consistent in being calm and sunny.

A second method used in the field each day was a random search for incidental sightings of endangered species. In conjunction with the first method this should determine whatever populations of endangered birds were present. A total of 34 hours were spent in random searching and this was important since direct attention could be given to watching and listening for the several possible, endangered species. (Table 1)

A tape recorder was carried at all times to attempt to record any of these vocalizations, but its use was emphasized in this incidental sightings method. In addition, 3 hours from 6:30 p.m. to 9:30 p.m. on 2 nights were spent listening for diurnal and nocturnal species that may be present; the Hawaiian Owl, the threatened Newell's Shearwater and the endangered Hawaiian Hoary Bat.

STUDY METHODS

Transect Selection

In selecting the transects on a topographic map the distances between the transects had to be as close as possible for the required thoroughness, yet remain statistically independent of the other transects' detection distance. A distance of 400 m. between transects was selected since the detection distance of the most conspicuous species is usually not more than 125 m. This habitat is fairly uniform in vegetation, therefore the transect lines were decided to run parallel to the contour of the gradual slope. The magnetic North-South axis happened to approximate the transect direction therefore was utilized to place the primary transect at the lower boundary and placed the following transects parallel and 400 m apart. Placement of the transects in some areas had to be irregular to accommodate the barriers of thick guava stands and steep ravines.

STUDY METHODS

Placement of Stations

A decision to survey just 100 m beyond all borders of the 341 acre parcel was accomplished by first placing stations at the ends of all transects near the boundaries. With the first transect placed at the lower border, stations were selected at least 200 m. apart and farther in a few instances. This is to insure the statistical independence of each station and still be as precise in locating the rarer or less obvious endangered species.

The field forms used were the standard U. S. Fish and Wildlife forms for use with the Variable Circular Plot Method for estimation of species density.

LIMITATIONS

In such an avian survey there are limitations to the desired accuracy which must be considered and stated in the report. The 54 man-hours spent in the methods of this survey's fieldwork would be sufficient to detect whatever populations of endangered or threatened species are present, but may not determine those species that occur in the area in other seasons of the year. Following is a number of factors that may contribute to scattered individuals escaping detection as would be the case with endangered species whose abundance is scarce:

- A. The accessibility of this area was limited in a few places due to the thick guava tree stands and steep ravines.
- B. Near the higher elevations in the 341 acres the area is narrow and may be utilized by endangered species in adjacent areas at this elevation. Effort was taken to survey outside the higher area by the addition of 10 stations placed at the upper boundaries.
- C. A number of the endangered species in Hawaii have extensive foraging ranges that would make detection difficult.
- D. Again, this survey, conducted largely in the month of October was but one month of the year, and the species found in the area may fluctuate seasonally.

These limitations therefore allow the author only to state what was encountered during the 54 man-hours in the fieldwork. Also, the author can suggest which endangered species possibly utilize this area that were not detected for any of the above stated factors. This survey was not intended as a representation of this elevation or any other adjacent area, but the 341 acres called Puueo, in Amaulu, Hawaii.

SUMMARY

During the entire 54 man-hours in the fieldwork, no endangered species were detected. This area does not resemble in any context what could be viewed as a prime habitat for endemic or endangered bird species. Indeed, this area was found to be poor in resources for native birds, either for food, shelter, or breeding. However, this does not infer that there are no endangered species utilizing this 341 acres now, or at other times of the year. All that can be said is that during this survey, none were detected. The Variable Circular Plot method generated useful data that gives a fair estimate of the species diversity and density.

Again it is known that the Endangered Hawaiian Hawk does utilize the elevation and area of the Hilo district, as might be found the threatened Newell's Shearwater at other times of the year.(11) The Consultant Botanist reported sighting the Hawaiian Hawk near the lower boundary of the survey area.

Other endemic species also known to inhabit these elevations is the Hawaiian Owl and the Elepaio according to Munro.(12) It would be fairly accurate to state that no populations of endangered avian species exist here with the exception of the Hawaiian Hawk. If an endangered species is residing, or foraging in this 341 acres, called Puueo, it would have to be as isolated individuals or pairs.

ACKNOWLEDGEMENTS

The author would like to thank Dr. Michael Scott of the U. S. Fish and Wildlife Service at Volcano National Park for his help in compiling the data collected in the field with the use of his computer program for the Variable Circular Plot Method and for his suggestions in the selection of the methods for this Avian Assessment Survey.

Also, thanks to Howard Sakai of the Forestry Service for his aide with the designing of the study methods and transects for this survey.

