Environmental Impact Statement

APPENDIXES

KEAHOLE - KAILUA
69 kV TRANSMISSION LINE PROJECT

APPLICANT

Hawaii Electric Light Company, Inc.

An HEI Company

APRIL 1993

CH2M HILL

Environmental Impact Statement

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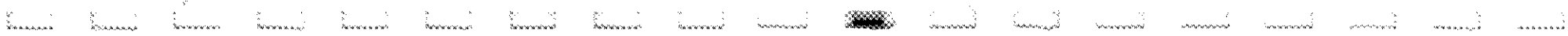
APPENDIX A



Appendix A

Regional Resource Inventory and Constraints Evaluation

Appendix A

Regional Resource Inventory and Constraints Evaluation

This appendix provides a detailed inventory of the resources and proposed and existing land uses for the Keahole-Kailua study area and an evaluation of the constraints and opportunities of siting a transmission line there. The inventory includes data factors for nine resource categories: land ownership, land regulation, existing land use, proposed land use, visual resources, geological resources, biological resources, cultural resources, and utility and transportation systems. The description of each category includes a discussion of siting issues applicable to a new transmission line and an evaluation that rates data factors according to corridor constraint criteria. Corridor constraint criteria are listed in Chapter 4, in the section on criteria for alternative corridor evaluation. The resource inventory and constraint evaluation support the alternative corridors evaluation in Chapter 4. Table 4-3 lists the data factors and their associated constraint ratings for each environmental data map. The table can be found in Chapter 4, along with all of the environmental data maps. Appendix B contains detailed land use project profiles. Figure 4-7 and Tables 4-4 and 4-5 in Chapter 4, this appendix, and Appendix B (Land Use Project Profiles) considered those proposed land uses that had progressed substantially in the land use approval process as existing land uses in this regional analysis.

Land Ownership

Siting Issues

Parcel size and ownership can affect the right-of-way location and acquisition for a transmission line corridor. The acquisition of a right-of-way on large tracts of land may divide landholdings into small, irregular parcels that could eventually reduce the value of the property. However, if a corridor were selected in an area with numerous small parcels, each with different owners, the amount of time required to negotiate transmission line easements could be substantially longer than if the corridor were in an area with a single owner.

Other factors that can influence corridor location include the permits, policies, and guidelines that regulate development. These regulations may vary depending on land ownership. The types of land ownership identified and mapped in the Keahole-Kailua project area are federal, state/county, and private lands. These three ownership classes can also influence corridor location in the region.

Inventory

Land ownership is shown on Figure 4-5 in Chapter 4. The study area includes property owned by the U.S. Department of Interior (National Park Service), the State and County of Hawaii, and various private landowners.

Federal Lands

There are only two federally owned parcels of land in the study area. One is approximately 322 acres makai of Queen Kaahumanu Highway, is administered by the U.S. Department of Interior, and is being developed as the Kaloko-Honokohau National Historic Park. The other federally owned land is the 10-acre U.S. Coast Guard lighthouse facility at Keahole Point.

State/County Lands

The State of Hawaii owns and, through various agencies, administers approximately 6,600 acres of land in the study area. Keahole Airport, Natural Energy Laboratory of Hawaii (NELH), Hawaii Ocean Science and Technology (HOST) Park, Kealakehe Residential Community, Kealakehe Wastewater Treatment Plant, Old Kona Airport State Park, state highway rights-of-way, and other undeveloped properties are located on state lands. The County of Hawaii owns rights-of-way along county roads, such as Palani Road. The State of Hawaii leases land to HELCO at the site of Keahole Generating Station and to tenants at Keahole Agricultural Park.

Private

The majority of land in the study area is privately owned. The major private land owners include Liliuokalani Trust Estate; Lanihau Corporation; Palani Land Trust II; Y.O. Ltd.; TSA International, Ltd.; Nansay Hawaii, Inc.; American Trust Company of Hawaii; Robert Greenwell; and THC Financial.

Constraint Evaluation

Constraint Rating–High

Federal Lands. Federal lands are rated high constraint because siting a transmission line across federal property requires lengthy and complex reviews, and acquiring approvals and permits is uncertain.

Constraint Rating–Low

State/County Lands. Siting a transmission line within state or county public lands is subject to the permit requirements of the agency with jurisdiction over the land. However, utility companies typically acquire perpetual easements of state and county public lands for utility uses. For example, HELCO's franchise grants it the authority to use state and county road rights-of-way for transmission and distribution lines. State and county lands are rated low constraint.

Private Land. Private lands are considered low constraint because utility companies regularly negotiate easements with private landowners for utility uses.

Land Regulation

Siting Issues

The land regulation inventory within the study area identifies areas subject to state and county regulatory controls that may influence the siting of a new transmission line. The only land use category that expressly prohibits the construction and operation of a transmission line is the State Land Use Conservation District, Protective Subzone, which is designated by the State Land Use Commission.

The study area would also be subject to county regulatory review and permits designed to protect special resource values. The only county land use controls that would regulate siting a new transmission line are the Special Management Area (SMA) Use Permit, required for any development within a designated SMA, and the Shoreline Setback Variance, required for development within 40 feet of the shoreline.

Inventory

The principal data factors mapped under land regulation are state Land Use Districts (LUDs), the SMA, and the Shoreline Setback Area. Each of these regulatory factors is shown on Figure 4-6 and described below.

State Land Use Districts

The State of Hawaii Land Use Commission, pursuant to Chapter 183 of the Hawaii Revised Statutes, has established LUDs throughout the state. Three LUD designations exist on lands within the Keahole-Kailua study area: Agricultural, Conservation, and Urban. Overhead transmission lines are a permitted use within Urban and Agricultural LUDs. However, siting new lines in a Conservation LUD requires a Conservation District Use Application for review and approval by the Board of Land and Natural Resources.

Urban LUD. Land designated Urban LUD covers about 30 percent of the Keahole-Kailua study area. Kailua and Keahole Airport are within the Urban District. With the exception of portions of the shoreline (e.g., Honokohau Bay and Keahole Point), the majority of land makai of Queen Kaahumanu Highway between Kailua and Keahole Airport is also designated Urban LUD. Existing residential subdivisions in the area between Queen Kaahumanu and Mamalahoa Highways—including Kona Highlands, Kona Wonderview Lots, Kona Coast View Subdivision, Kona Acres, Kona Palisades Estates, and Kealakehe Homesteads—are also located within the Urban District. A portion of Queen Kaahumanu Highway in front of the Kaloko Industrial Park is within the Urban District.

Agricultural LUD. About one-third of the Keahole-Kailua study area is designated Agricultural LUD. Agricultural LUD lands are located between Queen Kaahumanu Highway and Mamalahoa Highway as well as in areas mauka of Mamalahoa Highway. The Keahole Agricultural Park, located mauka of Queen Kaahumanu Highway near Keahole Airport, is

in the Agricultural District. A portion of the Liliuokalani Trust Estate near the Queen Liliuokalani Children's Center, and the portion of Queen Kaahumanu Highway from this area south into Kailua-Kona, are within the Agricultural District.

Conservation LUD Lands. Conservation LUD land is classified into four subzones: General, Limited, Resource, or Protective. Each subzone varies in terms of its level of restrictiveness over permittable land uses. The least restrictive subzone is the General Subzone. Siting a transmission line within the General Subzone is normally permitted. The Limited and Resource Subzones allow a narrower range of permitted uses but do not preclude transmission lines. The most restrictive subzone is the Protective Subzone, which prohibits the construction of transmission lines. About one-third of the Keahole-Kailua study area is designated Conservation LUD.

The majority of Conservation District land is classified General Subzone. Keahole Generating Station and Keahole Switching Station are located in a General Subzone. Except for Keahole Agricultural Park and Kaloko Industrial Park, the General Subzone lands in the study area extend approximately 3,000 to 4,000 feet mauka of Queen Kaahumanu Highway from Keahole Airport south to Kealakehe Parkway. Sections of General Subzone land are also found mauka and makai of Keahole Airport and makai of Queen Kaahumanu Highway north of Kaloko Industrial Park and north of Queen Liliuokalani Children's Center. Nearly all of Queen Kaahumanu Highway from Keahole Airport to the vicinity of Queen Liliuokalani Children's Center—except for the portion in front of Kaloko Industrial Park—is within the General Subzone.

Protective Subzone land in the study area is limited to small areas at Honokohau Harbor and Kaloko Fishpond. Lands designated Resource Subzone are located adjacent to the shoreline; they include Keahole Point, Kaloko and Maliu Points, and Pawai Bay. No land in the study area is designated Limited Subzone.

Special Management Area

The general purposes of the Special Management Area (SMA) are to control development along the shoreline, to avoid the loss of valuable resources, and to ensure adequate access to publicly owned or used beaches, recreation areas, and natural reserves. On the island of Hawaii, the County of Hawaii Planning Department designates and administers the SMA. The SMA is defined to include coastal lands lying between the shoreline and an established boundary a minimum of 100 yards inland. Any development costing more than $125,000 or determined to have a significant adverse environmental effect within a designated SMA requires a Special Management Area Use Permit.

About 40 percent of the Keahole-Kailua study area is designated SMA. The SMA includes land along the shoreline from Keahole Airport to Kailua. The SMA boundary is located through the center line of Queen Kaahumanu Highway.

Shoreline Setback Area

A Shoreline Setback Variance is required for all proposed construction, improvements, grading, and other related activities within the Shoreline Setback Area. The Shoreline Setback Area is defined as 40 feet inland from the upper reaches of the waves, other than storm or tidal waves. A Special Management Area Use Permit must be approved prior to County Planning Commission approval of a Shoreline Setback Variance. All land within the Shoreline Setback Area is part of the SMA.

Constraint Evaluation

Constraint Rating–High

Conservation LUD, Protective Subzone. The Protective Subzone is rated high constraint because under most circumstances it prohibits the construction of transmission lines. The State Land Use Commission usually denies development within the Protective Subzone unless no alternatives to the proposed project exist. If there are no alternatives, the review and approval process can take as long as 6 months to complete. The environmental reporting requirements promulgated under Chapter 343 of the Hawaii Revised Statutes (HRS) must be completed before the review and approval process can begin.

Shoreline Setback Area. The Shoreline Setback Area is rated high constraint because siting a transmission line within this area requires a Shoreline Setback Variance. This variance triggers the environmental reporting requirements promulgated under Chapter 343, HRS. The Shoreline Setback Variance can only be approved after the SMA Use Permit has been approved by the County Planning Commission.

Constraint Rating–Medium

Conservation LUD, Limited and Resource Subzones. Conservation District lands in both the Limited and Resource Subzones are rated medium constraint because siting transmission lines on these lands would require application for a Conservation District Use Permit to the Board of Land and Natural Resources. The environmental reporting requirements promulgated under Chapter 343, HRS, must be completed before processing of a Conservation District Use Permit can begin. Development in both the Limited and Resource Subzones is less restrictive than in Protective Subzone lands.

Special Management Area. SMA lands are rated medium constraint because development within the SMA boundary requires application for an SMA Use Permit to the County of Hawaii Planning Department for approval by the Planning Commission. Application for the SMA Use Permit triggers the environmental reporting requirements promulgated under Chapter 343, HRS.

Constraint Rating—Low

Conservation LUD, General Subzone. Lands designated General Subzone are rated low constraint because siting transmission lines in this area would normally be permitted. Siting a transmission line within a General Subzone would require application for a Conservation District Use Permit to the Board of Land and Natural Resources, in addition to the environmental reporting requirements promulgated under Chapter 343, HRS. The General Subzone is the least restrictive subzone in Conservation District lands.

Urban and Agricultural LUD. Urban and Agricultural District lands are rated low constraint because there is no inherent conflict between transmission lines and the types of uses developed in these districts.

Existing and Proposed Land Uses

Detailed land use project profiles for all existing and proposed land uses are presented in Appendix B. Each profile provides the project name, owner/developer, status of development acreage, and complete project description. In Chapter 4, Table 4-4 and Table 4-5 present inventories of the land uses within each of the alternative corridors analyzed. For the purposes of the regional constraint analysis conducted in Chapter 4, those proposed land uses that had progressed substantially in the land use approval process were considered existing land uses. The land use project profiles in Appendix B indicate in the "Resource Category Assignment" section whether a land use project was considered an existing or a proposed land use for the regional constraint analysis.

Existing Land Use

Siting Issues

The study area contains 18 existing land use categories. Existing land uses are shown on Figure 4-7. The sensitivity associated with different land uses varies depending on the number of people, the land use restrictions, and the types of activities that occur in each area. For example, a school or residential area would be considered more sensitive to a new transmission line than an industrial area, because of the concentration of human uses.

The types of land uses that can influence corridor location include:

- Residential and other high-public-use areas, including local and regional parks and recreation areas. These land uses are of concern because of the public's general concerns regarding the potential health effects of electric and magnetic fields (EMF) and the visual impacts of the proposed transmission line.

- Shoreline areas. Shorelines in the study area are fragile resources that are protected from development by local policies. These areas often contain

sensitive biological and cultural resources. The shoreline is regulated by the County's Special Management Area Permit and Shoreline Setback Variance regulations.

Inventory

Residential. The majority of residential single-family housing stock in the study area consists of subdivisions located off Palani Road and Mamalahoa Highway. According to a 1988 housing survey, there were a total of 1,511 housing units composed of 1,397 single-family and 118 multifamily dwelling units in the study area (Hawaii County, Department of Planning, 1991). Major subdivisions include Kealakehe Homesteads, Kona Chocho Estates, Kona Macadamia Acres, Kona Heavens Lots, Kona Acres, Kona Palisades, Kona Coast View Subdivision, Kona Wonderview Lots, and Kona Highlands Lots. Small groups of individual residences are clustered both mauka and makai of Mamalahoa Highway. Other developments in the area that include residential elements and are well along in the land use approval process were also included in the existing residential inventory. These include the Y-O Residential Development, the TSA-Kaloko Properties Development, and the Kealakehe Residential Community project.

Industrial. Industrial activities are concentrated in the coastal region of the study area and include warehousing, storage, and high-technology activities. The major industrial land uses are Keahole Airport, the Natural Energy Laboratory of Hawaii (NELH) and the Hawaii Ocean Science and Technology (HOST) Park, and the Kealakehe Wastewater Treatment Plant. Kaloko Industrial Park is located adjacent to and mauka of Queen Kaahumanu Highway about three miles south of Keahole Generating Station. Kailua Substation is located in the Kona Industrial Park.

Commercial. Commercial development in downtown Kailua serves both year-round residents and seasonal tourists. These developments include retail shops, local businesses, restaurants, and commercial centers.

Agricultural. Agricultural activities are concentrated in the upland portions of the study area. These activities include cultivation of macadamia nuts, coffee, avocado, flowers, and nursery plants, and some pastureland for cattle. An agricultural park is located mauka of Queen Kaahumanu Highway and adjacent to Keahole Generating Station.

Forest. Land designated as forest occupies a small amount of the study area mauka of the Kona Highlands Lots Residential area. Forest areas are concentrated north of the study area boundary and mauka of Mamalahoa Highway.

Range and Grazing. The majority of land in the study area is classified as range and grazing. This land supports sparse vegetation and is undeveloped.

Barren Land. Barren land (from the lava flow of 1801) is located north of Keahole Airport and in areas both mauka and makai of Queen Kaahumanu Highway near Honokohau Harbor.

Public and Community Facilities. The Kailua-Kona police, fire, and post offices serve the local population in the region. The Kailua Post Office and Fire Station are both located on Palani Road near Queen Kaahumanu Highway. The main station of the Kona Police is located about 100 yards mauka of Queen Kaahumanu Highway near the Kealakehe Landfill. A number of churches are also located throughout the Kailua area.

Schools. There are a total of four schools in the upland portion of the Keahole-Kailua study area. Kealakehe Elementary School, Kealakehe Intermediate School, and Creative Day Preschool are located off Palani Road. Honokohau School is located on Mamalahoa Highway.

Head Start and two preschool facilities are located in downtown Kailua. The Queen Liliuokalani Children's Center is located about 1 mile north of Kailua makai of Queen Kaahumanu Highway. This center provides counseling for orphans and a children's beach program. The Pacific & Asia Christian University is makai of Kuakini Highway in Kailua outside the study area.

Resort and Recreation Areas, and Cemeteries. Kailua is a growing resort destination for many visitors to the island of Hawaii. Several small resort developments are located along the shoreline in downtown Kailua.

Major park and recreation facilities in the study area include Kailua Park (Old Kona Airport), Old Kona Airport State Park, and beaches. The Kealakehe Elementary School playground also serves as an informal recreation area.

Kailua Park is located less than one-half mile from Kailua Substation mauka of Kuakini Road. This 14-acre park contains lighted fields for baseball, softball, football, and soccer. There are also four lighted tennis courts and a bike track.

Old Kona Airport State Park is an 85-acre coastal park adjacent to Kailua Park. It has facilities for picnicking, sunbathing, fishing, wading, tidepooling, and surfing. This state park area includes approximately 2,500 linear feet of sand beach.

Numerous cemeteries are located along Mamalahoa Highway and in the vicinity of Kailua.

Hospitals and Clinics. The only medical-related facility located within the study area boundary is the Pregnancy Problem-Free Test Center on Kaiwi Street near Queen Kaahumanu Highway, about two blocks from Kailua Substation. Other medical clinics are located immediately outside the study area boundary in downtown Kailua.

Utilities. Utility facilities identified in the study area include transmission lines, switching stations and substations, electrical power and telephone service lines, and a wastewater facility.

Keahole Switching Station, near Keahole Generating Station, is one terminus of the proposed transmission line. Keahole Switching Station is located approximately 1 mile east of Keahole

Airport. The other terminus of the proposed line is Kailua Substation, located makai of Queen Kaahumanu Highway on Kaiwi Street in Kailua-Kona. Existing 69 kV transmission lines as well as telephone lines are located along Queen Kaahumanu Highway, Mamalahoa Highway, and Palani Road.

Cesspools are used to dispose of wastewater. However, a new regional wastewater treatment facility was under construction near Honokohau Harbor in 1992 and is expected to be operating by the spring of 1993.

Landfills. Solid waste is disposed of at a 15-acre landfill located at Kealakehe mauka of Queen Kaahumanu Highway and about 1 mile north of Kailua. There are plans to site a new landfill facility 14 miles to the north of Keahole Generating Station at Puu Anahulu, which is located outside of the Keahole-Kailua Study Area.

Quarries. Two quarries are located mauka of Queen Kaahumanu Highway in the central portion of the study area.

Communication Sites. A group of radio towers are located along Keahole Airport Road, less than 1 mile makai of Keahole Generating Station. A second radio facility is located at the end of a private road near Pawai Bay.

Airports, Air Fields, and Harbors. The only airport within the study area is Keahole Airport. Keahole Switching Station is located approximately 1 mile east of Keahole Airport. Because of the proximity of Keahole Switching Station to airport operations, some of the proposed transmission lines may be located below the imaginary surface area that the Federal Aviation Administration (FAA) defines to protect air traffic. The imaginary surface area is commonly referred to as the air interference zone. This zone delineates the area where objects or structures cannot penetrate any of the imaginary surfaces extending outward and upward surrounding the airport.

Construction within the air interference zone would require submittal of a Notice of Proposed Construction or Alteration/Determination of No Hazard to Air Navigation, issued by the FAA. Based on this application notice, the FAA determines if the proposed lines would exceed any FAA standards, would be a hazard to air navigation, or would require special lighting or marking.

Honokohau Small Boat Harbor consists of approximately 160 small boat slips, a marina complex, a drydock facility, and boat hauling and storage facilities. This facility has the capacity for 450 small boats and has other facilities to accommodate boat repair and dry storage.

Constraint Evaluation

Constraint Rating–High

Residential Areas, Schools, Resort and Recreation Areas, Cemeteries, and Hospitals and Clinics. Health and aesthetics are usually issues of concern in areas where people spend a significant amount of time or in areas that receive intensive use. These areas are rated high constraint; they include residential areas, schools, resort and recreation areas (e.g., parks, playgrounds, golf courses, and playing fields adjoining local schools), and hospitals and clinics. Cemeteries are considered high-constraint areas because of both aesthetic and social considerations.

Communication Sites. Communication sites include antennas, transmitters, and receivers operated by radio stations. These facilities are rated high constraint because transmission lines have the potential to cause electrical interference with the communications equipment. Transmission lines would have to be sited beyond measurable electromagnetic radiation from any other source (e.g., transmitters).

Airports, Air Fields, and Harbors. Airports and airfields are rated high constraint because of the high potential for conflict between airport operations and transmission lines. Transmission lines could be a hazard to air navigation if poles and lines are constructed within the imaginary surface area that surrounds the runways or if they cause electrical interference with airport traffic control equipment. Harbors are rated high constraint because of the high potential for conflict between harbor operations and transmission lines. Small boat harbors are rated as high constraint areas if they appear to be used substantially for recreation.