Thanks to Mark Collins with the U. S. Forestry Service for his suggestions about the format and his guidance in preparation.

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APPENDIX

In this section is included all the data compiled during the 100 count periods, generated by the Variable Circular Plot method.

Table 1 is a comparison of Habitat descriptions and elevational ranges of the endangered birds of Hawaii according to the publishings of A. J. Berger and G. C. ^{Munro}~~Berger~~. These species accounts of the endangered species of Hawaii is to review of some of the published information on their distributions and abundance.

Table 2 shows the species actually observed during the count periods, and those species estimated densities in number of birds/100 acres, number of birds/341 acres and the 95% confidence levels of the latter, as computed from the data generated. The estimation of species densities and related computations were made by the Variable Circular Plot computer program as used by ornithologists with the U. S. Fish and Wildlife Service and the U. S. Forestry Service. Where minute numbers of a species are encountered density estimation may appear unusual.

Table 3 is the calculated species frequency, the species incidence, and relative abundance of those species located during the count periods to give three additional indicators relating to abundance.

Figure 1 is a map of the 341 acres called Puueo with the transect and station positions selected for this survey.

FIG. 1

TRANSECT AND STATION POSITIONS



TABLE 1

ENDANGERED SPECIES HABITAT ACCOUNTS ON HAWAII

	<u>Berger (8)</u>	<u>Munro (9)</u>
HAWAIIAN HAWK <u>Buteo solitarius</u>	Primarily occurs in wet, native forest from sea level to 8500'.	Widely distributed, generally from 2000' to 500' prefers open forest rather than a wet dense one.
HAWAIIAN CROW <u>Corvus tropicus</u>	Sighted Baldwin as being above 3700' rough AA lava with undisturbed native vegetation. Only on Hualalai at present. Tomich sighted a nest at 2300' near Puuwaawaa Ranch.	Seems confined to Hualalai and Kona. Formerly ranged from 1000' to 8000' in the 1890's. Now habitat is degraded and population is almost extinct.
HAWAIIAN CREEPER <u>Loxops maculatus mana</u>	Uncommon on Hawaii. Perkins stated that distribution was puzzling. Could be found above 3500' in South Kona. Food sources of insects primarily from large Koa trees.	No apparent reasons why numerous in some locations and scarce in others.
HAWAIIAN COOT <u>Fulica americana alai</u>	Prefer more open water, but often found in brackish marshes in low land areas.	Seen in fresh and brackish water, but prefers areas of open water, particularly shore lagoons.
HAWAIIAN STILT <u>Himantopus himantopus knudseni</u>	Prefers marsh areas and ponds. Generally abundant where receding tides leave exposed marine animals in the mud. Can occur short distances from the sea, but keeps to open plains.	Found in marshy areas and swamps, but mostly in tidal mud flats. Munro states that there seems to be no record of it on Hawaii.
HAWAIIAN DUCK <u>Anas wyvilliana</u>	In recent years found only on Kauai, more recently reintroduced on Hawaii.	Originally common in coastal lagoons, marshes and mountain streams. Perkins reports it in small pools on mountain streams on the main islands.
HAWAIIAN GOOSE <u>Branta sandvicensis</u>	Found in open lava flows with suitable vegetation. Breeding habitat here also at elevations about 5000'.	Accustomed to semiarid waterless high country acquiring moisture from the berries. Thought to winter in low land lava flows. Some collected at 2000' in early 1900's.

Berger (8)

Munro (9)

AKIAPOLAAU
Hemiganthus wilsoni

Recently only found in Mamane-Naio forests and some koa from 3500' and above. Perkins in 1903 reports commonly sighted in Koa trees from 1500' and above in the Hilo forests.

Generally found above 3500' however reported in Kilauea and Olaa Forest Reserves.

AKEPA
Loxops coccinea
coccinea

Perkins notes that it is widely distributed on Hawaii occurring in Koa, Ohia, and Naio trees for food sources. Specimens found between 3000' and 5000'. Baldwin reports in 1950 observing them in South Hilo districts.

Note on Hawaii and can be found above 4000'. On Mauna Kea above 5000'.

OU
Psittirostra
psittacea

At low elevations certain diseases may have caused destruction there. The OU on Hawaii is seldom seen. Richards reports several in the upper Olaa forest at 4000'.

Did formerly forage in low elevations but, diseases carried it to near extinction. High Flier, migrates over large areas of forest, now predominately native.

PALILA
Psittirostra
bailleui

In the past the Palila had a wide distribution. Now they are common from 7000' upwards to treeline. Only rarely are they found below 6500' and only in the Mamane forest which is their main food source on Mauna Kea.

Formerly in 1890 found at 4000'. At present, reported only high on Mauna Kea slopes in Mamane-Naio forest above 6000'.

DARK RUMPED PETREL
Pterodroma
phaeopygia
sandwichensis

One reported at Kilauea Crater in 1948 and 5 dead birds found above 9000' on Mauna Loa from feral cats. Munro reports nests from 1500' to 5000'. The mongoose has caused its demise on Hawaii.

Endemic to main islands formerly from 1500' to 5000'. Now on Hawaii thought to be restricted to volcanic slopes above 7000'.

NEWELL'S SHEARWATER
Puffinus newelli

(Threatened) Population reduced on Hawaii also by mongoose. Known to frequent island of Hawaii. Nesting colony on Kauai is located about 1500'. Munro reports nesting from 500' to 1000'.

Nests found in burrows near the sea from 500' to 1000' in forested areas.

HAWAIIAN HOARY BAT
Lasiurus linereus
semotus

Only endemic land mammal.

Observed this mammal at sea level, and at 9000' on Haleakala, Maui.

Steven Sabo
U.S. Fish and Wildlife
Service (per. communication)

TABLE 2

Species	Actual # Sighted	Estimated Density		95% Confidence Lev For Population Den In Total Area (341)	
		Birds/ 100 Acres	Birds/ 341 Acres	Lower	Upper
House Sparrow	23	4.90	16.71	10.57	24.21
N. American Cardinal	53	4.33	14.77	11.06	19.00
Japanese White Eye	232	67.01	228.51	200.05	258.86
Elepaio	40	12.89	43.94	31.38	58.62
Spotted Munia	13	4.03	13.73	7.28	22.21
Red-billed Leiothrix	7	.45	1.54	.61	2.89
House Finch	5	.66	2.24	.70	4.64
Melodious Laughing Thrush	2	.16	.55	.05	1.55
Kalij Pheasant	1	.03	.09	.000037	.36
Helmeted Guinea Fowl	2	5.73	19.53	1.84	55.98

TABLE 3

<u>Species</u>	<u>Species Frequency</u>	<u>Species Incidence</u>	<u>Species Abundanc</u>
House Sparrow	8/100 = .08	23/8 = 2.875	23/232 = .099
N. American Cardinal	37/100 = .37	53/37 = 1.432	53/232 = .228
Japanese White Eye	89/100 = .89	232/89 = 2.607	232/232 = 1.00
Elepaio	32/100 = .32	40/32 = 1.25	40/232 = .172
Spotted Munia	5/100 = .05	13/5 = 2.60	13/232 = .056
Red-billed Leiothrix	5/100 = .05	7/5 = 1.40	7/232 = .030
House Finch	3/100 = .03	5/3 = 1.67	5/232 = .021
Melodious Laughing Thrush	2/100 = .02	2/2 = 1.00	2/232 = .009
Kalij Pheasant	1/100 = .01	1/1 = 1.00	1/232 = .004
Helmeted Buinea Fowl	1/100 = .01	2/1 = 2.00	2/232 = .009

Species Frequency - Number of count periods species is recorded
divided by Total number of count periods.

Species Incidence - Number of a species recorded divided by
Number of count periods species is recorded.

Species Abundance - Number of a species recorded divided by
Number of most abundant species.

RECOMMENDATIONS

Considerations must be made for the adjacent areas to this 341 acres. The higher elevations of this area is approximately 500 ft. below the predominantly native forest where endemic birds are thought to occur. Effort must be taken to ensure that the degradation of adjacent areas by additional exotic vegetation does not occur. The native forest above, utilized by endemic bird species hopefully will not be affected by the clear cut logging of this 341 acres.

APPENDIX D: ARCHAEOLOGICAL SURVEY

ARCHAEOLOGICAL RECONNAISSANCE SURVEY
OF THE EUCALYPTUS BIOMASS FARM SITE
PUUEO, SOUTH HILO, ISLAND OF HAWAII
(TMK: 3-2-6-18: Por. 8)

by

Paul H. Rosendahl, Ph.D.
Principal Archaeologist

Prepared for

Juvik and Juvik
Environmental Consultants
223 Makani Circle
Hilo, Hawaii 96720

June 1981

PAUL H. ROSENDAHL, PH.D., INC.
Consulting Archaeologist
P.O. Box 504
Kurtistown, Hawaii 96760

INTRODUCTION

BACKGROUND

At the request of Juvik and Juvik, Environmental Consultants, an archaeological reconnaissance survey was conducted at the site of the proposed Eucalyptus Biomass Farm in Puueo, South Hilo District, Island of Hawaii. This survey was carried out to provide necessary input for the preparation of an Environmental Impact Statement required by the State of Hawaii because of the location of the proposed farm site within Conservation District lands.