Constraint Rating–Medium

Public and Community Facilities and Commercial Areas. Public and community facilities and commercial areas are rated medium constraint because these facilities are used regularly by many people but are not permanent residences. The high rate of use of these facilities suggests that there may be public concerns about the health and aesthetic effects of siting transmission lines nearby. The public and community facilities category includes churches, fire stations, and police stations. Commercial areas include retail stores, restaurants, and other services.

Landfills and Quarries. Ongoing use of heavy equipment at landfill and quarry operations may conflict with transmission line construction and maintenance activities. These facilities are rated medium constraint.

Constraint Rating–Low

Industrial. Industrial areas are rated low constraint because transmission lines generally do not conflict with the storage, manufacturing, or distribution of industrial products. In addition, visual or aesthetic concerns are not significant issues in these areas.

Agricultural. A potential conflict between agricultural uses in the study area and transmission lines is the loss of productive farmland for pole or access road excavation. Because the amount and intensity of use of farmland is low, agricultural areas are rated low constraint.

Forest. A potential conflict between transmission lines and forest lands is that trees growing too close to the right-of-way could interfere with the lines. Land designated forest is rated low constraint because the study area has limited tree cover and routine maintenance operations would mitigate any potential conflict between trees and a new transmission line.

Range or Grazing and Barren Land. Range or grazing and barren lands are rated low constraint because they are generally undeveloped and transmission lines would generate minimal conflicts with these uses. These lands provide opportunities for siting a new transmission line corridor.

Utilities. Utilities are rated low constraint because they provide siting opportunities within an existing right-of-way. Utilities typically are linear facilities that include other electrical, water, and sewer lines.

Proposed Land Use

Siting Issues

Similar to existing land use, proposed land use can influence corridor selection if the proposed project includes high-public-use facilities such as residences, schools, or recreation areas. Future development of these types of uses could cause public concern regarding visual impacts and the potential health effects associated with transmission lines. Potential conflicts between transmission line siting and new development can be minimized through early consultation with the project proponents.

A list of proposed projects within the study area was compiled from a number of sources, including the *Keahole to Kailua Development Plan* (Hawaii County, Department of Planning, 1991) and the *North Hawaii Open Space and Community Development Plan* (Townscape, Inc., January 1992). County planners and the proponents of each project were contacted to determine the location, size, and status of the projects.

Inventory

Proposed projects within the study area are mapped on Figure 4-8 in Chapter 4. There are a total of four residential/resort projects and one industrial/commercial project proposed in the study area. A total of approximately 6,925 dwelling units would be added to the region as a result of buildout of all proposed residential/resort developments. The University of Hawaii is planning to develop a 500-acre parcel mauka of the Keahole Airport as part of its West Hawaii campus.

Table B-1 in Appendix B summarizes the proposed projects within the study area. This table lists the owner/developer, key project elements, total acreage, target project completion date, and current status of each project.

Constraint Evaluation

Constraint Rating–Medium

Proposed Residential, Schools, Resort, and Recreation. Proposed residential, school, resort, and recreation projects are rated medium constraint because of public concern generally expressed about the potential visual and health effects of transmission lines. Whereas existing residential, school, resort, and recreation land uses are rated high constraint, when those uses are proposed rather than existing, they are rated medium constraint because proposed projects provide opportunities to site transmission lines into or around the proposed development before the project is constructed.

Constraint Rating–Low

Proposed Industrial. Siting a new transmission line near a proposed industrial project would not create significant land use conflicts or generate substantial community concerns regarding health or visual effects. Industrial land use is generally compatible with transmission lines and is rated low constraint.

Visual Resources

Siting Issues

Goals to protect Hawaii's natural beauty and scenic qualities are addressed in the *Hawaii County General Plan* (Hawaii County, 1989). These goals include:

- Protecting, preserving, and enhancing the quality of areas endowed with natural beauty, including the quality of coastal scenic resources
- Protecting scenic vistas and view planes from becoming obstructed
- Maximizing opportunities for current and future generations to appreciate and enjoy natural and scenic beauty

Specific general plan policies seek to improve public access to scenic places and to preserve views of scenic or prominent landscapes viewed from specific locations. The general plan lists views of the mountains and the ocean along Queen Kaahumanu Highway as examples of natural beauty. Other examples of natural beauty in the study area cited in the general plan include Kaloko Pond, Honokohau Fish Pond, Honokohau Harbor, Honokohau Coastline, Aimakapa White Sand Beach, the White Sand Beach at the Old Kona Airport State Park,

Keahole Point, and Kailua Bay. Views from points of interest cited in the *Keahole to Kailua Development Plan* (Hawaii County, 1991) included those from Keahole Airport, Honokohau Harbor, and the Old Kona Airport State Park.

The study area's visual context is characterized by sparse vegetation and lack of significant tree cover, especially along the shoreline and lowland areas. These characteristics make this area sensitive to visual impacts. In the short term, while the area between Mamalahoa and Queen Kaahumanu Highways remains largely undeveloped, the introduction of overhead transmission lines would be visible against the flat terrain.

Inventory

The following visual resources inventory identifies areas with sensitive viewer groups that could constrain the location of a transmission line corridor. The inventory also identifies areas that would provide opportunities for siting a new corridor. The methodology followed for preparing this inventory consisted of first identifying critical viewer groups in the study area and then defining areas around each group in which a transmission line would be significantly visible.

The four critical viewer groups identified in the Keahole-Kailua study region are those in existing residential areas, in existing recreation areas, at natural and scenic sites recognized in the *Hawaii County General Plan*, and at points of interest shown in the *Keahole to Kailua Development Plan*. These areas, sites, and points of interest have the highest numbers of potential viewers in the study area and are considered to be the most sensitive to the visual impacts from a new transmission line.

Next, an area one-half mile in radius was defined around each viewer group in the existing residential areas, in the existing recreational areas, and at natural and scenic sites. This distance was calculated based on general observations of the visibility of other transmission lines at various distances. In general, transmission line poles or other objects that are up to 100 feet in height and are located at a distance greater than one-half mile begin to merge into the surrounding landscape and are considered visually unobtrusive.

An area 1 mile in radius was defined around the viewer groups at the points of interest shown in the *Keahole to Kailua Development Plan*. This 1-mile distance was used because the views from these points of interest were of more expansive view planes, which would be more susceptible to visual impact.

The critical viewer groups discussed above were identified and mapped on Figure 4-9 in Chapter 4. The following visual inventory describes the general character of views in the study region from these groups.

Existing Residential Areas

Major existing residential subdivisions in the study area include Kona Highlands, Kona Wonderview Lots, Kona Coast View Subdivision, Kona Acres, Kona Palisades, Kona Heavens Lots, Kona Chocho Estates, Kona Macadamia Acres, Queen Liliuokalani Village, and the Kealakehe Homesteads. A number of smaller clusters of single-family homes are located mauka and makai of Mamalahoa Highway. Other developments that are well along in the land use approval process and contain residential elements include the Y-O Residential Development, the TSA-Kaloko Properties, and Kealakehe Residential Community; these were treated as existing residential areas for this analysis. Makai views from these areas are generally of undeveloped land in the foreground, with the shoreline and ocean in the background. Mauka views include the barren slopes of Hualalai.

Existing Recreation Areas

Major recreation areas in the study area include Wawaloli Beach, the Kaloko-Honokohau National Historic Park, Honokohau Harbor, and Old Kona Airport State Park. The golf course in the TSA-Kaloko Properties Project and the golf course in the Kealakehe Residential Community are within projects that are well along in the land use approval process; they are considered existing recreation areas for this analysis. Makai views from these areas are of the coast and ocean. Mauka views comprise the gentle slopes of the coastal plain in the foreground and the lower slopes of Hualalai in the background.

Natural and Scenic Sites Described in the Hawaii County General Plan

Queen Kaahumanu Highway. Queen Kaahumanu Highway is a major north-south transportation corridor connecting Kailua with Keahole Airport and destinations to the north. Views both southbound and northbound are principally seen by motorists travelling at speeds of 35 to 55 miles per hour (mph). At these speeds, a motorist's cone of vision is approximately 30 degrees to the right or left. Makai views within this 30-degree cone of vision include the gently sloping grassy coastal plain and ocean.

Existing transmission line poles, located within approximately 1,000 feet of the highway right-of-way, occupy a motorist's mauka foreground views. Some existing commercial and industrial development located adjacent to and mauka of Queen Kaahumanu Highway also can be seen in the foreground of this view. Other features in this mauka view include rising grassland in the middle ground and the slopes of Hualalai in the background.

Kaloko Pond, Honokohau Fish Pond, Honokohau Harbor, Honokohau Coastline, Aimakapa White Sand Beach, the White Sand Beach at the Old Kona Airport State Park, Keahole Point, and Kailua Bay. These areas are all located on or near the shoreline. Makai views from these sites are dominated by the ocean while mauka views comprise the coastal plain in the foreground and Hualalai in the background.

Views from Points of Interest Described in the Keahole to Kailua Development Plan

Keahole Airport, Honokohau Harbor, and the Old Airport State Park. High public usage is typical at these points of interest. Expansive mauka views consist of the coastal plain in the foreground and Hualalai in the background.

Constraint Evaluation

Constraint Rating--High

Natural and Scenic Sites Described in the Hawaii County General Plan and Views from Points of Interest Described in the Keahole to Kailua Development Plan. The views from natural and scenic sites are rated high constraint because these resources are recognized in the *Hawaii County General Plan* or *Keahole to Kailua Development Plan* for their unique and high value as examples of natural beauty in the region.

Constraint Rating – Medium

Existing Residential and Recreation Areas. The views from existing residential, resort, and recreation uses are rated medium constraint because of general community concerns regarding the aesthetic effects of transmission lines near these areas.

Biological Resources

Siting Issues

Biological resources could affect the location of a new transmission line, particularly in areas where there are known or potential endangered, threatened, or sensitive vegetation or wildlife species. Sensitive biological resources identified and mapped include endangered and candidate endangered plants and animals, natural communities, remnant forest dominated by native Hawaiian vegetation, lava tube openings, and potential lava tube corridors. These areas are shown on Figure 4-10 in Chapter 4.

The biological resources map is based on a reconnaissance survey of the study area and a search and review of the Hawaii Heritage Program data base and the state and federal lists for threatened and endangered plants and animals. The specific location of sensitive biological elements sighted in the study area often could not be identified precisely. Individual sightings of biological elements are also identified on Figure 4-10 with graduated circles and diamonds. These circles and squares define the area where the element would probably be located. For example, the larger the circle, the larger the area that the element could be located within. Diamonds represent highly mobile elements (e.g., animals).

Aa Lava Flows

Aa lava flows cover approximately 55 percent of the study area. This land type includes bare aa lava flows on the lower elevations of Hualalai and aa lava flows covered by thin soils at higher elevations.

Soil thickness on aa flows varies according to the age of the flow and the amount of rainfall. At elevations below 800 feet, soil consists of thin windblown sand and silt that accumulates in crevices and depressions on the aa surface. At elevations greater than 800 feet, rainfall is greater and the aa is covered by a 2- to 20-inch mat of organic-rich stony silt soil. In general, permeability is rapid, runoff is slow, and the erosion hazard is considered slight on aa land surfaces.

Beaches and Near-Shore Lava Flows 1,000 Feet Inland

Beaches and near-shore lava flows are located adjacent to the shoreline. Beach sand ranges in thickness from 1 foot to more than 20 feet. Loose beach sands or lagoonal sediments along the shoreline may extend approximately 1,000 feet inland under pahoehoe and aa lava flows.

Constraint Evaluation

Constraint Rating—High

Beaches and Near-Shore Lava Flows 1,000 Feet Inland. Beaches and near-shore lava flows and the area measured 1,000 feet inland from the beach are rated high constraint because the loose composition of these surfaces is a significant hazard to transmission line construction and operations.

Constraint Rating—Low

Pahoehoe Lava Flows. A potential conflict in siting a transmission line on the pahoehoe land type is the presence of subsurface cavities that may be hazardous during foundation construction. However, pahoehoe lava flows are rated low constraint because this hazard is routinely mitigated through construction practices.

Aa Lava Flows. The high variability in the composition of aa lava formations could be a potential hazard to transmission line construction. These formations could contain clinker or hard aa core rock. However, these hazards are routinely mitigated through foundation design; therefore, aa lava surfaces are rated low constraint.

Cultural Resources

Siting Issues

The presence of large areas containing numerous archaeological or historic sites could affect the location of a transmission line corridor. A sensitivity study was prepared that identified known archaeological and historic sites. Trails, burials, and recent lava flows were then mapped and classified with low, moderate, or high potential for the presence of undiscovered cultural resources based on project-specific sensitivity criteria developed by an archaeologist. These areas are shown on Figure 4-12 in Chapter 4.

Inventory

Areas with High Potential for Cultural Resources

Areas identified with high potential for cultural resources are found near the coast, in inland areas lower than 500 feet in elevation, and in areas associated with natural phenomena such as lava tubes and sinkholes. Archaeological and cultural sites in these areas date to both prehistoric and historic periods. Prehistoric sites or features include burials and fish ponds. Historic sites include burials, trails, and petroglyphs.

Areas with Moderate Potential for Cultural Resources

Areas of moderate potential for cultural resources identified in the study area are generally located above the 500-foot elevation level. These areas cover the majority of the study area. Cultural resource sites in these areas would date to both prehistoric and historic periods.

Areas with Low Potential for Cultural Resources

Areas identified with low cultural resources potential include the recent lava flows from Mauna Loa and Hualalai; these flows would have destroyed any evidence of cultural use in the area. These areas are located in the northwest corner of the study region and in areas north of the study region boundary.

Constraint Evaluation

Constraint Rating—High

Areas with High Potential for Cultural Resources. Areas with a strong potential for cultural resources are rated high constraint based on the high incidence of sensitive and significant cultural remains documented in the area. These areas would require further site investigation during the corridor evaluation process.

Constraint Rating–Medium

Areas with Moderate Potential for Cultural Resources. These sections of the study area are rated medium constraint because they have low archaeological site density and because the overall probability that they contain clusters of significant cultural sites or features is also low. These areas would require further site surveys after the alternative corridors are selected.

Constraint Rating–Low

Areas with Low Potential for Cultural Resources. These areas are rated low constraint because there is a poor likelihood of archaeological recovery in the area based on the limited number and variety of cultural resource sites and features.

Utility and Transportation Systems

Siting Issues

Certain regulatory restrictions on land use preclude rather than constrain the location of transmission lines. Consequently, such areas are excluded at the outset from consideration as potential locations for transmission lines. Areas where the siting of transmission lines is essentially precluded within the study area include Air Interference Zones (Federal Aviation Administration [FAA] Regulations, Part 77, Objects Affecting Navigable Airspace) at the Keahole Airport, and where the minimum separation requirement between transmission lines would not be met (Public Utilities Commission General Order No. 6).

Siting a new 69 kV transmission line through areas that do not have any existing utility or transportation systems poses more of a difficulty than siting a new transmission line adjacent to or within an easement containing an existing utility or transportation system. Long transmission line corridors are also more costly than short transmission line corridors.

Within the Keahole-Kailua study area, the typical width of an existing right-of-way for linear facilities (e.g., roads and transmission lines) ranges from approximately 25 feet for 69 kV transmission lines to more than 100 feet for state highways. All major roadways and existing transmission lines are identified on all of the environmental data maps and in Chapter 4.

An analysis was conducted of each corridor's sensitivity to a utility and transportation system by measuring the distance that each corridor passes through areas without existing utility or transportation systems, areas adjacent to an existing utility or transportation system, or areas within an existing utility or transportation easement. The sensitivity analysis favors shorter lines over longer lines, and it favors corridors that are adjacent to or within the same easement as an existing utility or transportation system over those corridors that are not within the same easement as an existing utility or transportation system.

Inventory

State Highways

Two routes in the study area are designated state highways: Queen Kaahumanu and Mamalahoa.

Transmission Lines, Switching Stations, Substations, and Generating Stations

Keahole Switching Station, which is next to Keahole Generating Station, is located in the northern portion of the study area mauka of Queen Kaahumanu Highway. HELCO maintains one switching station and five 69 kV substations in the study region: Keahole Switching Station, Keahole Airport Substation, HOST Park Substation, Kaloko Substation, Kealakehe Substation, and Kailua Substation.

Two 69 kV lines are located in the study area. One 69 kV line travels south from Keahole Switching Station about 1,000 feet mauka to and along Queen Kaahumanu Highway and connects into Kailua Substation. A second 69 kV line originates from Keahole Switching Station, travels mauka through undeveloped land and then south, adjacent to and mauka of Mamalahoa Highway. After Palani Junction, this transmission line switches back and forth along both sides of Palani Road before entering Kailua Substation.

Constraint Evaluation

Constraint Rating—High

Areas without any utility or transportation systems are rated high constraint.

Constraint Rating—Medium

Areas that are adjacent to an existing utility or transportation system are rated medium constraint.

Constraint Rating—Low

Areas that are within an existing utility or transportation system easement are rated low constraint.

APPENDIX B

Appendix B

Land Use Project Profiles

Contents

Residential/Resort Projects

Project Name: Keahuolu Lands

Owner/Developer: Liliuokalani Trust Estate

Status: Preliminary planning stage; selecting developer

Land Use Summary: Total Acreage: 1,135 Total DUs: 2,915

Project Description:

Conceptual plans have been prepared to develop a mixed-use/residential project on 1,135 acres belonging to the Liliuokalani Trust Estate near Kailua. The project plans include a mix of 1,365 single family and 1,550 multi-family units on about 700 acres. Other project features include commercial, agricultural, service/industrial uses, parks/open space, and a wastewater treatment plant. As of May 1992, the project was on hold and Liliuokalani Trust Estate was in the process of selecting a developer.

Resource Category Assignment: Proposed Land Use

Source: Telephone conversation with Lee Sichter, Belt Collins & Associates, on May 5, 1992 (telephone 521-5361).

Belt Collins & Associates, Liliuokalani Trust Keahuolu Lands Environmental Impact Statement, August 1990.

Project Name: Kealakehe Residential Community

Owner/Developer: State of Hawaii/Hawaii Housing Finance and Development Corporation (HFDC)

Status: Phase I infrastructure construction underway; construction of first village development anticipated by the end of 1992

Land Use Summary: Total Acreage: 900± Total DUs: 4,158

Project Description:

The Hawaii Housing Finance and Development Corporation (HFDC) is undertaking a 900± acre mixed used development in the area between Queen Kaahumanu Highway and Palani Road. The project includes development of approximately 589 acres for residential land uses, with a total of 4,158 units distributed among 14 villages. Each village will feature a mixture of residential units equal to 60 percent affordable and 40 percent market price. There will be a total of 1,254 single family and 2,904 multi-family units. Other project features include recreation facilities such as a golf course and parks, neighborhood commercial services and a community shopping center, schools, civic centers, and a police facility. Phase I infrastructure, including roads, sewer, water, and drainage facilities, was being constructed in May 1992. Phase I and Phase II infrastructure is anticipated to be complete by the fall of 1992 with ground breaking for the first village at the end of 1992.

Resource Category Assignment: Existing Land Use

Projects under construction are considered as existing land uses.

Source: Telephone conversation with Francis Blanco, Project Manager, Kealakehe Planned Community, Hawaii Housing Finance and Development Corporation, on May 5, 1992 and June 22, 1992 (telephone: 587-0550).

Belt Collins & Associates, Kealakehe Planned Community Environmental Impact Statement, June 1990.

Project Name: Kohanaiki Resort

Owner/Developer: Nansay Hawaii

Status: State Land Use Reclassification approved; general plan amendment approved; zoning approved; preliminary subdivision approval in process; SMA permit for 70% of land in litigation since November 1990

Land Use Summary: Total Acreage: 470 Total DUs: 710

Project Description:

Nansay Hawaii plans to develop a residential/resort project on 470 acres makai of Queen Kaahumanu Highway. The project plans include 1,050 hotel units, 710 residential units, and an 18-hole golf course. The SMA permit is currently being contested in court. The project was initially scheduled to be completed by the year 2005. The start of construction and the project's schedule will depend upon the outcome of the litigation.

Resource Category Assignment: Proposed Land Use

Source: Telephone conversation with Keith Kato, project manager, Nansay Hawaii, on May 6, 1992 (telephone: 895-5300).

Department of Planning, County of Hawaii, Keahole to Kailua Development Plan, North Kona, Island of Hawaii, April 1991.

Project Name: Lanihau Residential Community

Owner/Developer: Lanihau Partners LP and Palani Land Trust II

Status: In Preliminary Planning Phase

Land Use Summary: Total Acreage: 1,325 Total DUs: 3,000

Project Description:

Lanihau Partners LP and Palani Land Trust II plan to develop 3,000 acres between Queen Kaahumanu and Mamalahoa Highways and mauka of Mamalahoa Highway for a mixed-use residential project. The plan calls for 3,000 multi-family, low-density units on 630 acres that includes public parks, recreational areas, and open space. Other project features include neighborhood convenience centers and nursing and retirement homes mauka of Mamalahoa Highway, commercial/service and office uses, light industry, and approximately 100 to 110 one-acre agricultural parcels. The commercial and light industrial areas will be developed during the first phase of the project. The project is anticipated to be completed after the year 2000.

Project is consistent with County General Plan, and so no amendment to the County General Plan is required. As of June 1992, no environmental assessment has been prepared.

Resource Category Assignment: Proposed Land Use

Source: Telephone conversation with Jim Greenwell, Lanihau Partners, L.P., on June 26, 1992 (telephone 836-2076).

Planning Department, County of Hawaii

Project Name: Ooma Resort

Owner/Developer: American Trust Company of Hawaii, Inc./Kahala Capital Corporation

Status: State Land Use Reclassification in process (May 1992)

Land Use Summary: Total Acreage: 314 ± Total DUs: 300 multi-family

Project Description:

The Kahala Capital Corporation is planning a mixed-use/resort development on 314 acres makai of Queen Kaahumanu Highway. The project will include a 600-unit resort hotel, 300 multi-family residential units, an 18-hole golf course and clubhouse, 20-acre office park, 50-acre high-tech area, open space, and sewage treatment plant. Approval from the State Land Use Commission on the petition to reclassify land designated Conservation to Urban is anticipated by the fall of 1992. If other County approvals (e.g.: re-zoning, SMA permit) are approved in 1993, the anticipated project completion date will be 1996.

Resource Category Assignment: Proposed Land Use

Source: Telephone conversation with Toni Fortin, Vice-President, Kohala Capital Corporation, on May 5, 1992 (telephone: 326-1333).

Project Name: TSA-Kaloko Properties/Kona International Golf Course

Owner/Developer: TSA International, Ltd./Kaloko Properties

Status: State Land Use boundary amendment granted
Subdivision approval for some portions granted other portions pending approval.

Land Use Summary: Total Acreage: 1,168 Total DUs: 5,652

Project Description:

TSA International, Ltd. and Kaloko Properties are developing 1,168 acres mauka of Queen Kaahumanu Highway for a mix of residential, business/commercial/light industrial, and recreational uses. Approximately 5,652 medium-low density residential units will occupy 753 acres, with 225 acres in the makai portion of the project site proposed for business/commercial use. The central portion of the project site will be developed with the 18-hole Kona International Golf Course.

A mauka-makai roadway, connecting Queen Kaahumanu and Mamalahoa Highways, bisects the site, and was under construction in June 1992 (Subdivision approval obtained for adjacent Kaloko light industrial portion granted contingent on completion of roadway.) Subdivision approval is pending for other portions of the project.

Resource Category Assignment: Existing Land Use

Projects which have obtained substantial land use approvals, and had infrastructure under construction, were considered existing land uses.

Source: Telephone conversation with Brian Fievet, TSA International, Ltd., on June 26, 1992 (telephone 942-2131).

Wilson Okamoto & Associates, Inc., Master Plan, Kaloko Properties.

Project Name: Y-O Residential Development

Owner/Developer: Y-O Ltd. Partnership

Status: Zoning approved, Subdivision in process

Land Use Summary: Total Acreage: 410 Total DUs: 1,433

Project Description:

Y-O Ltd. Partnership is planning on developing 410 acres between the Mamalohoa and Queen Kaahumanu Highways with a mixed-use residential subdivision. The project would consist of a total 1,093 single family residential units on lots ranging in size from 7,500 to 15,000 square feet, and 340 multi-family units. The single and multi-family units would be developed at a density of 2.9 and 14 dwelling units per acre, respectively. Commercial development would occupy 5.5 acres of the project site, with the remainder reserved for a 5-acre park, two water reservoirs, and roadways. An 80-foot wide right-of-way for a mauka-makai roadway connecting Queen Kaahumanu and Mamalahoa Highways bisects the project site and was under construction in June 1992. The project would be developed in six increments over a five year period.

Resource Category Assignment: Existing Land Use

Projects which have obtained substantial land use approvals, and had infrastructure under construction, were considered existing land uses.

Source: Telephone conversation with Steven Menezes, Menezes and Tsukazaki, representing Y-O Ltd. Partnership, on June 26, 1992 (telephone 961-0055).

Belt Collins & Associates, Proposed Mixed Use Residential Subdivision.
Planning Department, Hawaii County, Keahole-Kailua Development Plan, April 1991.

School Project

Project Name: University of Hawaii West Hawaii Campus

Owner/Developer: State of Hawaii

Status: Preliminary Planning Stage

Land Use Summary: Total Acreage: 500± Total DUs: Unknown

Project Description:

The University of Hawaii has selected a site for its University of Hawaii West Hawaii Campus on 500± acres mauka of Keahole Airport. The project will include a core-university site, and will also include University related residential areas. The University of Hawaii intends to apply for a 65-year lease with the State DLNR by the end of 1992, and intends to submit a budget request at the 1993 session of the State Legislature.

Resource Category Assignment: Proposed Land Use

Source: Meeting with Ralph Horii, Vice-President for Administration, University of Hawaii, July 22, 1992.

Industrial, Commercial, and Recreation Projects

Project Name: Hawaii Ocean Science & Technology (HOST) Park Research Facility

Owner/Developer: State of Hawaii/KAD Partners, various developers

Status: Zoning approval in process (May 1992)

Land Use Summary: Total Acreage: 547-acre HOST Park including 66 acre KAD Project

Total DUs: 0

Project Description:

KAD Partners is planning to develop 66 acres at the 547-acre Hawaii Ocean Science and Technology (HOST) Park, an industrial park planned for high-technology aquaculture, mariculture, and ocean science business. The proposed 66-acre KAD development will include a lobster farm, research area, visitor center, archaeological preserve, and 1 megawatt ocean thermal energy conversion (OTEC) plant. The energy produced by the OTEC plant will be used solely for facility operations. This project is planned for completion by mid-1995. Although there are no additional projects proposed at this time for HOST Park, there are plans to develop two or three aquaculture farms within the next three years (by 1995).

Resource Category Assignment: Existing Land Use

Projects which are located within areas already set aside for and substantially developed, are considered existing land uses.

Source: Telephone conversation with Clair Hachmuth, Executive Director, National Energy Laboratory of Hawaii, on May 4, 1992 (telephone: 329-7341).

Honolulu Star Bulletin, July 13, 1992.

Project Name: Honokohau Harbor Expansion

Owner/Developer: Department of Land and Natural Resources, Small Boats Division (formally Department of Transportation, Harbors Division)

Status: Design plans complete; waiting on bids for construction contract

Land Use Summary: Total Acreage: N/A Total DUs: 0

Project Description:

Planned improvements to Honokohau Harbor include construction of a new Harbor Master Office, restrooms, and catwalks. Design plans for these improvements are complete. The anticipated completion date for project construction is the end of 1992.

Resource Category Assignment: Existing Land Use

Projects within areas substantially developed are considered existing land uses.

Source: Telephone conversation with Ken Denton, Harbor Agent, Department of Land and Natural Resources, Small Boats Division, Honokohau Harbor, on May 1, 1992 (telephone: 329-4215).

Project Name: Honokohau Industrial Park

Owner/Developer: Robert F. McLean

Status: EIS on State Land Use Reclassification accepted, re-zoning application in process

Land Use Summary: Total Acreage: 84 Total DUs: 0

Project Description:

Robert McLean plans to develop 84-acres mauka of Queen Kaahumanu Highway for light industrial use. The project site is divided into two parts: makai and mauka. Increment I of the project will occur on the makai segment, and will include a nursery, retail/manufacturing of lumber products, an office complex, automotive sales, service and repair, and short-term quarry use on a total of 40 acres. The remaining 44 acres on the mauka segment will be subdivided at a later date as part of Increment II development. An EIS on the reclassification of the makai segment from Conservation to Urban land has been accepted and the application for re-zoning is in process. Project build-out is anticipated over the next 10-15 years.

Resource Category Assignment: Existing Land Use

Source: Telephone conversation with David Curry, Helber, Hastert & Kimura, on May 5, 1992 (telephone: 545-2055).

Project Name: Kaloko-Honokohau National Historic Park

Owner/Developer: U.S. National Park Service

Status: Initial general management planning stages; pending Congressional funding

Land Use Summary: Total Acreage: 600± Total DUs: 0

Project Description:

The U.S. National Park Service is developing a cultural and historic park for the preservation, interpretation, and perpetuation of traditional Native Hawaiian activities and culture on approximately 600 acres makai of Queen Kaahumanu Highway. Tentatively planned facilities at the park include a visitor/orientation center, trails to fishponds, and a replica of a village. The park will also preserve all archaeological sites. Only one road into the site has been developed, and a "portable" visitor center is in place. The Draft Management Plan was prepared in May 1992. Project construction will depend upon Congressional approval to appropriate the necessary funding. As of June 1992, the project completion date is unknown. Public meetings to discuss the draft management plan scheduled for August 1992.

Resource Category Assignment: Existing Land Use

Federal projects on lands already set aside for that use are considered existing land uses.

Source: Telephone conversation with Jerry Case, Chief Ranger, Koloko-Honokohau National Historic Park, on May 4, 1992 and June 19, 1992 (telephone: 329-6881).

Department of Planning, County of Hawaii, Keahole to Kailua Development Plan, North Kona, Island of Hawaii, April 1991.

Project Name: Kaloko Light Industrial Park

Owner/Developer: TSA International, Ltd.

Status: Portion of re-zoning approved

Land Use Summary: Total Acreage: 240 Total DUs: 0

Project Description:

TSA International, Ltd. plans to subdivide 240 acres mauka of Queen Kaahumanu Highway into 194 one-acre lots for light industrial use. Phase I of this four phase project is complete and includes 49 lots located in the makai portion of the project site.

Subdivision approval obtained for Kaloko Light Industrial park contingent upon completion of mauka-makai roadway. Roadway was under construction in June 1992.

Resource Category Assignment: Existing Land Use

Projects which have obtained substantial land use approvals, and had infrastructure under construction, were considered existing land uses.

Source: Planning Department, County of Hawaii.

Wilson Okamoto & Associates, Inc., Master Plan, Kaloko Properties.

Telephone conversation with Brian Fievart, TSA International, Ltd. on June 26, 1992 (telephone 942-2131).

Project Name: Keahole Airport Expansion

Owner/Developer: Department of Transportation, Airports Division, Keahole Airport

Status: Under construction

Land Use Summary: Total Acreage: N/A Total DUs: 0

Project Description:

The Keahole Airport is being expanded to accommodate increased air traffic. Specific projects include: extension of the existing runway from 6,500 to 11,000 feet; overlaying the existing runway to increase landing load; expanding and renovating the existing terminal, including the addition of passenger loading bridges; and addition of general parking and storage areas south of the airport. With the exception of terminal renovations, the majority of the projects will be under construction by the fall of 1992. Terminal renovations will begin at the start of 1993. Approximately 80% of the expansion projects will be complete by the end of 1993, with the remainder scheduled for completion by mid-1995.

Resource Category Assignment: Existing Land Use

Projects which are located within areas already set aside for a use and substantially developed, are considered existing land uses.

Source: Telephone conversation with Frank Kamahele, Airports District Manager, Keahole Airport, on May 4, 1992 (telephone: 329-2484).

Project Name: Kealakehe Wastewater Treatment Facility

Owner/Developer: County of Hawaii

Status: Under construction (July 1992)

Land Use Summary: Total Acreage: 63 Total DUs: 0

Project Description:

The County of Hawaii is constructing a regional wastewater treatment facility on 63 acres makai of Queen Kaahumanu Highway near Honokohau Harbor. The facility uses aerated lagoons in its treatment process and has the capacity to treat a total of 4.4 million gallons per day (mgd) of wastewater. Approximately 1.6 of the total 4.4 mgd is reserved for the Kealakehe Residential Community. The treatment facility was under construction in July 1992 and is scheduled to be complete by May 1993.

Resource Category Assignment: Existing Land Use

Projects under construction are considered existing land uses.

Source: Telephone conversation with Harold Sugiyama, Division Chief, Wastewater Division, Hawaii County Public Works Department, on May 5, 1992 (telephone: 961-8338).

Project Name: Kona Industrial Subdivision Expansion

Owner/Developer: Liliuokalani Trust Estate

Status: Re-zoning approved; project on hold, no developer selected

Land Use Summary: Total Acreage: 100± Total DUs: 0

Project Description:

The project involves expansion of the existing Kona Industrial Subdivision onto 100 acres of land makai of Queen Kaahumanu Highway in Kailua. This property would be subdivided into approximately 76 lots ranging in size from 1 to 2 acres. The project has been granted a re-zoning but development is on hold until a new developer is selected.

Resource Category Assignment: Proposed Land Use

Source: Telephone conversation with Lee Sichter, Belt Collins & Associates, on May 5, 1992 (telephone: 521-5361).

Project Name: Natural Energy Laboratory of Hawaii (NELH) Expansion

Owner/Developer: State of Hawaii/NELH

Status: Re-zoning approved

Land Use Summary: Total Acreage: 322 Total DUs: 0

Project Description:

The State of Hawaii plans to expand existing operations at the Natural Energy Laboratory of Hawaii at Keahole Point. Expansion plans include upgrading the Seacoast Test Facility to add an experimental test facility, ocean water pump station, and disposal facility for Ocean Thermal Energy Conversion water, and installation of pipes and distribution lines. The NELH laboratory compound will be expanded to accommodate research and development of mariculture and future energy projects. Plans also call for expansion of exiting aquaculture and mariculture activities, as well as development of 21 acres along Hoona and Makake Bays for solar ponds, wave energy conversion, and marine biomass energy projects.

Resource Category Assignment: Existing Land Use

Projects which are located within areas already set aside for a use and substantially developed, are considered existing land uses.

Source: Planning Department, County of Hawaii

Table B-1
Summary of Land Use Projects in the Study Area

Project Title	Owner/Developer	Project Elements	Total Acreage	Project Completion Date	Current Status	Resource Category Assignment
Residential/Resort Projects						
Keahuolu Lands	Liliuokalani Trust Estate	1,550 multi-family units; 1,365 single family units; commercial; service/industrial; agricultural	1,135	UN	P	P
Kealakehe Residential Community	State of Hawaii/Hawaii Housing Finance and Development Corporation	2,904 single family units; 1,254 multi-family units; resort hotel; neighborhood commercial; recreation facilities (golf course, parks); community and public facilities (community center, schools, sewage treatment plant)	1,500±	2007-2012	U	E
Kohanaiki Resort	Nansay Hawaii	380 single family units; 330 multi-family units; 1,050 resort hotel units	273	2005	A	P
Lanihau Residential Community	Lanihau Partners LP and Palani Land Trust II	3,000 multi-family units; commercial (neighborhood convenience centers, regional market); industrial (light industrial uses); agricultural	1,325		UN	P
Ooma Resort	Kahala Capital Corporation	600-unit resort hotel; 300-unit multi-family residential; marine park/visitor center; office park; high-tech area; 18-hole golf course and clubhouse	314±	1996	P	P
TSA-Kaloko Properties/Kona International County Club	Takemasa International Inc./TSA International, Ltd. & Kaloko Properties	5,652 single-family units; Kona International Country Club (18-hole golf course); business commercial; recreation	1,168		UN	E
Y-O Development Residential	Y-O Ltd. Partnership	1,093 single-family units; 340 multi-family units; commercial area; park	410		A	E

Table B-1
Summary of Land Use Projects in the Study Area

Project Title	Owner/Developer	Project Elements	Total Acreage	Project Completion Date	Current Status	Resource Category Assignment
School Project						
University of Hawaii, West Hawaii Campus	State of Hawaii	500-acre core university site. May also include university-related residential areas in surrounding area	500±	UN	P	P
Industrial, Commercial, and Recreation Projects						
Hawaii Ocean Science & Technology (HOST) Park Research Facility	Hawaii Technology Development Corporation, individual developers	41-lot subdivision for high-technology, alternate energy, marine biotechnology, pharmaceutical development, aquaculture, mariculture, and ocean science business. Proposed 66-acre KAD project includes lobster farm, research area, and 1 megawatt ocean thermal energy conversion plant	547±	UN/ 1995 (KAD project)	P	E
Honokohau Harbor Expansion	Department of Land and Natural Resources, Small Boat Division	New Harbor Master Office, restrooms, catwalks	--	end-1992	A	E
Honokohau Industrial Park	Robert F. McLean	Short-term quarry use; nursery; retail/manufacture lumber; office; storage	84	2002±	A	P
Kaloko-Honokohau National Historic Park	U.S. National Park Service	Cultural and historic park for preservation, interpretation, and perpetuation of traditional Native Hawaiian activities and culture. Visitor/orientation center, trails	600±	1994-2002	P	E
Kaloko Light Industrial Park	TSA International, Ltd.	194 1-acre lots for light industrial use	240±	UN	A	E
Keahole Airport Expansion	State of Hawaii/State Department of Transportation, Airports Division	Existing runway expansion; terminal expansion/renovation; general parking and storage areas	--	mid-1995	U	E
Kealakehe Wastewater Treatment Facility	County of Hawaii	Aerated lagoons; pump station	63	May 1993	U	E

Table B-1
Summary of Land Use Projects in the Study Area

Project Title	Owner/Developer	Project Elements	Total Acreage	Project Completion Date	Current Status	Resource Category Assignment
Kona Industrial Subdivision Expansion	Liliuokalani Trust Estate	Expansion of existing adjacent industrial subdivision containing 76 lots ranging from 1 to 2 acres	100±	UN	A	P
Natural Energy Laboratory of Hawaii (NELH) Expansion	State of Hawaii	Upgrade Seacoast Test Facility, expand NELH laboratory compound, aquaculture and mariculture facilities, shoreside marina projects, parking area	322	UN	A	E

Project Completion Date Code
UN = Project Completion Date Unknown

Current Status Codes
P = Planned/Proposed (project proposed, but no permits or approvals received)
A = Approved (some or all permits or approvals received)
U = Under construction (at least one phase of the project under construction)

Resource Category Assignment Codes
P = Proposed Land Use
E = Existing Land Use

Sources:
Planning Department, County of Hawaii, Keahole-Kailua Development Plan, April 1991.
Planning Department, County of Hawaii. "County of Hawaii Developments and Proposed Projects, Information Sheet," presentation by Norman Hayashi, Director of County of Hawaii Planning Department, at the American Planning Association Luncheon, Honolulu, Hawaii June 30, 1992.
Various telephone conversations with project proponents.

APPENDIX C

APPENDIX C

Appendix C

Geological Resources: Alternative Corridor Evaluation

MFA
MASA FUJIOKA & ASSOCIATES
A PROFESSIONAL PARTNERSHIP

APPLIED ENVIRONMENTAL AND EARTH SCIENCES

- ENVIRONMENTAL SCIENCES
- GEOTECHNICAL ENGINEERING
- HYDROGEOLOGY

REPORT
ALTERNATIVE CORRIDOR EVALUATION
PROPOSED KEAHOLE-KAILUA 69kV
TRANSMISSION LINE
NORTH KONA DISTRICT
HAWAII, HAWAII

MFA JOB NO. 92045-002
February 1, 1993

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Proposed Keahole-Kailua 69kV Transmission Line
North Kona District, Hawaii, Hawaii

1.0 INTRODUCTION

This report presents the results of a corridor evaluation conducted by Masa Fujioka & Associates (MFA) for the proposed Keahole-Kailua 69kV transmission line in the North Kona District on the Island of Hawaii. The approximate location of the site is shown on the Map of Area (Figure 1 inset).

A geologic field investigation of the site was conducted on October 7 and 8, 1992. Published information was used to assist in compiling a detailed description of the geologic/geotechnical/and physical characteristics of the site.

The site consists of pahoehoe and aa lava flows overlain in some areas by a thin soil layer. Vegetation is present in some areas and ranges from grass to 15-foot trees.

2.0 PROJECT CONSIDERATIONS

The area of investigation for this study includes two corridors of land which extend approximately 6.8 miles from the Keahole Airport Substation to the Kailua Substation. Close proximity to the Queen Kaahumanu Highway allowed easy access to Corridor S1. Private ownership of the land mauka of the Queen Kaahumanu Highway (Corridor S2) prevented access on foot. Therefore, an aerial survey of Corridor S2 was done via helicopter.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of this investigation was to evaluate the general geotechnical condition of two alternative corridors for the proposed Keahole-Kailua 69kV transmission line in the North Kona District on the Island of Hawaii. The following scope of work has been completed:

1. Background Data Review - MFA reviewed background data on the geology and soils of the alternative corridors. Information reviewed includes our report and maps developed for the regional background study. We also reviewed U.S. Soil Conservation Service and U.S. Geological Survey reports and maps, as well as topographic maps and aerial photographs specific to the two corridors under consideration.