Survey field work was conducted on May 27-28, 1981 by a team consisting of Project Director Dr. Paul H. Rosendahl and Field Archaeologists Michael W. Kaschko, Ernest A. Kahana, and James Landrum. A preliminary oral report of survey findings and recommendations was made to Dr. James Juvik of Juvik and Juvik on May 30, 1981. The present report comprises the final report on the reconnaissance survey, and includes recommendation for full archaeological clearance for the site of the proposed Eucalyptus Biomass Farm.

SCOPE OF WORK AND DESCRIPTION OF PROJECT AREA

The basic purpose of the reconnaissance survey was to locate any sites of possible archaeological significance. A reconnaissance survey is simply a walk-through survey--extensive rather than intensive in scope--conducted to determine the presence or absence of archaeological resources within a specified project area. A reconnaissance survey (1) permits a preliminary evaluation of archaeological resources, and (2) facilitates formulation of realistic recommendations and estimates for any further archaeological work that might be necessary. Such additional work could include intensive survey--detailed recording of sites, and selected

test excavations; and possibly subsequent mitigation--salvage and/or research excavations, interpretive planning, and/or preservation of sites with significant research, interpretive, and/or preservation value.

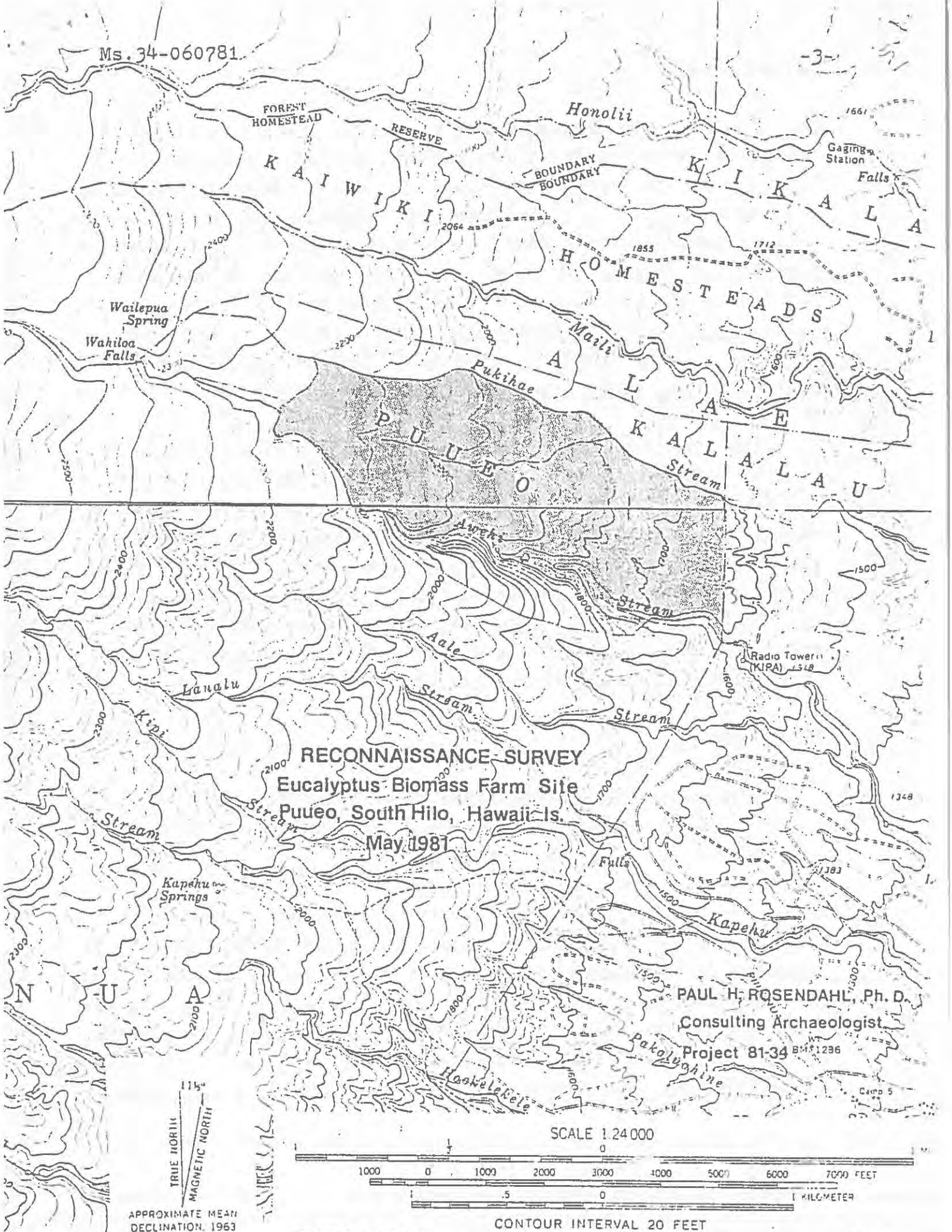
The significance of archaeological resources can be defined in terms of potential research, interpretive, and/or preservation value. Research value refers to the potential of archaeological resources for producing information useful in the understanding of culture history, life-ways, and cultural processes at the local, regional, and inter-regional levels of organization. Interpretive value refers to the potential of archaeological resources for public education and recreation, and for promotion of ethnic identity. Preservation value refers to the need to conserve an adequate and representative sample of the archaeological resource base for future use.

To attempt evaluation of the significance of archaeological resources on the basis of a preliminary assessment such as a reconnaissance survey is generally premature. Occasionally it is possible at even a preliminary level of study, such as that of a reconnaissance survey, to evaluate the significance of specific sites when their research, interpretive, and/or preservation value is obvious; however, in most instances it is necessary to conduct more intensive survey, often including test excavations, to determine and document the significance of specific archaeological remains.

The proposed Eucalyptus Biomass Farm site consists of approximately 300 acres located in the inland portion of the land of Puueo, South Hilo District, Island of Hawaii (TMK:3-2-6-18:Por.8). The farm site project area is situated between Awehi Stream on the south and Pukihae Stream on the north, and extends inland from the edge of the presently cultivated cane land at c. 1620-foot elevation, to the 2200-foot elevation (Figure 1). For the most

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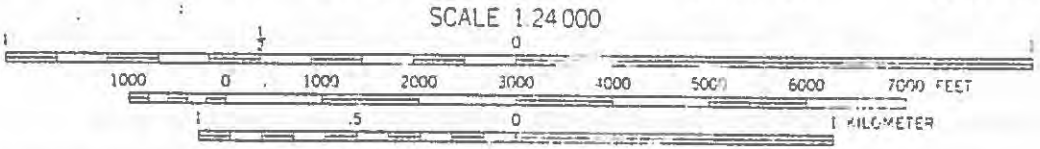
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RECONNAISSANCE SURVEY
 Eucalyptus Biomass Farm Site
 Puueo, South Hilo, Hawaii Is.
 May 1981

PAUL H. ROSENDAHL, Ph. D.
 Consulting Archaeologist
 Project 81-34 BM 1296

TRUE NORTH
 MAGNETIC NORTH
 APPROXIMATE MEAN DECLINATION, 1963



SCALE 1:24 000
 CONTOUR INTERVAL 20 FEET
 DATUM IS MEAN SEA LEVEL

TMK 3-2-6-18-000

part, the terrain of the survey area rises gently in slope, with local areas of greater slope and several dry gullies. Portions of the survey area along the edge of Awehi Stream have a steep drop down to the stream bed. Virtually the entire survey area is covered with a dense vegetation cover of which guava (Psidium guajava L.) is the dominant, especially in the lower portion of the survey area. In the upper portion of the survey area, 'ohi'a-lehua (Metrosideros collina (Forst.) Gray subsp. polymorpha (Gaud.) Rock) becomes a co-dominant with guava, and the native koa (Acacia koa Gray) is commonly found.

The dense vegetation cover of the survey area makes it in general difficult to move through the area. Movement through the portion of the area nearer to Awehi Stream is made considerably easier by the presence of several hunter trails, the principal one of which extends along the course of a now-abandoned irrigation ditch. Movement through the portion of the survey area closer to Pukihae Stream is considerably more difficult because there are few hunter trails present, and passage through much of the area involves the breaking of new trails.