2. Field Reconnaissance - MFA personnel (a geotechnical engineer and geologist) performed field reconnaissance for the corridors. The purpose of the field investigation was to confirm the land type designations presented on the Land Types map, which was submitted with our regional background study report, as well as to determine any geomorphologic features that might be of concern with respect to construction of the proposed transmission line and access road.

3. Report - A copy presenting the findings of MFA's investigation is herewith submitted. It includes a detailed geologic map and comparison of the general soils and geologic features of the

features of the alternative corridors, as well as a discussion of the geotechnical considerations associated with the proposed construction.

4. Engineering Consultation - We are available to provide geotechnical consultation during the preliminary corridor selection process.

4.0 GEOLOGIC SETTING

4.1 General Conditions

The proposed transmission line corridors are located on the west side of the Island of Hawaii, on the west-southwest slope of Hualalai Volcano. The corridors are situated approximately 10 miles west of Hualalai's summit and approximately 1 mile east of the coastline.

Hualalai last erupted in 1801 from two vents along the northwest trending rift zone. The most recent activity at Hualalai occurred in 1929, when a series of earthquakes shook the area for over a month. These quakes have been attributed to a localized intrusion of lava and subsequent readjustment of the surrounding rock (Moore, et al., 1987).

The land surface in the vicinity of the proposed corridors consists of aa and pahoehoe lava flows which slope toward the coastline. The average slope of the land surface in the study area is approximately 120 feet per mile, or an average slope of 0.02:1. The elevation range in the area is from +40 feet mean sea level (msl) to +400 feet msl.

4.2 Rock & Soil Types

Two types of lava flows occur in the area of the proposed corridors. These are pahoehoe lava and aa lava. The lava bedrock is at or near the surface throughout the study area. Thin windblown soil covers the lava in a few limited areas. The lava flows are not significantly weathered because of the low rainfall (approximately 10 inches annually) and relatively young age - generally less than 10,000 years.

4.2.1 Pahoehoe Lava Flows

Pahoehoe lava is erupted as very gaseous and fluid molten rock. It may flow for many miles, covering hundreds of square miles of land. The cooled surface is relatively flat and glassy, with a wide range of textures, such as shelly, ropy, and blistered.

Lava tubes and pressure ridges are characteristic features of the pahoehoe flows throughout the area. Lava tubes form when the pahoehoe flow surface solidifies and the fluid core drains out. Tube systems can extend for miles and can be identified by "skylights" or holes along the tube where the roof never crusted over or has collapsed since formation. Tube systems visible from the air are present in about 40% of the pahoehoe flows in the area. The tubes extend from the southwest slope of Hualalai toward the coast and appear as a linear series of collapse features. The tubes appear to be about 10-15 feet in diameter. The roof thickness of the tubes is variable, but appears to average about two feet. Probable lava tube features are indicated on Figure 1. It is likely that additional tube systems occur in the subsurface, but are not indicated on the surface.

Pressure ridges are elongated walls of lava which can be up to 20 feet high, 50 feet wide and several hundred feet long. They are commonly found in areas where lava ponds or flows over a gentle slope. The ridges form when horizontal pressure from the underlying fluid buckles the cooled crust, causing the relatively flat surface to bow upward. These structures are generally fractured. Cavities are occasionally created beneath the uplifted crust. Pressure ridges observed in the proposed corridors are fractured extensively. The core of the pressure ridge is a mass of basalt blocks two to four feet across separated by cooling joints. An example of a pressure ridge occurs along the S-1 alignment approximately one half mile from Kailua, where a 20 foot high pressure ridge is exposed in a road cut along the Queen Kaahumanu Highway. Tumuli are similar to pressure ridges, but are elliptical in shape and do not extend for long distances.

4.2.2 Aa Lava Flows

Aa lava covers approximately 40% of the study area. These flows are easily distinguished from the surrounding pahoehoe in that they are darker in color (dark brown to reddish brown), less weathered, exhibit higher relief (from 1-20 feet above the surrounding surface), and have less than 15% of the surface area covered by vegetation. The surface is extremely jagged and uneven, and ranges from angular blocks five feet across to loose clinker five inches in diameter. Aa lava is less gaseous and is crystallized to a greater degree than pahoehoe; thus its viscosity is higher, and it flows much more slowly.

Aa flows are fed by a lava river which moves downslope in an open channel. The flow front is a wall of clinker blocks which, when pushed by the plastic inner core, breaks apart and partially collapses. The collapsed blocks of clinker form a mat upon which the flow advances. A dense basalt core is almost always found sandwiched between the clinker and accounts for more than half of the total volume of the flow (Wentworth and MacDonald, 1953). It rarely, if ever, forms voids and tubes as observed in pahoehoe because of its high viscosity and slow flow rate. These flows exhibit more relief than the more fluid pahoehoe, with heights approaching 25 feet or more. Vesicles are irregular, and are usually stretched in the direction of the flow.

4.2.3 Soils

Soil in the area consists of thin windblown silt and sand which accumulate in cracks and crevices of the lava flows. Thickness of the soil is less than one foot and generally less than four inches. The soil is very rocky and friable, with an abundance of roots and very fine pores. It is non-sticky, non-plastic, and non-smeary. Permeability of the soil is high, runoff is low, and the erosion hazard is minimal. The soil supports grass, and scattered shrubs and small trees.

5.0 SITE CONDITIONS

5.1 Corridor S1

Corridor S1 is located along the Queen Kaahumanu Highway, parallel to an existing transmission line. The topography is relatively flat to gently sloping throughout most of the corridor. The surface consists of pahoehoe and aa lava flows. Pressure ridges and cavities were observed in the pahoehoe flows. The locations of pressure ridges and cavities are indicated on Figure 1. An example of these features can be found between the Keahole Generating Station and Kaiminani Drive (location #1 on Figure 1). At this location the 40-foot-wide pahoehoe lava lobe exhibits pressure ridges five feet high and cavities three feet deep. In other areas cavities in the

pahoehoe as deep as 30 feet were observed (Figure 2.1). Pressure ridges are as high as 40 feet occur within the pahoehoe flows in Corridor S-1 (Figure 2.2). A large collapsed lava tube was observed at location #3 (Figure 1).

The aa lava in corridor S-1 consists of clinker and large boulders. Diameter of the large boulders averages about 2-3 feet. The surface of the aa flows is very jagged and uneven (Figure 2.3), with relief at flow boundaries as high as 20 feet (Figure 2.4).

An aa lava channel was observed in Corridor S1 between the Keahole Substation and Kaiminani Drive.

5.2 Corridor S2

Corridor S2 is approximately one-half mile wide and is located about one-half mile mauka of Queen Kaahumanu Highway. The topography is relatively flat to gently sloping throughout most of the corridor (Figure 2.5). Numerous lava tubes and cavities were observed along Corridor S-2 (Figures 2.6, 2.7, and 2.8). Tubes and cavities did not appear as abundant in the southern half of Corridor S-2; it is likely that more tubes and cavities exist, but are shielded by vegetation growth.

Corridor S-2 is free of any major topographic obstacles. Features with significant relief are the aa flows and flow boundaries, which provide up to 15 feet of relief. Vegetation on the aa is very sparse.

6.0 VOLCANIC HAZARDS

Volcanic hazard zones have been established by the U.S. Geological Survey for the Island of Hawaii for long term planning purposes (Mullineaux, et al., 1987). Lava flow hazard zones are based on the percentage of the potential flow area that has been covered by lava flows during specific time periods, the frequency of past eruptive events, and on the assumption that the rate of current volcanic activity will continue for the next several decades.

Lava flow hazard zones are denoted 1 through 9, with land in zone 1 the most likely to be covered by lava flows in the near future. For example, areas along the currently active rift of Kilauea are rated as zone 1 and the inactive Kohala Volcano is rated as zone 9. The proposed Keahole-Kailua transmission line corridors are located within lava flow hazard zone 4, indicating a moderate risk of coverage by lava. Historical eruptions of Hualalai have been much less frequent than on Mauna Loa and Kilauea. Less than 15 percent of the Hualalai Volcano slopes have been covered in the last 750 years (Mullineaux, et al., 1987).

Three tephra hazard zones have been delineated on the Island of Hawaii. Tephra is airborne volcanic material produced by lava fountains. Tephra hazard zones are based on eruption frequency, proximity to potential vents, and prevailing wind direction. The proposed corridors are located within tephra hazard Zone 2. Zone 2 covers the slopes of Kilauea, Mauna Loa, and Hualalai. Areas in Zone 2 may be covered by a tephra layer less than 4 inches thick. Zone 1 includes the active rift areas of Mauna Loa and Kilauea. Areas in Zone 1 may be covered by a layer more than 4 inches thick which includes large fragments. Zone 3 includes Mauna Kea and Kohala where the most recent eruptions occurred more than 3,500 years ago. No tephra eruptions have occurred from Hualalai in historical time. However, limited potential exists for coverage of the site by a layer of volcanic cinders less than 4 inches thick erupted from within Zone 1.

Four hazard zones for potential ground fractures and subsidence have been identified on the Island of Hawaii (Mullineaux, et al., 1987). The proposed Keahole-Kailua transmission line corridors are located within zone 4 for ground fractures and surface subsidence. The area of highest hazard, Zone 1, consists of the summit areas and rift zones of Mauna Loa and Kilauea. Zone 2 covers the south flank of Kilauea where fracturing and subsidence occur along northeast trending fault systems. Zone 3 consists of the less active Kaoiki and Kealakekua fault systems on the southeast and southwest flanks of Mauna Loa. Zone 4, where the hazard is least, covers the remainder of the island. In addition, subsidence at the rate of 1-2 feet per century is estimated for the entire island due to the cumulative effect of worldwide rise in sea level and the downwarping of the seafloor around the island.

7.0 GEOTECHNICAL CONSIDERATIONS

7.1 Pahoehoe Lava

Transmission lines could be supported by either spread or pier foundations on pahoehoe. The principal concern for either type of foundation, as well as guy anchors, is the potential presence of tubes and cavities in pahoehoe lava. For spread foundations, the presence of cavities could be checked by probing individual footing locations during construction. This procedure would be more difficult to implement for pier foundations, but could be mitigated by pressure grouting the pier excavations to fill potential cavities. Large cavities should be excavated, backfilled, and compacted. Maintenance road construction would require some grading, proof-rolling, and cavity remediation.

Preliminary and final grading usually involves a net loss of material as the site materials are crushed and compacted. Placement of fill will be necessary where the maintainance road route crosses interflow depressions. Judicious planning of earthwork is necessary to avoid import of materials to the site.

7.2 Aa Lava

Aa lava would also adequately support spread or pier foundations. However, since the surface of aa lava is very rough and can be loose or solid, more site preparation is needed than on pahoehoe lava. Grading with a large bulldozer equipped with ripper bars can remove surface clinker and dislodge large slabs of dense aa core. This will generate large quantities of fill material which can be used during final grading. This fill material will probably be oversized and suitable only for general fills. Crushing will be necessary for the material to be used in the deep areas of the fill. Because of the high variability of conditions, several typical foundation designs could be developed, and the most appropriate design could be chosen based on the characteristics of each foundation site.

Subsurface cavities are not a problem in aa lava, therefore, costly probing below the surface can be avoided if the aa layer is of sufficient thickness. If a foundation is to be installed where a thin aa flow overlies pahoehoe, the geotechnical aspects of the underlying pahoehoe must be considered as well.

7.3 Soils

Soils overlying the lava are generally very thin and permeable. These soils are not a major consideration for foundation support of transmission lines. Foundations and anchors would generally be founded below the thin soil cover within the underlying rock. Erosion is not a significant problem in the thin soils of either corridor, due to high soil permeability and low runoff.

8.0 DISCUSSION OF ALTERNATIVE CORRIDORS

Both proposed possible corridors, S-1 and S-2, are covered by approximately 60% pahoehoe lava flows and 40% aa lava flows. The pahoehoe flows of Corridor S-2 appear to contain significantly more tube systems and cavities than the pahoehoe flows of Corridor S-1. The apparent higher concentration of tube systems in pahoehoe of Corridor S-2 would likely result in the need for more care in selection of foundation sites, increased subsurface exploration, and increase in remedial action, such as pressure grouting.

The aa flows of both Corridors S-1 and S-2 predominantly consist of clinker, except for a few local areas of large 2-3 feet diameter boulders. There are no apparent differences between the nature and extent of aa flows in the two corridors.

The topography of both corridors is relatively flat to gently sloping. Pressure ridges occur in pahoehoe flows of both corridors, providing topographic relief of 5 to 10 feet. Boundaries between pahoehoe and aa flows also provide significant topographic relief of up to 15 feet in both corridors.

Access to the site during construction and for post-construction maintenance would require a significantly greater effort for Corridor S-2. Access to Corridor S-1 is relatively easy because of its proximity to the existing highway, and can probably employ sections of existing maintenace roads currently in place for the existing transmission lines. The proposed S-2 route would require a significantly greater effort in grading and levelling to allow access for construction equipment.

Corridors S-1 and S-2 are located within the same volcanic hazards zones. Therefore the selection of one over the other is not influenced by volcanic hazard.

9.0 CONCLUSIONS

MFA's investigation of the two proposed corridors has led us to conclude that Corridor S1, adjacent to the existing transmission line along Queen Kaahumanu Highway, is more suitable for the proposed transmission line than Corridor S2. The considerations are:

1. Fewer pahoehoe lava tubes were observed in S-1. Foundation construction will be costly in these pahoehoe areas because of the need to check for and remediate cavities.

2. Access to S-1 is relatively easy because of the close proximity to the highway, thus, minimal effort will be needed to get equipment to the site. In addition, portions of an existing maintenance road may be incorporated into the maintenance road for the proposed line. This is an important consideration since the aa areas will require significant grading and leveling before they can be accessed by construction and/or maintenance equipment.

10.0 LIMITATIONS

This report has been prepared for the use of CH2M Hill and HELCO for the purpose of providing a detailed site and corridor evaluation for the proposed Keahole-Kailua 69kV transmission line. This report may not contain sufficient information for other uses by other parties. Findings and conclusions have been prepared in accordance with generally accepted soils and geological practices. No warranty, expressed or implied, is made as to the professional advice contained in this report.

11.0 REFERENCES

Moore, R.B., Clague, D.A., Rubin, M., Bohrson, W.A., 1987, Hualalai Volcano: A Preliminary Summary of Geologic, Petrologic, and Geophysical Data; *in*, Volcanism in Hawaii; U.S. Geological Survey Professional Paper 1350: 571-585.

Mullineaux, D.R., Peterson D.W., Crandell, D.R., 1987, Volcanic Hazards in the Hawaiian Islands; *in*, Volcanism in Hawaii; U.S. Geological Survey Professional Paper 1350: 599-621.

U.S. Department of Agriculture, Soil Conservation Service, 1972, Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.

Wentworth, C.K., MacDonald, G.A., 1953, Structures and Forms of Basaltic Rocks in Hawaii; Geological Survey Bulletin 994.

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The following figures are attached and complete this report:

Figure 1- Land Types Map Showing Alternative Corridors
Figures 2.1 - 2.8 - Site Photographs

Respectfully Submitted

MASA FUJIOKA & ASSOCIATES
A Professional Partnership

Masanobu R. Fujioka, P.E.
Principal-In-Charge

Figure 2.3 Aa boulder field in Corridor S-1. Boulders are 2-3 feet in diameter.

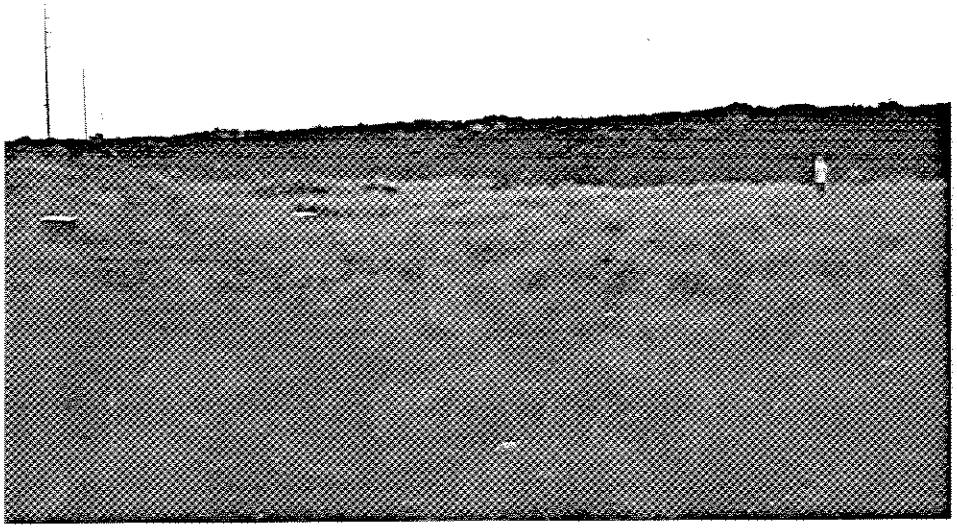


Figure 2.4 Boundary of aa flow overlying pahoehoe flow in Corridor S-1. Relief as great as approximately 20 feet.

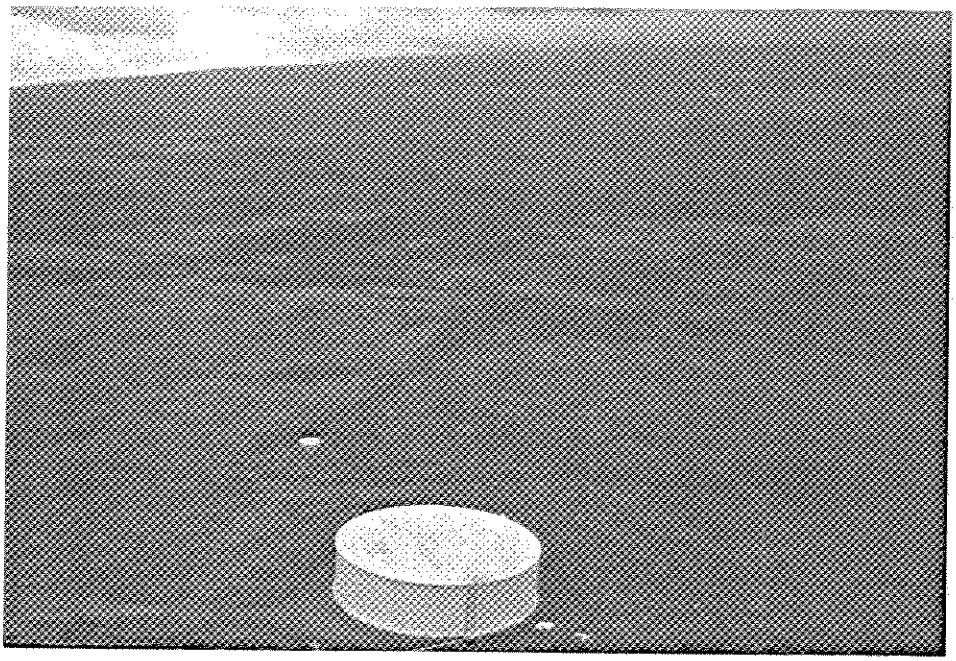


Figure 2.5 Aerial view of Corridor S-2. Topography is relatively flat to gently sloping throughout most of the corridor.

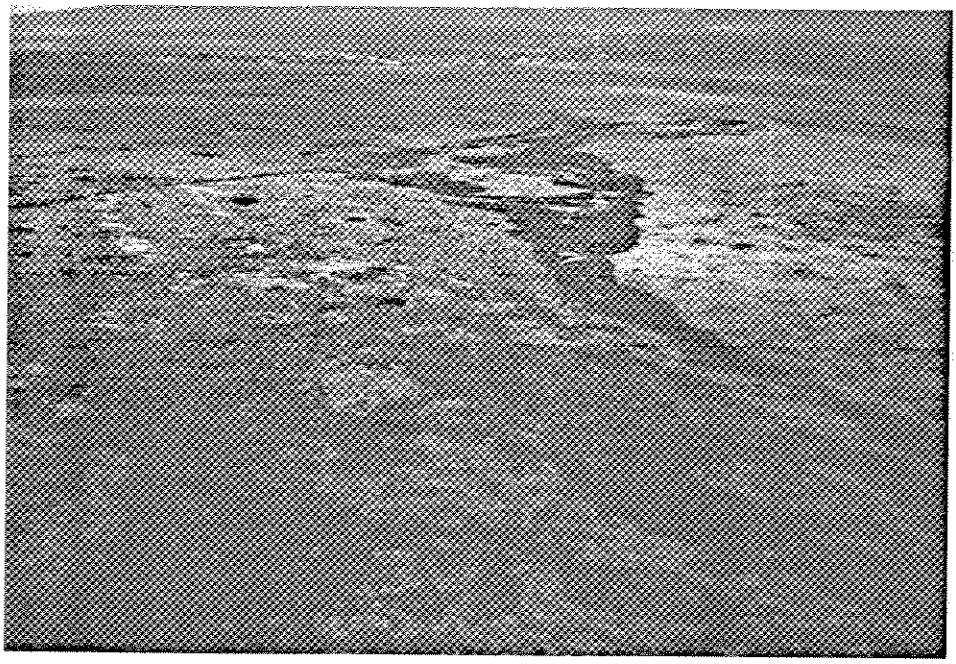


Figure 2.6 Collapse features of a lava tube in pahoehoe of Corridor S-2 (left of center, extending from foreground to background).