SURVEY METHOD

Despite the dense vegetation cover that made it difficult to traverse the survey area--often it was impossible to see more than ten meters ahead, the method utilized to carry out the survey was relatively simple. Beginning at the southeast corner of the area, near Awehi Stream, the initial inspection of the survey was made on May 27 by proceeding inland along the main hunter trail adjacent to the abandoned ditch. At irregular intervals, secondary hunter trails and feral pig runs that branched off were followed and the proximate land inspected. In this fashion, the portion of the survey area nearer Awehi Stream was explored to the approximate location of the 2200-foot elevation limit. At one point--

estimated to be about the 2000-foot elevation, the survey team dropped down to the stream bed of Awehi Stream and inspected the side of the stream area for several hundred meters.

For the most part it was virtually impossible to be certain of exact location within the survey area at any specific point. With the exception of the 1:24,000 scale U.S.G.S. 7.5 minute series quadrangle maps, there were no maps of the survey area available. Furthermore, the density of the vegetation and the absence of prominent points of high ground prevented establishment of specific position with reference to other known points.

Survey work on May 28 began by heading inland along the same main trail from the southeast corner of the survey area, but proceeded by bearing further to the north, cutting through the central portion of the survey area. The unnamed tributary of Pukihae Stream was crossed and a trail continued to be broken on into the northwest corner portion of the survey area. The survey team gradually turned and began heading seaward, in the area near Pukihae Stream. The absence of any trails and the presence of extremely dense vegetation made progress very slow. As it became late in the day, final exit from the survey area was made by cutting across through less dense forest to Maile Stream on the north, which was then followed down to c. 1600-foot elevation where the stream was intersected by a recently constructed dirt road that could be followed back to Pukihae Stream.

The total number of acres inspected during the reconnaissance cannot be estimated with any degree of accuracy, but it is felt that the two days spent traversing the survey area from the seaward to the approximate inland limits, and through both the southernly and northernly portions of the survey area, comprised a good sampling of the survey area. Any more formal sampling strategy would have required considerably greater expenditure of man-hours, and most likely would not have produced significantly different results.

SURVEY FINDINGS

No archaeological sites or features on any kind, nor any portable remains such as surface artifacts or midden, were found within the survey area of the proposed Eucalyptus Biomass Farm site. This negative finding is based on a sampling of the survey area, as discussed in the preceding description of survey method.

CONCLUSION

No archaeological remains of any kind were found within the site of the proposed Eucalyptus Biomass Farm during the two days of reconnaissance survey field work. A check of records on file in the Hawaii County Planning Department in Hilo failed to reveal the presence of any previously recorded or known archaeological sites within or immediately adjacent to the survey area. Based on the completely negative results of the reconnaissance survey, it is concluded that no further archaeological work of any kind is necessary or justified, and it is recommended that full archaeological clearance be granted.

This conclusion and recommendation is given on the basis of the negative findings of the reconnaissance survey, and with the general qualification--given the scope of the survey as a surface, sampling inspection--that during any development activity involving the modification of the land surface there is always the possibility that previously unknown or unexpected sites or subsurface cultural features might be encountered. In such a situation, immediate archaeological consultation should be sought.

APPENDIX E: COUNTY PLANNING DEPARTMENT COMMENTS

March 24, 1981

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, HI 96809

Dear Mr. Ono:

Conservation District Use Application HA-3/3/81-1345
Eucalyptus Biomass Farm Development Use
at Puueo, South Hilo, Hawaii TRK: 2-6-13:8

Thank you for the opportunity to comment on the subject proposed project. We concur with your determination and notice of the preparation of an environmental impact statement (EIS) due to potential effects of the proposed actions on the environment.

In preparing the EIS, we feel that it should consider and discuss in detail the impacts on the following areas:

1. Grading of the area (especially if it is conducted during rainy season);
2. Erosion and sedimentary control/pollution in the streams alongside and within the parcel.
3. At present it does not appear that there is any vehicular access to the parcel. The EIS should discuss the location, creation, and concomitant impacts if any of a proposed access.

Please be informed that the project site area is not situated within the Special Management Area (SMA). Consequently, requirements established under Chapter 205-A, HRS, and Rule 9 of the County Planning Commission are not applicable.

We hope these comments will be of help and look forward to the drafting of an EIS for this project. We will withhold comments on the CDUA itself until the EIS has been completed.

MAR 25 1981

Mr. Susumu Ono, Chairman

Page 2

March '24, 1931

Should you have any questions, please feel free to contact us.

Sincerely,

Sidney M. Fuke

SIDNEY FUKU
Planning Director

AK/VKG:wkm

cc: Glenn Taguchi
Roland Higashi