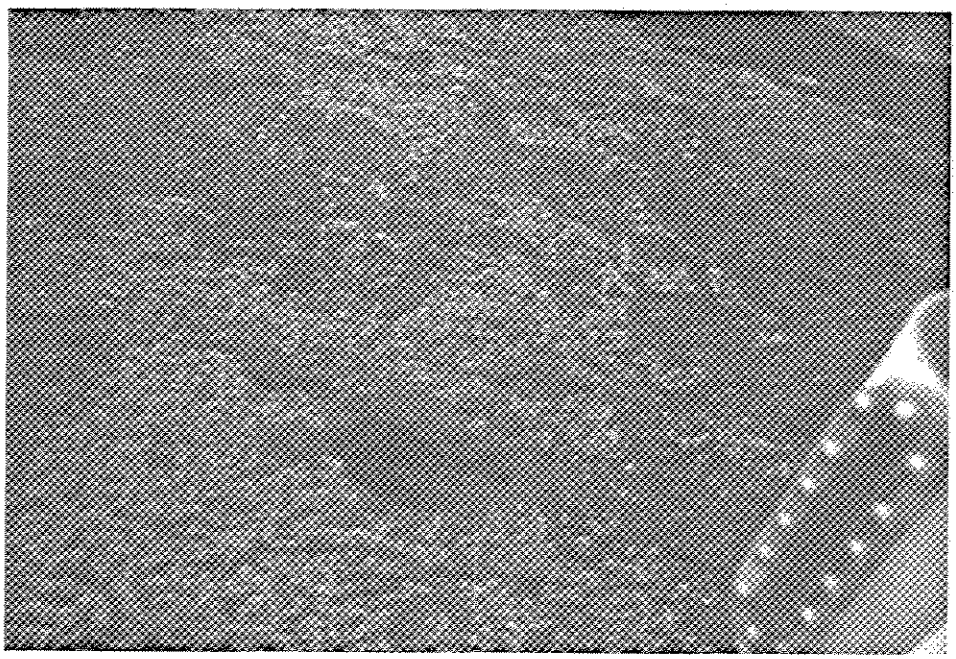


Figure 2.7 Collapse features/cavities in pahoehoe lava of Corridor S-2

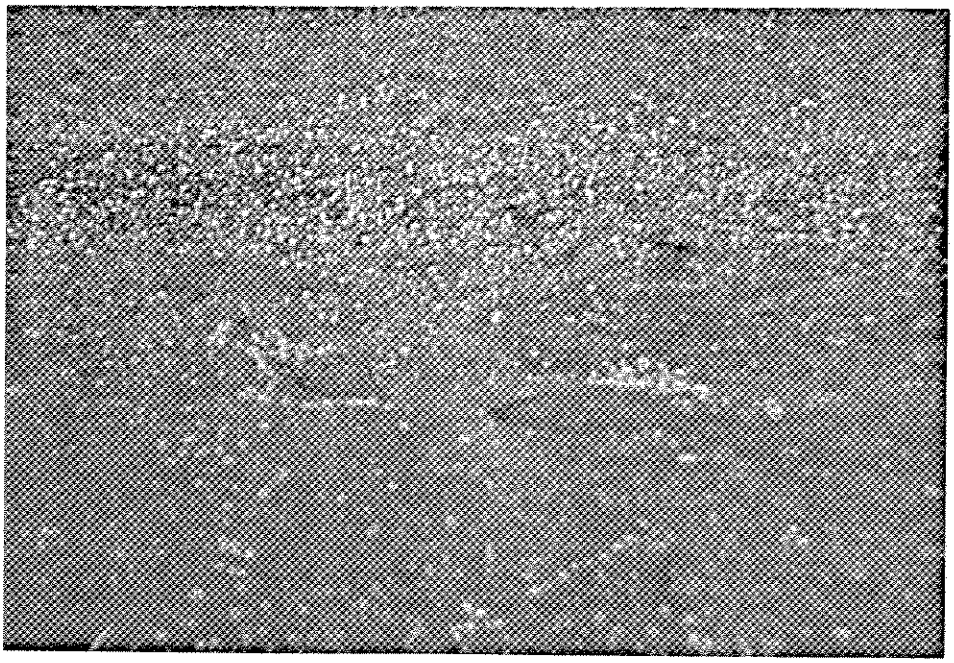


Figure 2.8 Collapse features/cavities in pahoehoe lava of Corridor S-2

Figure 2.1 Cavity in pahoehoe lava of Corridor S-1. Cavity extends to at least 30 feet deep.

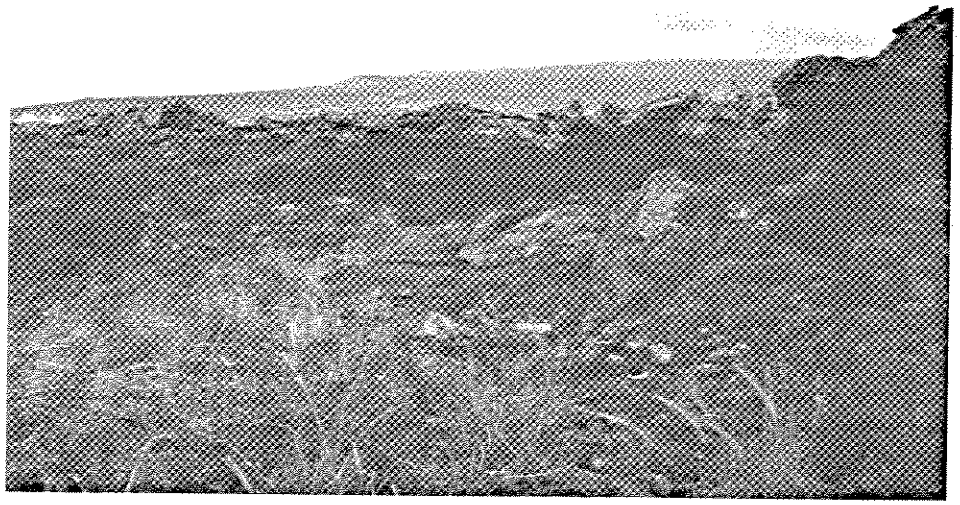
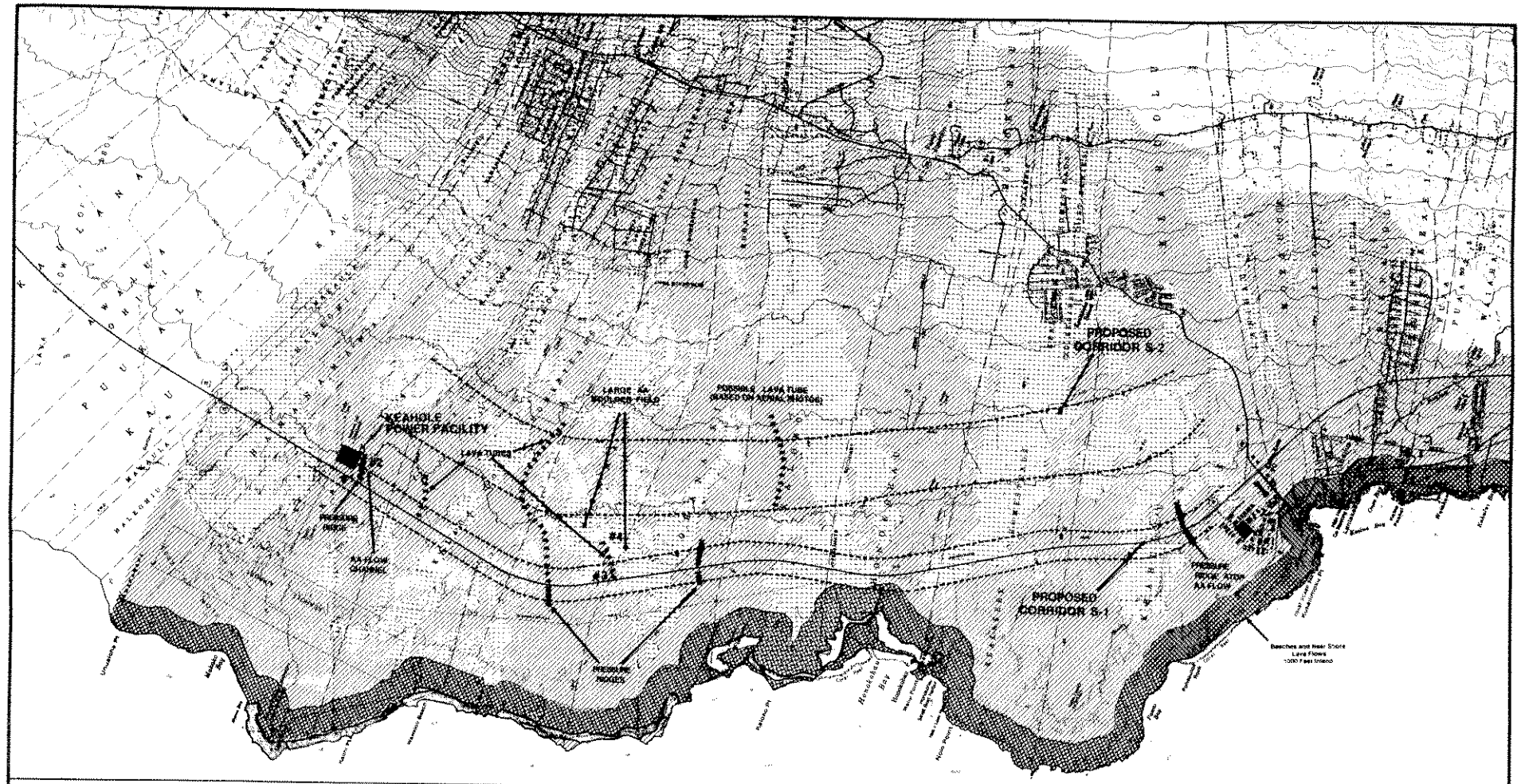


Figure 2.2 Pressure ridge in pahoehoe lava of Corridor S-1. Ridge is approximately 40 feet high and contains a large collapsed lave tube (center).



LAND TYPES

The land types indicated on the map represent groups of soil and land surface categories having similar engineering characteristics pertaining to power transmission line and access road construction. The source of the soil category designations and descriptions is the *Soil Survey of the Island of Hawaii, State of Hawaii* published by the U.S. Soil Conservation Service. General accuracy of the descriptions was spot-checked in the field.

ENGINEERING CHARACTERISTICS

BEACHES AND NEAR SHORE LAVA FLOWS

Beaches consist of narrow accumulations of loose sand and gravel adjacent to the shoreline. Thickness of the beach sand ranges from 1 foot to more than 20 feet. These areas have been removed from consideration for transmission line alignment for reasons of aesthetics and potential permitting difficulties.

PAHOEHOE LAVA FLOWS

The pahoehoe land type is generally suitable for the proposed transmission line and access road construction. The surface of the pahoehoe lava flows is uneven and rolling and is broken by numerous cracks, skylights and pressure domes. The uneven surface of the pahoehoe may conceal open voids in the subsurface ranging from 1 foot to more than 20 feet in diameter. Near the shoreline beach or lagoonal sediments may be present in the shallow subsurface below the pahoehoe.

Soil at elevations below 800 feet generally consists of thin accumulations of windblown sand and silt. At elevations above 800 feet where rainfall is sufficient to support dense vegetation the pahoehoe is covered by a 2 inch to 18 inch thick mat of organic rich stony silt soil. Permeability is rapid, runoff is slow and the erosion hazard is slight for this land type.

AA LAVA FLOWS

As land types are suitable for the proposed transmission line and access road construction. As lava is rough and broken with clinker, cauli, glassy, and sharp places piled in jumbled heaps. Beneath the rough surface, the as flows generally consist of a loose clinker mat of variable thickness overlying a dense vesicular basalt (blue rock) core. Total thickness of the flow unit consisting of the clinker mat and dense core ranges from 5 feet to 30 feet. Near the shoreline beach or lagoonal sediments may be present in the shallow subsurface below the as.

Soil thickness on the as flows varies according to age of the flow and available rainfall. At elevations below 800 feet vegetation is rare and thin windblown soil is present only in crevices and depressions on the as surface. At elevations greater than 800 feet where rainfall is sufficient to support dense vegetation the as is covered by a 2 inch to 20 inch thick mat of organic rich stony silt soil. Permeability is rapid, runoff is slow and the erosion hazard is slight on the as land type.

NORTH

0 1000 2000 3000 4000 5000 FEET

MAP AREA HAWAII

FIGURE 1

LAND TYPES MAP

PROPOSED KEAHOLE-KAILUA TRANSMISSION LINE
NORTH KONA AND SOUTH KOHALA DISTRICTS
HAWAII, HAWAII

FOR

HAWAIIAN ELECTRIC LIGHT COMPANY, INC.

MASA FUJIOKA & ASSOCIATES

APPENDIX D

Appendix D
Biological Resources

Biological Resources of the Keamuku to Kailua 138 kV Transmission Line Project Area

PART I: Keahole to Kailua

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Life Sciences Division
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Bishop Museum Technical Report MS-111692

Prepared for CH2M HILL
February 16, 1993

EXECUTIVE SUMMARY

The Bishop Museum has been subcontracted by CH2M HILL to provide information on the biological resources within potential corridors for a proposed Hawaii Electric Company and Hawaii Electric Light Company 138 kV transmission line from the Keamuku substation to Kailua on the island of Hawaii. By request of CH2M HILL, the project has been divided into two segments, Keamuku to Keahole and Keahole to Kailua. This report discusses the biological resources of the Keahole to Kailua segment. The information provided is meant to help CH2M HILL conduct the necessary routing studies and environmental analyses for the two projects.

From October 16 - 19, 1992, a biological field inventory of the Keahole to Kailua Transmission Line Project Area was conducted. The objectives of the biological field inventory were to: 1) identify plants and animals and compile a species list for the project area; 2) describe and map any rare plant and animal taxa and rare natural communities expected or observed in the project area[1]; 3) describe and map any lava tube openings which may indicate the presence of substantial lava tube corridors; and 4) identify resource sensitive areas that might be adversely affected during construction of the transmission line. Prior to the field survey, The Nature Conservancy of Hawaii's Hawaii Heritage Program (HHP) Database was consulted for previous records of rare native plants, animals, and natural communities in the project area. Similarly, official federal and Hawaii State lists were examined to verify if plants or animals recorded from the study area were registered as endangered, threatened, or candidates for endangered or threatened status. These taxa would be subject to protection under the Endangered Species Act of 1973 and/or Hawaii State Law (H.R.S. 195-D) on all lands within the State of Hawaii.

The Keahole to Kailua Transmission Line Project Area is mostly privately owned urban or undeveloped land. Nevertheless, areas dominated by native Hawaiian vegetation are present, and these and other areas contain rare plants.

The HHP database contained records of seven rare plant taxa that had been recorded from or near the project area prior to the field survey. In addition, one federally endangered animal taxon was previously recorded near the project area. No rare natural communities had been recorded from the project area.

All seven of the rare plant taxa identified in the database query were observed within or adjacent to the border of the project area during the field survey. One of these plants is federally listed as endangered, two are currently being proposed for endangered status, and four are candidates for endangered or threatened status. Two additional rare plant taxa

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[1]Throughout this report, the use of the term "rare" is in accordance with the definition used by The Nature Conservancy of Hawaii's Hawaii Heritage Program, which maintains a database of the imperilled native plants, animals, and natural communities within the State of Hawaii. This definition has no official meaning in the context of the U.S. Fish and Wildlife Service's federal status categories for endangered, threatened, or candidate endangered or threatened species (USFWS 1991).

were observed adjacent to the project area. One is being proposed for endangered status, the other is a candidate for endangered or threatened status. Numerous common native plant taxa were also encountered during the field survey. Native invertebrates occurred within the study areas, but none were proposed candidates for endangered status. Two native vertebrate animal taxa were observed during the survey, but no rare animals were detected.

Although not considered rare, two natural communities were observed during the field survey. These natural communities are significant because they provide habitats for endangered and candidate endangered or threatened plants.

Many lava tube entrances were also discovered, but the interiors of these tubes were not explored and may contain significant native subterranean ecosystems.

Based on the survey results, and other reasons expressed in this report, building the Keahole to Kailua 138 kV Transmission Line in the lower section of the project area, parallel to the Queen Kaahumanu Highway affects the minimum number of known sensitive biological resources. A follow-up survey focussing on the biological resources within lava tubes is also highly recommended.

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FIGURES

APPENDICES

INTRODUCTION

The Bishop Museum has been subcontracted by CH2M HILL to provide information on the biological resources within potential corridors for a proposed Hawaii Electric Company and Hawaii Electric Light Company 138 kV transmission line from the Keamuku substation to Kailua on the island of Hawaii. By request of CH2M HILL, the project has been divided into two segments, Keamuku to Keahole and Keahole to Kailua. The biological information will be provided in two parts. Part I discusses the biological resources of the Keahole to Kailua route. Part II (to be presented at a later date) will discuss the Keahole to Keamuku line. The material provided is meant to help CH2M HILL conduct the necessary routing studies and environmental analyses for the two projects.

The Keahole to Kailua Transmission Line Project Area is located in the district of North Kona, Hawaii, between the Keahole Airport and Kailua (Figure 1). The project area is large (ca. 3,000 acres) and encompasses two proposed corridors for the transmission line which will carry electricity from the Keahole Power Plant to the Kailua Substation. Most of the project area is privately owned, and much of it is either urban or undeveloped lands. Elevation changes are relatively gradual and climatic conditions are fairly constant.

From October 16 - 19, 1992, a biological field inventory of the Keahole to Kailua Transmission Line Project Area was conducted. The objectives of the biological field inventory were to:

1. Identify plants and animals and compile a species list for the project area;

2. Describe and map any rare plant and animal taxa and rare natural communities (assemblages of plants and animals occurring together at a site) expected or observed in the project area;

3. Describe and map any lava tube openings which may indicate the presence of substantial lava tube corridors, and;

4. Identify resource sensitive areas that might be adversely affected during construction of the transmission line.

NOTE ON TERMINOLOGY

The definition of a "**rare**" plant or animal varies depending on professional opinion. Throughout this report, the use of the term is in accordance with the definition used by The Nature Conservancy of Hawaii's Hawaii Heritage Program, which maintains a database of the imperilled native plants, animals, and natural communities within the State of Hawaii.

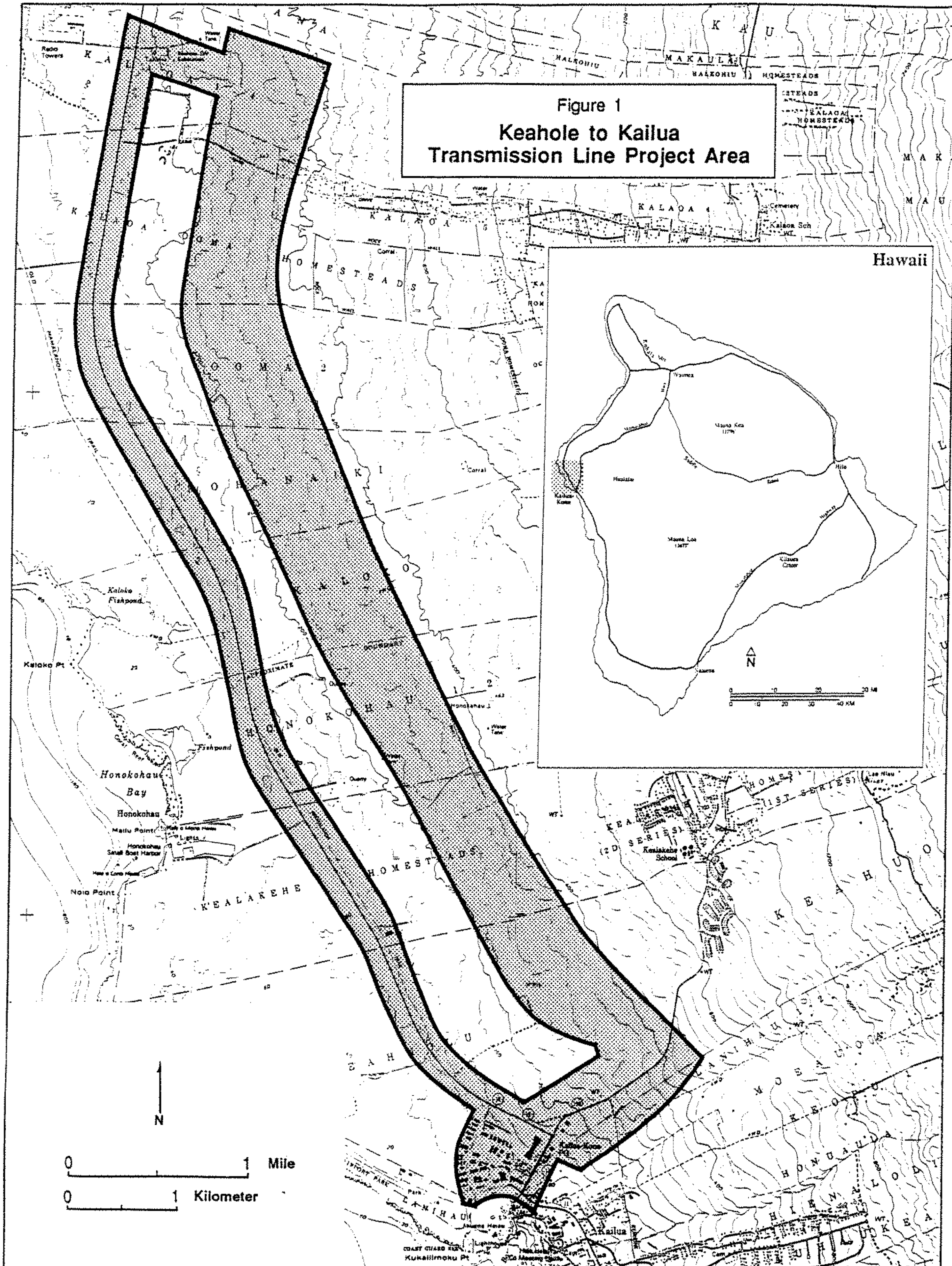


Figure 1
Keahole to Kailua Transmission Line Project Area

This database was consulted for pertinent information within the study area (see Methods section below).

The Hawaii Heritage Program regards all native Hawaiian plants, animals, or natural communities imperilled with extinction by such factors as displacement by non-native species, direct destruction, or loss of habitat to be rare. By the Heritage definition, any native plant, animal, or natural community with 20 or fewer current (within the last 15 years), viable occurrences is considered rare. Other more widespread plant and animal taxa may also be considered rare if imperilled with destruction throughout all or a significant portion of their range. A natural community may also be considered rare if it covers less than 2,000 acres worldwide.

This definition of rare has no official meaning in the context of the U.S. Fish and Wildlife Service's federal status categories for endangered, threatened, or candidate endangered or threatened species (USFWS 1991). It also does not relate to definitions within the Endangered Species Act of 1973 (USFWS 1973) or the Hawaii State Law (H.R.S. 195-D) that protects state listed threatened and/or endangered plant and animal species within Hawaii (DLNR 1990). Plants or animals with official federal or state protected status are identified as such throughout this report. For the island of Hawaii, the state and federal lists of threatened or endangered plants and animals are identical.

METHODS

DATABASE CONSULTATION

The Nature Conservancy of Hawaii's Hawaii Heritage Program (HHP) Database contains information on the location of rare Hawaiian plants, animals, and natural communities. The information is compiled from numerous sources, including herbarium collections at the Bishop Museum and the University of Hawaii's Botany Department and Harold H. Lyon Arboretum, published and unpublished scientific materials, environmental impact studies, and personal communications with various local biologists (e.g., staff of the U.S. Fish and Wildlife Service, Hawaii Division of Forestry and Wildlife, and University of Hawaii). Prior to the survey, the HHP Database was consulted for previous records of rare native plants, animals, and natural communities in the Keahole to Kailua Transmission Line Project Area.

Bishop Museum's arthropod collections and databases were consulted to provide identification and information regarding the invertebrates observed during this survey. The Hawaiian Terrestrial Arthropod Checklist is the standard for the invertebrate names included in this report.

LISTED SPECIES

Official federal (USFWS 1991) and Hawaii State (DLNR 1990) lists were examined to verify if plants or animals recorded from the study area were registered as endangered, threatened, or candidates for endangered or threatened status. Any taxa classified as such were identified throughout this report. These taxa are subject to protection under the Endangered Species Act of 1973 (USFWS 1973) and/or Hawaii State Law (H.R.S. 195-D) within the study area, and on all lands within the State of Hawaii.

BIOLOGICAL FIELD INVENTORY

A biological field inventory of the Keahole to Kailua Transmission Line Project Area was conducted October 16 - 19, 1992 by a survey team of four (an entomologist, a zoologist, and two botanists) for a total of 16 person-days. The survey area was divided into an upper section and a lower section, corresponding to the two potential corridors for the proposed line. The upper section was a 0.8-kilometer (0.5-mile) corridor that paralleled the Queen Kaahumanu Highway from about 60 to 120 meters (200 to 400 feet) in elevation. From information provided by CH2M HILL, the upper limit of this corridor was determined to be ca. 1.6 kilometers (1 mile) from the Queen Kaahumanu Highway, and the lower limit was determined to be ca. 0.8 kilometers (0.5 miles) from the highway. This corridor was surveyed using a walk-through method, with emphasis in areas dominated by native

vegetation (these areas have the highest potential for harboring rare plants, animals, and natural communities).

The lower section was a corridor that followed the Queen Kaahumanu Highway from the Keahole Power Plant to the Kailua Substation and extended to 150 meters (500 feet) on either side of the highway. This corridor was surveyed from 19 stations made along the highway. Figures 2A and 2B show all stations and routes surveyed for this biological inventory.

Over the course of the survey, all plant and animal taxa encountered were identified and recorded. Plant and invertebrate specimens were taken whenever confirmation of identification was needed. The field team walked through and identified plants and animals in all of the different major vegetation types.

Standard beating and sweeping techniques were the methods used for invertebrate sampling. When appropriate, plants were visually inspected, stones or logs overturned and examined, or specimens individually collected by netting or aspirating. An ultraviolet light was used during one evening to sample night-flying insects.

Audio and visual signals were used to detect and identify numbers of animal taxa in the lower and upper sections. Observations of bones and/or scat also indicated the presence of some mammals within the project area. No population or density estimates were made for the animal taxa that were identified.

Two night surveys were conducted between 1830 and 1930 hours monitoring for Hawaiian Hoary Bats (*Lasiurus cinereus semotus*) in the project area. Bat surveys were conducted visually, and by audio means through the use of bat echolocation detectors at the 30 kHz setting (Fullard 1989).

A classification system distinguishing native natural communities in the Hawaiian islands (Wagner et al. 1990) was used to describe the vegetation types observed in the project area. The classification system is hierarchical. The terrestrial community types are grouped and named according to elevation, moisture conditions, and vegetation structure. Individual community types are named for the most common or dominant plants present.

Reviews of 1977 aerial photographs and vegetation maps for the area compiled by the U.S. Fish and Wildlife Service (Jacobi 1985) were also used to evaluate the known and potential native natural communities in the area. Boundaries for major vegetation types were plotted on U.S. Geological Survey topographic maps. Vegetation descriptions and distributions were updated during the field survey. Both native and alien (non-native) communities were mapped and described.

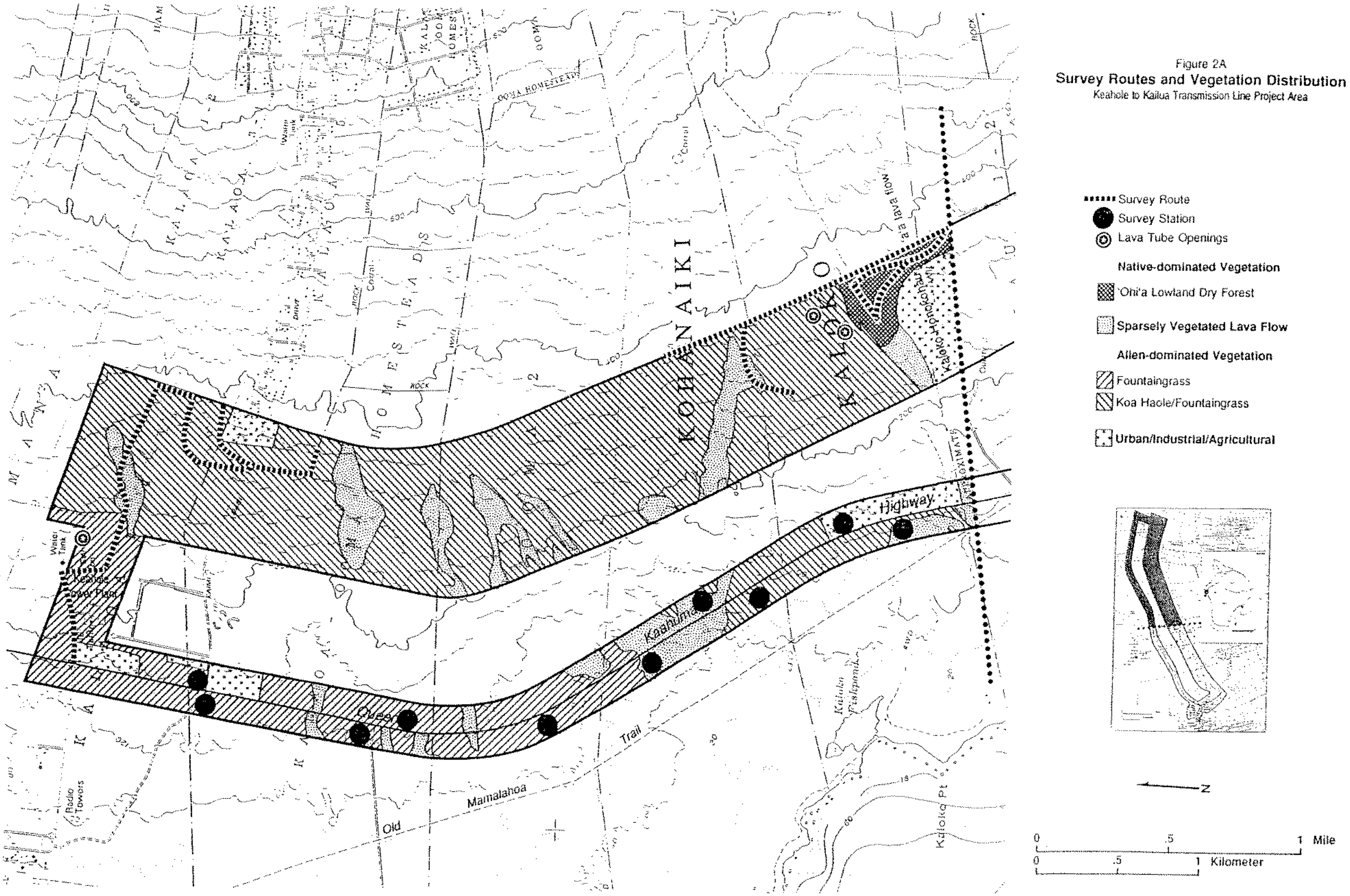
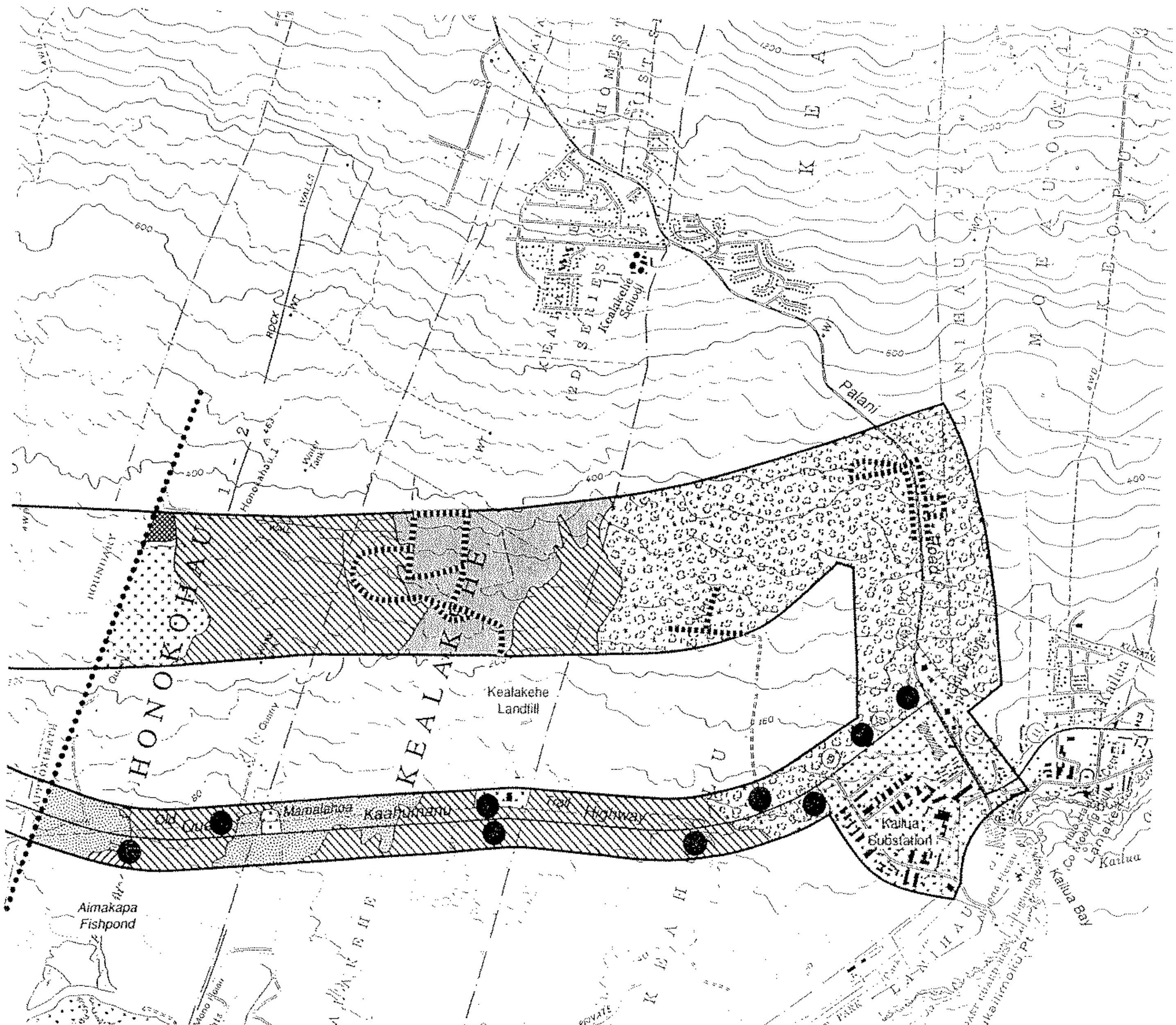


Figure 2A
Survey Routes and Vegetation Distribution
Keahole to Kailua Transmission Line Project Area

Figure 2B

Survey Routes and Vegetation Distribution

Keahole to Kailua Transmission Line Project Area



- Survey Route
- Survey Station

Native-dominated Vegetation

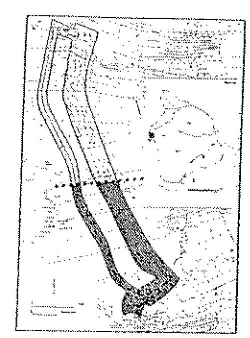
- 'A'ali'i Lowland Dry Shrubland
- 'Ohi'a Lowland Dry Forest

Sparsely Vegetated Lava Flow

Alien-dominated Vegetation

- Fountaingrass
- Koa Haole/Fountaingrass
- Kiawe/Mixed Trees/Christmas berry

Urban/Industrial/Agricultural



N

0 .5 1 Mile

0 .5 1 Kilometer

RESULTS

DATABASE QUERY

The HHP database contained records of seven rare plant taxa that had been recorded from or near the Keahole to Kailua Transmission Line Project Area prior to the field survey. In addition, one rare animal taxon was previously recorded near the project area. No rare natural communities had been recorded from the project area.

FIELD SURVEY

All seven of the rare plant taxa identified in the database query were observed within or adjacent to the border of the project area during the field survey. Two additional rare plant taxa not previously reported from the area were also observed adjacent to the upper project area. Numerous common native plant taxa were also encountered.

Although native invertebrates were encountered during the survey, none were identified as candidate taxa (see Appendix B).

Two native vertebrate taxa were detected during the field survey; they are not considered rare. The survey team did not detect any rare vertebrate taxa within the project area.

No rare natural communities were observed during the field survey; however, two areas dominated by native vegetation were found in the upper section of the project area. Many lava tube entrances were also discovered, but most did not extend very far. Several lava tubes appeared to have potential for biological significance and the openings to these tubes are mapped. Owing to time, access and improper equipment constraints, the interiors of these tubes were not explored.

Checklists of plants and animals recorded during the survey are provided in Appendices A - C. Descriptions of the different vegetation types observed in the project area are presented below, followed by species accounts of rare plants and animals.

NATURAL COMMUNITY DESCRIPTIONS

The Keahole to Kailua Transmission Line Project Area extends approximately 11 kilometers (7 miles) through what is mostly privately owned urban or undeveloped lands. The vegetation of these lands is mostly dominated by alien plant taxa. Nevertheless, areas dominated by native Hawaiian vegetation are present, and these areas contain rare plants.

The distribution of vegetation types throughout the project area is shown in Figures 2A and 2B. A description of these vegetation types and a discussion of their significance with regard to native biological resources is presented below.

Native Vegetation

Overall, the vegetation observed within the Keahole to Kailua Transmission Line Project Area was alien-dominated. However, two portions of the upper corridor were predominately native. These portions supported two native natural communities, 'Ohi'a (*Metrosideros polymorpha*) Lowland Dry Forest and 'A'ali'i (*Dodonaea viscosa*) Lowland Dry Shrubland. Neither is considered rare, but both communities support rare native Hawaiian plants.

'Ohi'a Lowland Dry Forest
Metrosideros polymorpha Lowland Dry Forest

Lowland dry forests dominated by 'ohi'a (*Metrosideros polymorpha*) can be found on the islands of Maui and Hawaii, generally on younger volcanic substrates. 'Ohi'a Lowland Dry Forest is not currently considered rare; however, some examples of this natural community are known to contain rare plants.

An example of 'Ohi'a Lowland Dry Forest was located on the Kaloko-Honokohau 'a'a lava flow in the upper corridor (Figures 2A and B). The relatively young lava flow was sparsely vegetated. The open forest was composed of scattered 'ohi'a, and the native 'ohe makai tree (*Reynoldsia sandwicensis*) was also common. Other native trees and shrubs that were locally common within this community type were alahe'e (*Canthium odoratum*), mamane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), and ko'oko'olau (*Bidens micrantha* ssp. *ctenophylla*). The native vines huehue (*Cocculus trilobus*) and koali 'awa (*Ipomoea indica*) were common, and the native herb 'ala'ala wai nui wahine (*Plectranthus parviflorus*) and the native fern kumuniu (*Doryopteris decora*) were also present.

Rare trees observed in the Kaloko-Honokohau example of this forest type were halapepe (*Pleomele hawaiiensis*) and 'aiea (*Nothocestrum breviflorum*). Another rare tree species collected from this forest type at Kaloko (but not observed on this survey) was uhiuhi (*Caesalpinia kavaiensis*) (see "Plant Descriptions" section below). Three rare shrubs observed were ko'oko'olau (*Bidens micrantha* ssp. *ctenophylla*), ma'aloa (*Neraudia ovata*) and maiapilo (*Capparis sandwichiana*). Rare sedges seen were *Fimbristylis hawaiiensis* and *Mariscus fauriei*. Accounts of all rare plants recorded from this natural community are provided in the rare plant descriptions below.

Invasive alien plants appear to be the main biological threat to this community. The most noxious weeds observed during the survey were Christmas berry (*Schinus terebinthifolius*) and fountaingrass (*Pennisetum setaceum*).

'A'ali'i Lowland Dry Shrubland
Dodonaea viscosa Lowland Dry Shrubland

Lowland dry shrublands dominated by 'a'ali'i (*Dodonaea viscosa*) are known from the islands of Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii. This community type is not considered rare, but some examples are known to contain rare plants. The dominant 'a'ali'i shrub is an indigenous species known from throughout the tropics and can be found on a variety of substrates, ranging from coastal dunes up to subalpine basalt. Associated taxa vary by location and may include any of the shrub, grass, and herb taxa typically found in Hawaiian coastal and lowland zones.

During this survey, 'A'ali'i Lowland Dry Shrubland was found in the upper corridor of the study area in the land section of Kealakehe (Figure 2B). In addition to 'a'ali'i, other native shrubs included alahe'e (*Canthium odoratum*), mamane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), kolomana (*Senna gaudichaudii*), and maiapilo (*Capparis sandwichiana*). The alien shrub koa haole (*Leucaena leucocephala*) was also very common throughout the Kealakehe example of this shrubland, often codominant with the native shrubs. A few native tree species were scattered in this shrubland, including lama (*Diospyros sandwicensis*) and 'ohe makai (*Reynoldsia sandwicensis*). Also found in this shrubland were the native vines huehue (*Cocculus trilobus*) and koali 'awa (*Ipomoea indica*).

Rare native trees observed in this shrubland were uhiuhi (*Caesalpinia kavaiensis*), 'aiea (*Nothocestrum breviflorum*), and halapepe (*Pleomele hawaiiensis*). Also observed were the rare native shrubs koko'olau (*Bidens micrantha* ssp. *ctenophylla*) and maiapilo (*Capparis sandwichiana*). The extremely rare shrub aupaka or wahine noho kula (*Isodendrion pyrifolium*) was also seen. Accounts of all rare plants recorded from this natural community are provided in the rare plant descriptions below.

The most noxious weeds observed in this vegetation type were koa haole (*Leucaena leucocephala*), fountaingrass (*Pennisetum setaceum*), and Christmas berry (*Schinus terebinthifolius*).

Sparsely Vegetated Lava Flow

Relatively young lava flows supporting sparse vegetation were distributed through much of the study area. Most of these lava flows consisted of 'a'a lava, although a few were of pahoehoe lava. The freshest lava flows were nearly devoid of vegetation. The older lava flows supported a low density of mixed native and alien plant species, including many of the common species occurring in adjacent, more heavily vegetated areas.

The rare shrub maiapilo (*Capparis sandwichiana*) occurred on many of the sparsely vegetated lava flows (see "Plant Descriptions" section below).

Alien-dominated Vegetation

Large portions of the survey area were dominated by alien (non-native) vegetation (Figures 2A and 2B). The northern areas of alien-dominated vegetation were mostly grasslands dominated by fountaingrass (*Pennisetum setaceum*). In much of the project area, extensive areas of vegetation were dominated by both fountaingrass and koa haole (*Leucaena leucocephala*). The southern portion of the project area was dominated by other various alien tree species. One alien forest, for example, was composed largely of kiawe (*Prosopis pallida*). Another alien forest found primarily along the lower end of Palani Road was composed of a mix of alien tree species including kiawe, monkeypod (*Samanea saman*), Christmas berry (*Schinus terebinthifolius*), ʻopiuma (*Pithecellobium dulce*), kukui (*Aleurites moluccana*), and koa haole. Also along the Palani Road (especially at the upper elevations), was an alien forest composed primarily of Christmas berry that had a significant amount of the native alaheʻe (*Canthium odoratum*) in the understory.

Native species, including alaheʻe (*Canthium odoratum*), maiapilo (*Capparis sandwichiana*), ʻaʻaliʻi (*Dodonaea viscosa*), and ʻuhaloa (*Waltheria indica*) persisted in all of the areas that were dominated by alien vegetation.

The rare shrub maiapilo (*Capparis sandwichiana*) occurred throughout much of the alien-dominated vegetation (see "Plant Descriptions" section below).

Lava Tubes

Lava tubes in Hawaii are known to harbor cultural as well as rare biological resources. Many tubes contain specimens of preserved dead plants and animals, including the only examples of several kinds of native birds that are now extinct. In addition, lava tubes support unusual living ecosystems, inhabited by blind, pale animals, including crickets, bugs, moths, flies, and spiders. Some of Hawaii's cave-adapted invertebrates are candidates for endangered status.

The openings to many lava tubes were discovered during the field survey. Sites within the project area where extensive lava tubes were located are mapped in Figures 2A and 2B. Smaller and discontinuous lava tubes were also discovered, but have not been mapped. The interiors of the extensive tubes were not explored, but a description of lava tube ecosystems, typical of lowland dry habitats similar to the project area, is provided below:

Lowland Dry Lava Tubes

Caves in lava substrate extending into a permanently lightless zone containing sections with stagnant, water-saturated air, with entrances below 915 meters (3,000 feet) elevation, are classified as Lowland Dry Lava Tubes (HHP 1992). These tubes often support endemic,

obligatorily subterranean invertebrate species that characterize the biotic community found there. These species are detectable not only in the larger passages (macrocaverns), but also exist in smaller voids (mesocaverns) within the lava. It has been argued that mesocavern inhabitants venture only infrequently into macrocaverns (which tend to be drier than mesocaverns), doing so only when attracted to food sources that might be more abundant there, and only when air moisture conditions are tolerable.

Non-native species are considered a threat to the native biota within these ecosystems. Their effects are not certain, but they must compete for limited food resources, and some may be predatory on native cave animals. Cave species are also sensitive to human disturbance both within macrocaverns and on the surface.

PLANT DESCRIPTIONS

Nine rare plant taxa were recorded from the Keahole to Kailua Transmission Line Project Area or immediately adjacent to it. One of these, *Caesalpinia kavaiensis*, is listed as endangered (USFWS 1991). Moreover, a proposal to list three additional taxa (*Isodendrion pyrifolium*, *Mariscus fauriei*, and *Nothocestrum breviflorum*) as endangered is currently being prepared by the U.S. Fish and Wildlife Service (J. E. Canfield pers. comm.). The remaining five taxa are category 2 candidates. More information is needed before they are proposed for listing as endangered or threatened taxa (USFWS 1990).

With the exception of *Capparis sandwichiana*, which was found throughout the project area, rare plants were found within only two areas of the upper corridor: the land section of Kealakehe, and the Kaloko-Honokohau ʻaʻa lava flow. Construction of a transmission line through the upper corridor may impact the rare plants in this area. Alternatively, placing the transmission line through the lower corridor may impact *C. sandwichiana*; however, this species is relatively abundant throughout the project area.

The most critically imperilled plant taxon in the survey area is *Isodendrion pyrifolium*. It is currently known only from the upper corridor in the land section of Kealakehe, where there is a total of 10 to 12 plants.

State and Federally Listed Plant Taxa

***Caesalpinia kavaiensis* H. Mann**
Common name: Uhiuhi
Federal status: Endangered (USFWS 1991)
Hawaii State status: Endangered (DLNR 1992)

Caesalpinia kavaiensis is a shrub or tree 4 to 10 meters (ca. 10 to 30 feet) tall with doubly compound leaves. Its pinkish to reddish flowers are borne in terminal racemes 5 to 15

centimeters (2 to 6 inches) long. Its pods are obovate-oblong in shape and 9 to 13 centimeters (3.5 to 5 inches) long (Wagner, Herbst, and Sohmer 1990).

This member of the pea family (Fabaceae) has been recorded from Kauai, Oahu, Maui, Lanai (a recent discovery), and Hawaii. The species is known from 60 to 670 meters (200 to 2,200 feet) in elevation, from dry to mesic shrublands and forests (HHP 1992).

Caesalpinia kavaiensis was observed during the 1992 survey in the land section of Kealakehe (Figure 3B). This species was first recorded in that area in 1989 (Char 1989a).

Specimens of *Caesalpinia kavaiensis* were also collected in 1981 from the land section of Kaloko from 80 and 100 meters (270 and 320 feet) in elevation, on 'a'a lava (K. M. Nagata specimens 2347 and 2351, Bishop Museum) (Figure 3A). This plant was not seen in Kaloko on this survey, but may still occur there.

Proposed Plant Taxa

The following plant taxa are scheduled to be proposed as endangered species:

***Isodendrion pyrifolium* A. Gray**
Common name: Aupaka, wahine noho kula
Federal status: 3A (USFWS 1990); Scheduled to be proposed as an endangered species (J. E. Canfield pers. comm.)
Hawaii State status: None

Isodendrion pyrifolium of the violet family (Violaceae) is a shrub 0.8 to 2.0 meters (2.5 to 6.5 feet) tall with leaves 2.5 to 6.5 centimeters (1 to 2.5 inches) long. It has greenish yellow flowers borne singly in the leaf axils (Wagner, Herbst, and Sohmer 1990).

Isodendrion pyrifolium has been recorded from dry shrublands at low elevations on the islands of Niihau, Oahu (Waianae Mts.), Molokai, West Maui, and Hawaii (Wagner, Herbst, and Sohmer 1990).

The taxon was thought to be extinct until plants were discovered in the land section of Kealakehe in 1991 (K. M. Nagata pers. comm.). These *Isodendrion pyrifolium* were observed during the 1992 survey (Figure 3B). There were four to six plants in the known colony (it was unclear whether three closely-spaced stems represented a single plant or three separate plants). Also in Kealakehe, a new colony of six plants was found. The 2 colonies, totalling 10 to 12 mature plants, constitute the only known individuals of *Isodendrion pyrifolium* in the wild.

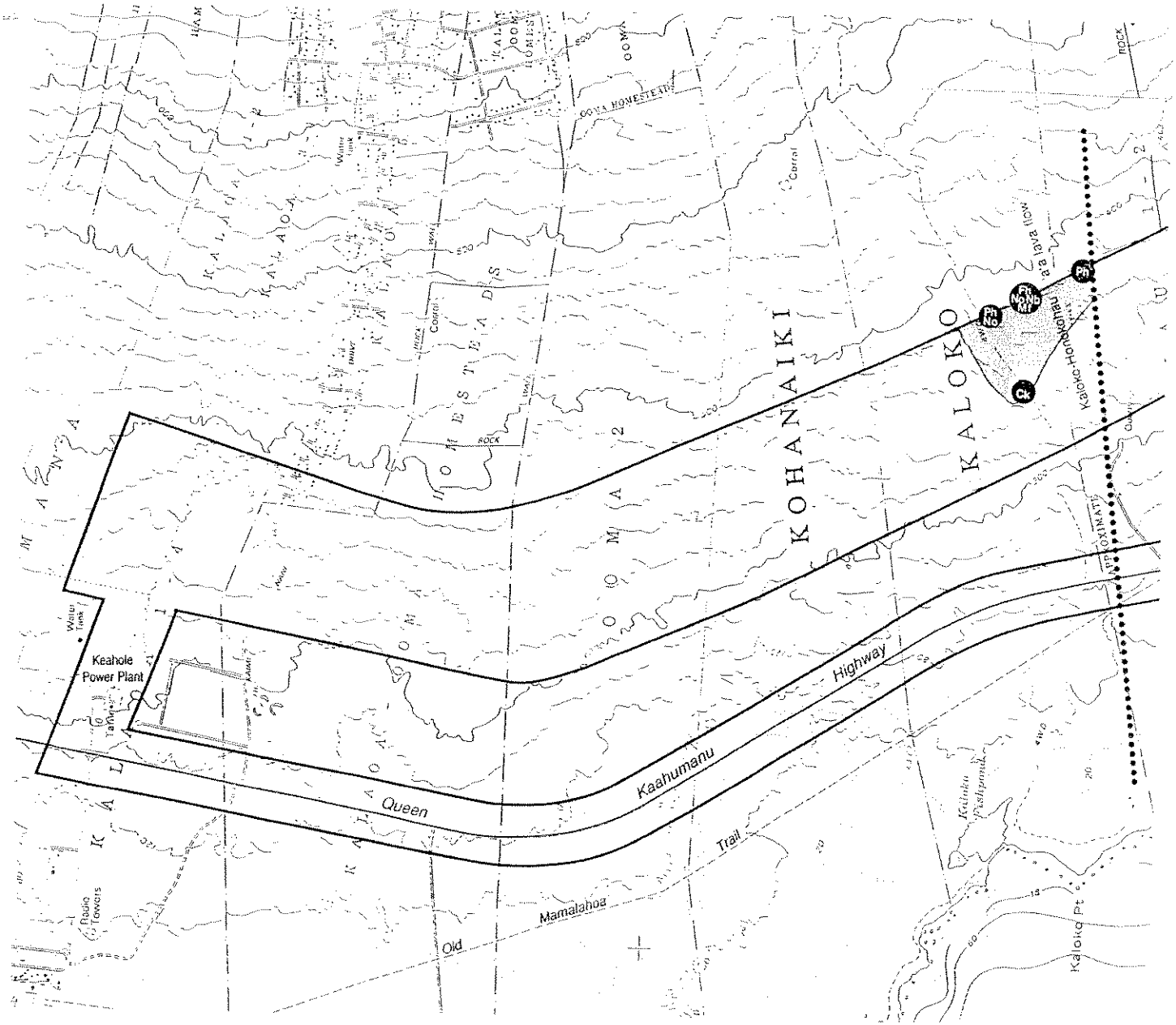


Figure 3A

Locations of Rare Plants and Animals

Keahole to Kailua Transmission Line Project Area

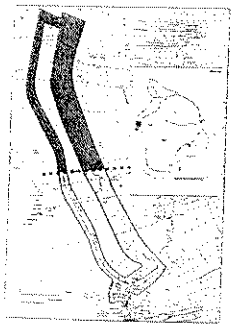
○ (Location Specific (w/in 0.33 mi radius)

● **Plants**

☐ *Bidens micrantha* ssp. *ctenophylla*

Ck = *Caesalpinia kavaiensis*
Fh = *Fimbristylus hawaiiensis*
Mf = *Mariscus fauriei*
No = *Neraudia ovata*
Nb = *Nothocestrum breviflorum*
Ph = *Pleomele hawaiiensis*

Note: *Capparis sandwichiana* not mapped (see text).



N

0 .5 1 Mile

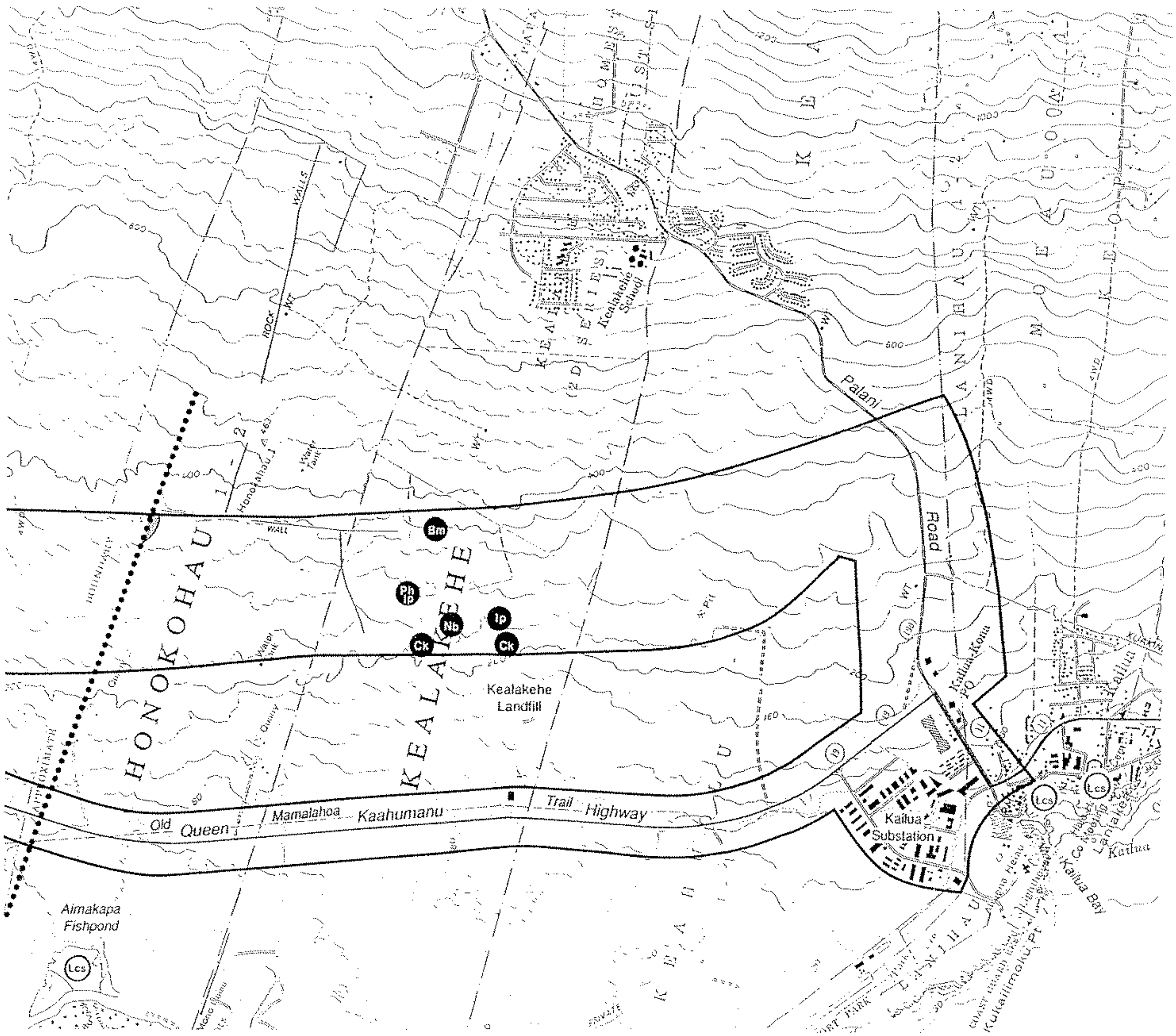
0 .5 1 Kilometer

Figure 3B

Locations of Rare Plants and Animals

Keahole to Kailua Transmission Line Project Area

◯ Location Specific (w/in 0.33 mi radius)



● Plants

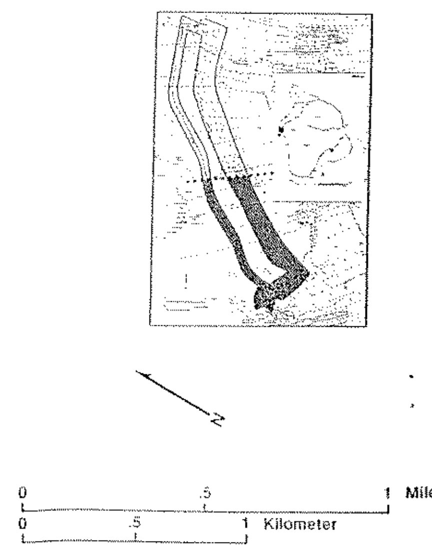
▒ *Bidens micrantha* ssp. *ctenophylla*

Bm = *Bidens micrantha* ssp. *ctenophylla*
Ck = *Caesalpinia kavaiensis*
Ip = *Isodendrion pyrifolium*
Nb = *Nothocestrum breviflorum*
Ph = *Pleomele hawaiiensis*

Note: *Capparis sandwichiana* not mapped (see text).

◯ Animals

Lcs = *Lasiurus cinereus semotus*



***Mariscus fauriei* (Kukenth.) T. Koyama**
Common name: None
Federal status: Category 1 candidate (USFWS 1990); Scheduled to be proposed as an endangered species (J. E. Canfield, pers. comm.)
Hawaii State status: None

Mariscus fauriei is a member of the sedge family (Cyperaceae). This grass-like plant ranges from 10 to 50 centimeters (4 to 20 inches) in height and bears inconspicuous flowers in compact heads (Wagner, Herbst, and Sohmer 1990).

The taxon has been recorded from the islands of Molokai, Lanai, and Hawaii. It is known from dry to mesic habitats from 110 to 1,830 meters (360 to 6,000 feet) in elevation (HHP 1992).

Mariscus fauriei was found during the 1992 survey at an elevation of ca. 115 meters (380 feet) in the land section of Kaloko at or just outside the project area boundary (Figure 3A). It was growing on ʻaʻa lava. Only five plants were seen growing on a single boulder.

***Nothocestrum breviflorum* A. Gray**
Common name: ʻAiea
Federal status: Category 1 candidate (USFWS 1990); Scheduled to be proposed as an endangered species (J. E. Canfield, pers. comm.)
Hawaii State status: None

A member of the nightshade family (Solanaceae), *Nothocestrum breviflorum* is a tree 10 to 12 meters (30 to 40 feet) tall. Its 5 to 12 centimeter- (2 to 4.5 inch-) long leaves are borne in clusters at the ends of branches. Numerous greenish-yellow flowers are borne on short axillary spurs. Its fruit is a round, orangish-red berry (Wagner, Herbst, and Sohmer 1990).

Nothocestrum breviflorum is endemic to the island of Hawaii. It occurs in dry to mesic forests and ranges from ca. 180 to 1,830 meters (600 to 6,000 feet) in elevation (HHP 1992).

Three trees of *Nothocestrum breviflorum* were seen during the 1992 survey. A single tree was observed in the land section of Kealakehe at an elevation of 79 meters (260 feet) on ʻaʻa lava (Figure 3B). Two additional trees were seen on the Kaloko-Honokohau ʻaʻa flow at 110 meters (360 feet) in elevation (Figure 3A), probably just outside of the study area.

Candidate Category 2 Plant Taxa

***Bidens micrantha* Gaud. ssp. *ctenophylla* (Sherff) Nagata and Ganders**
Common name: Ko'oko'olau, koko'olau
Federal status: Category 2 candidate (USFWS 1990)
Hawaii State status: None

Bidens micrantha ssp. *ctenophylla*, of the sunflower family (Asteraceae), is an erect herb 0.5 to 1.5 meters (1.5 to 5 feet) tall. Its leaves are simple or occasionally compound with three leaflets. Its yellow flowers are borne in dense clusters (Wagner, Herbst, and Sohmer 1990).

Bidens micrantha is endemic to the islands of Maui, Lanai, and Hawaii. There are three recognized subspecies. The subspecies *ctenophylla* is endemic to the district of North Kona. It has been recorded from lava flows in dry shrublands and forests on the leeward slopes of Hualalai between the elevations of 90 and 915 meters (300 and 3,000 feet) (HHP 1992).

Bidens micrantha ssp. *ctenophylla* was fairly common in the land section of Kealakehe above 85 meters (280 feet) (Figure 3B). It is also common on the Kaloko-Honokohau 'a'a lava flow, above an elevation of ca. 90 meters (300 feet) (Figure 3A).

***Capparis sandwichiana* DC**
Common name: Pua pilo, maiapilo
Federal status: Category 2 candidate (USFWS 1990)
Hawaii State status: None

A member of the caper family (Capparaceae), *Capparis sandwichiana* is a prostrate or upright shrub with light green, fleshy leaves and large white flowers that turn light pink with age (Wagner, Herbst, and Sohmer 1990).

It is possible that the Hawaiian populations of *Capparis* are part of the widespread Pacific species *C. cordifolia*, and not a separate Hawaiian species (Wagner, Herbst, and Sohmer 1990). More taxonomic studies are needed to determine if this is an endemic or indigenous taxon.

The taxon has been recorded from all of the main Hawaiian Islands as well as Midway Atoll, Pearl and Hermes Atoll, and Laysan Island in the Northwestern Hawaiian Islands. Usually this species grows in dry coastal areas, but sometimes it can be found inland up to ca. 915 meters (3,000 feet) in elevation (HHP 1992).

Capparis sandwichiana was distributed throughout most of the study area in all vegetation types. It was observed to be occasional to locally common.

***Fimbristylis hawaiiensis* Hillebr.**
Common name: None
Federal status: Category 2 candidate (USFWS 1990)
Hawaii State status: None

Fimbristylis hawaiiensis is a member of the sedge family (Cyperaceae). It is a grass-like plant 9 to 17 centimeters (3.5 to 6.5 inches) tall. Its inconspicuous flowers are borne at the end of long slender stalks (Wagner, Herbst, and Sohmer 1990).

The taxon is endemic to the districts of North Kona, South Kona, Kau, and Puna on the island of Hawaii. It occurs on pahoehoe or ʻaʻa lava substrates from ca. 10 to 275 meters (30 to 900 feet) in elevation (HHP 1992).

A localized population of about 50 plants was discovered on the Kaloko-Honokohau ʻaʻa lava flow at 113 meters (370 feet) near the upper project area boundary (Figure 3A). The plants were growing on top of ʻaʻa boulders within an area 5 meters (16 feet) across. This find represents the first record of the species from North Kona.

***Neraudia ovata* Gaud.**
Common name: Maʻaloa, maʻoloa, ʻoloa
Federal status: Category 2 candidate (USFWS 1990)
Hawaii State status: None

This member of the nettle family (Urticaceae) is a shrub with branches 1 to 3 meters (3 to 10 feet) long. Its leaves are 4 to 12 centimeters (1.5 to 4.5 inches) long and 2 to 6.5 centimeters (0.8 to 2.5 inches) wide. Its inconspicuous flowers are borne in axillary clusters. Female and male flowers are borne on separate plants (Wagner, Herbst, and Sohmer 1990).

The species occurs in dry forests, open lava flows, and subalpine forests on the leeward sections of the island of Hawaii. It ranges from ca. 115 to 1,460 meters (380 to 4,800 feet) in elevation (HHP 1992).

Two mature individuals of *Neraudia ovata* were observed on the Kaloko-Honokohau ʻaʻa lava flow at an elevation of 115 meters (380 feet) along or just beyond the upper project area boundary (Figure 3A).

***Pleomele hawaiiensis* Degener & I. Degener**
Common name: Halapepe
Federal status: Category 2 candidate (USFWS 1990)
Hawaii State status: None

Pleomele hawaiiensis is a member of the agave family (Agavaceae). It is a tree 5 to 6 meters (15 to 20 feet) tall with long narrow leaves 23 to 38 centimeters (9 to 15 inches) long clustered at the branch tips. The flowers are born in panicles 19 to 28 centimeters (7.5 to 11 inches) long. The pale yellow flowers are tubular, and 33 to 43 millimeters (1.3 to 1.7 inches) long. The fruit is a globose berry about 10 to 13 millimeters (0.4 to 0.5 inches) in diameter (Wagner, Herbst, and Sohmer 1990).

The taxon is endemic to the leeward side of the island of Hawaii. It occurs in dry to mesic forests from ca. 85 to 930 meters (280 to 3,050 feet) in elevation (HHP 1992).

Pleomele hawaiiensis was observed in the upper corridor of the project area on the lava flows of Kealakehe and Kaloko-Honokohau (Figures 3A and 3B). A single tree was seen in Kealakehe at 85 meters (280 feet) in elevation. Two additional plants were observed on the Kaloko-Honokohau lava flow at ca. 110 meters (360 feet) in elevation.

Alien Plants

As previously noted, large portions of the project area were dominated by alien (non-native) vegetation. In particular, the following alien plant taxa were abundant: fountaingrass (*Pennisetum setaceum*), koa haole (*Leucaena leucocephala*), kiawe (*Prosopis pallida*), and Christmas berry (*Schinus terebinthifolius*).

ANIMAL DESCRIPTIONS

A unique assemblage of animals evolved in Hawaii. When humans established themselves on the islands, they modified habitat and introduced numerous alien species that have been very successful in out-competing the native species. Consequently, many of the original animal species have gone extinct. The existing endemic species consist of 1 land mammal, 1 marine mammal, 49 birds, hundreds of land snails, and over 5200 insects and other terrestrial invertebrates. However, many of the remaining populations are now considered rare and in danger of extinction.

The following species accounts briefly describe the native Hawaiian animals detected during the 1992 field survey, or those previously reported from or near the Keahole to Kailua Transmission Line Project Area. A brief discussion of alien vertebrate animals is also presented. Appendix B lists all the invertebrate animals recorded during the 1992 field survey. Appendix C lists all the vertebrate animals recorded during the 1992 field survey, or reported in or near the project area from previous surveys or incidental observations.

State and Federally Listed Animal Taxa

Lasiurus cinereus semotus
Common name: Hawaiian Hoary Bat or 'Ope'ape'a
Federal status: Endangered (USFWS 1991)
Hawaii State status: Endangered (DLNR 1990)

The endangered Hawaiian Hoary Bat is Hawaii's only native terrestrial mammal. Originally considered to be a distinct species, the endemic Hawaiian Hoary Bat is now taxonomically classified as a subspecies of the American mainland populations of hoary bats (Tomich 1986). Very little information currently exists in the literature about its roosting behavior, breeding biology, home range, foraging patterns, or food supply (Kepler and Scott 1990).

Although the Hawaiian Hoary Bat is considered a solitary species, groups comprising 2 to 108 individuals have been described (Kramer 1971, Tomich 1986, Fujioka and Gon 1988, Kepler and Scott 1990). Observations have been reported from the islands of Hawaii, Kauai, Maui, Molokai, Kahoolawe, and Oahu (Kepler and Scott 1990, HHP 1992). Breeding has been recorded on both Hawaii and Kauai. Duvall and Gassmann-Duvall (1991) have recently suggested that at least one resident population, if not a breeding one, exists on Maui. There have been few observations of bats on Oahu, and only one observation has been recorded from Molokai. Although bats are more commonly seen in coastal and lowland forested areas, recorded sightings exist from a wide range of elevations (HHP 1992).

It has been suggested that the Hawaiian Hoary Bat is migratory (Kramer 1971), but there is little evidence to support this theory (although the American mainland species does migrate). Data analyzed by Kepler and Scott (1990) show that Hawaiian Hoary Bats "are much more active and conspicuous in the fall months."

The reproductive biology of the Hawaiian Hoary Bat has been virtually unaddressed by the scientific community (Kramer 1971). The small amount of data collected suggest that female bats typically produce two young in June (Kepler and Scott 1990).

Habitat requirements of the Hawaiian Hoary Bat are not fully understood. An analysis by Kepler and Scott (1990) showed no preference for native vegetation. There is some evidence of bats occupying lava tubes (Fujioka and Gon 1988), but Tomich (1986) does not believe that "deep caverns are of advantage to the physiological needs of the hoary bat in Hawaii." It appears that the bat is unselective in its choice of roosting sites (Kramer 1971, Tomich 1986) and it is quite possible that alien vegetation is not a significant threat to the species' survival. On the other hand, we do not know what changes may have occurred to the distribution of the Hawaiian Hoary Bat as a result of direct or indirect human interference.

The endangered Hawaiian Hoary Bat was not detected during the field survey, but it has been previously detected near the project area. Areas of recent detection are shown in Figure 3B and include 1992 sightings of one to four bats flying over Aimakapa Fishpond

and Kailua Bay (David pers. comm.), and a 1991 sighting of one bat at the Kona Inn Restaurant in Kailua (Fulton pers. comm.).

The lack of sightings directly within the Keahole to Kailua Transmission Line Project Area indicates that the habitat is probably not optimal for the endangered Hawaiian Hoary Bat. This may be due to the limited number of trees for roosting, or, perhaps suitable food sources are not readily available. Nevertheless, Hawaiian Hoary Bats are highly mobile animals. They probably fly through the project area when leaving their more forested roosting sites at higher elevations to feed on insects along the coast.

Although endangered Hawaiian Hoary Bats probably fly through the project area, the sightings noted above demonstrate that Hawaiian Hoary Bats utilize urban areas where powerlines already exist. Also, bats within the family Vespertilionidae (to which the Hawaiian Hoary Bat belongs) are well known for their exceptional navigational abilities (Vaughan 1986), and can probably maneuver quite easily around powerlines and associated structures. Therefore, it is likely that the installation of the proposed Keahole to Kailua 138 kV transmission line will not be detrimental to local bat populations.

Proposed Animal Taxa

No proposed animal taxa had been recorded from the project area prior to the field survey, and none were observed during the survey.

Candidate Animal Taxa

No animal taxa that are candidates for proposal as endangered or threatened had been recorded from the project area prior to the field survey, and none were observed during the survey.

Other Native Animal Taxa of Concern

The two animals listed below are not registered as endangered, threatened, or candidates for endangered or threatened status by the USFWS or the State of Hawaii on the island of Hawaii (*Asio flammeus sandwichensis* is listed by the State of Hawaii as endangered on the island of Oahu only). However, these animals are native and represent part of Hawaii's natural heritage.

Pluvialis fulva
Common name: Kolea or Pacific Golden-Plover
Federal status: None
Hawaii State status: None

The Kolea is a winter visitor to all of the Hawaiian Islands, arriving in August and remaining until early May before making the journey back to arctic breeding grounds. A few individuals stay in Hawaii year-round. Kolea can be seen on mudflats, fields, bogs, pastures, residential lawns, golf courses, and grassy mountain slopes from sea level to 3,000 meters (10,000 feet) or more (Berger 1981, Scott et al. 1986, Pratt et al. 1987, Hawaii Audubon Society 1989).

When searching for food, Kolea typically run in short bursts and stop to search for insects, crustaceans, snails, other invertebrates, and various plants (Berger 1981, Scott et al. 1986). They are territorial on wintering grounds, returning to the same area year after year (Hawaii Audubon Society 1989).

Kolea were detected only twice during the field survey. The first detection was between the Queen Kaahumanu Highway and the Old Mamalahoa Trail in the Kohanaiki land section. The other sighting was in the upper section of the project area, just east of the Kealakehe Landfill. On both occasions, the birds were flying and did not appear to be making significant use of the land within the project area. In light of the Kolea's abundance in other parts of Hawaii, its scarcity during the current survey suggests that much of the arid landscape within the project area does not provide favorable habitat for the Kolea.

Asio flammeus sandwichensis
Common name: Pueo or Short-eared Owl
Federal status: None
Hawaii State status: Endangered on the island of Oahu only (DLNR 1990)

The Pueo is considered by many ornithologists to be a full subspecies endemic to the Hawaiian Islands (Berger 1981, American Ornithologists' Union 1983, Scott et al. 1986, Hawaii Audubon Society 1989, Pyle 1992), but Olson (pers. comm. 1992) considers this classification debatable. The Pueo's relationships with its North American and Asiatic relatives may require further examination.

Pueo are found on all the main Hawaiian islands, but are most common on Kauai, Maui, and Hawaii. The total number of Pueo has not been estimated. While it has no federal status as a rare species, the Pueo is listed as endangered on the island of Oahu by the Hawaii Division of Forestry and Wildlife (DLNR 1990). Pueo have also been observed on some of the Northwestern Hawaiian Islands, but these individuals are considered by some to be mainland Short-eared Owl stragglers (Berger 1981, Hawaii Audubon Society 1989).

Unlike most owls, Pueo are often active at mid-day. They frequently soar at high altitudes, leading some observers to mistake the bird for the Hawaiian Hawk (*Buteo solitarius*), or 'Io (Berger 1981). Pueo occur from sea level to about 2,400 meters (8,000 feet) in elevation, and inhabit areas dominated by both native and alien vegetation, from pastures and grasslands to dry and wet forests. Pueo feed primarily on introduced rodents (Berger 1981, Scott et al. 1986) such as the European House Mouse (*Mus domesticus*) and the Roof Rat (*Rattus rattus rattus*).

Pueo build their nests on the ground, usually in grass. Three to six white eggs are laid (Hawaii Audubon Society 1989). Little is known about the breeding biology of this species; however, nests containing young have been observed in March, May, and November (Berger 1981). Because Pueo nest on the ground, eggs and nestlings are vulnerable to predation by feral cats (*Felis catus*) and Small Indian Mongooses (*Herpestes auropunctatus auropunctatus*).

Pueo were detected once during the field survey, in the upper section of the project area at approximately 100 meters (320 feet) in elevation and close to the existing powerline that runs east of the Keahole Power Plant. This species is probably attracted to the more open, grassy habitats associated with this area. Rodents such as *Rattus rattus rattus* and *Mus domesticus*, which almost certainly occur within the project area, would provide an excellent food source for Pueo.

Pueo are relatively common on the island of Hawaii and they are known to inhabit areas dominated by alien vegetation (Berger 1981; Hawaii Audubon Society 1989). Any habitat changes generated by the installation of the proposed transmission line are not expected to adversely affect the Pueo.

Alien Animals

A cursory discussion of alien vertebrate animal taxa detected in the Keahole to Kailua Transmission Line Project Area is presented below. A complete list of alien vertebrate animals detected within the project area is provided in Appendix C.

Game Birds - These birds belong to the families Phasianidae and Columbidae. All are used for recreational hunting purposes. A total of eight taxa had previously been detected within the project area (M&E Pacific, Inc. 1977, Wilson Okamoto & Associates, Inc. 1981, Char & Associates 1985, Bruner 1989a & 1989b). Three of these were detected during the field survey. The Spotted Dove (*Streptopelia chinensis*) and Zebra Dove (*Geopelia striata*) were common throughout the project area. The Erckel's Francolin (*Francolinus erckelii*) was also detected, but only on three occasions. It was found within the 'A'ali'i (*Dodonaea viscosa*) Lowland Dry Shrubland (Figure 2B). An unidentified francolin (*Francolinus* sp.) was also spotted by a member of the field crew who was driving along the Queen Kaahumanu Highway. The installation of the proposed transmission line is not expected to have a detrimental effect on game bird populations in the project area.

Alien Passerines - Many alien birds were intentionally released in the Hawaiian Islands to increase the number of songbirds, and many more have escaped from cages. A few other bird taxa, such as the Common Myna (*Acridotheres tristis*), have been introduced to combat agricultural pests. A large number of these alien birds have established viable populations and compete with native birds for habitat and other available resources (Berger 1981).

Twelve alien passerines, representing seven families, had previously been detected within the project area (M&E Pacific, Inc. 1977, R.M. Towill Corporation 1978, Wilson Okamoto & Associates, Inc. 1981, Char & Associates 1985, Bruner 1989a & 1989b). Eleven of these taxa were detected during the field survey. The House Finch (*Carpodacus mexicanus*), Yellow-fronted Canary (*Serinus mozambicus*), Japanese White-eye (*Zosterops japonicus*), and Common Myna (*Acridotheres tristis*) were the most numerous. They were recorded within all the major vegetation types. The installation of the proposed transmission line is not likely to be detrimental to alien songbird populations in the project area.

Small Mammals - Many small mammals have been introduced to the Hawaiian Islands either accidently or on purpose. Many of these taxa, especially rodents (family Muridae), Small Indian Mongooses (*Herpestes auropunctatus auropunctatus*), and feral cats (*Felis catus*), are known to prey on native Hawaiian birds. Eggs, nestlings, and fledglings of native birds are the most vulnerable to predation by these mammals (Berger 1981, Tomich 1986).

Two small mammals were observed during the field survey, the Small Indian Mongoose (*Herpestes auropunctatus auropunctatus*) and the feral cat (*Felis catus*). Both of these animals were observed near the Kealakehe Landfill. Evidence of rats (*Rattus* spp.) was present near the water tank east of the Keahole Power Plant. All of these mammals have previously been detected and/or suspected within the project area (M&E Pacific, Inc. 1977, Wilson Okamoto & Associates, Inc. 1981, Char & Associates 1985, Helber, Hastert & Kimura 1988, Bruner 1989a & 1989b, Helber, Hastert & Kimura 1990). These animals will not be adversely affected by the installation of the proposed powerline.

Feral Ungulates - Many ungulates (hoofed mammals) brought to the Hawaiian Islands have escaped or have been intentionally released into Hawaiian forests. Almost all of these animals are used for recreational hunting purposes. Unfortunately, their foraging habits cause extensive damage to native Hawaiian vegetation and destroy habitats essential for the survival of native Hawaiian birds.

Both scat and bones of the feral goat (*Capra hircus hircus*) were detected throughout much of the upper section of the project area, indicating its probable presence. Goat bones were often found within lava tubes directly below small skylights. This suggests that the animals had fallen, possibly creating the skylight in the process. Goat populations in the project

area are not expected to be negatively affected by the installation of the proposed transmission line.

BIOLOGICALLY SIGNIFICANT AREAS WITHIN THE KEAHOLE TO KAILUA TRANSMISSION LINE PROJECT AREA

Although many alien plants were present throughout the Keahole to Kailua Transmission Line Project Area, the survey team did observe many native Hawaiian plant species in the upper section of the project area within two native natural communities, 'Ohi'a (*Metrosideros polymorpha*) Lowland Dry Forest and 'A'ali'i (*Dodonaea viscosa*) Lowland Dry Shrubland (Figures 2A and 2B). These natural communities are significant because they provide habitats for one federally endangered plant, three plants which are being proposed for federal endangered status, and four other plants which are candidates for federal endangered or threatened status. The opportunity to preserve some of these ecosystems is important because of the clear history of diminishing size and quality of native natural communities in Hawaii. In addition, the shrub maiapilo (*Capparis sandwichiana*), which is a Category 2 candidate for endangered or threatened status, was observed throughout the project area.

Several significant lava tube openings were scattered throughout the study area (Figure 2A). These openings indicate regions that may contain substantial lava tube corridors. These lava tubes may support rare, subterranean animals, including candidate endangered invertebrates.

PROJECT IMPACTS AND RECOMMENDATIONS

This report has identified the biological resources of the Keahole to Kailua Transmission Line Project Area. The information provided below is meant to help CH2M HILL conduct the necessary routing studies and environmental analyses for the proposed Keahole to Kailua 138 kV Transmission Line:

ROUTING CONSIDERATIONS

The introduction and establishment of alien plant and animal species is an important environmental problem. These introductions are responsible for damage to native forests, streams, and watersheds; competition for food and habitat requirements with native animals; and introduction of diseases affecting both native and domesticated plant and animal species. Replacement of native habitats with introduced species such as fountaingrass (*Pennisetum setaceum*) also increases the likelihood of fire.

The majority of highly sensitive biological resources within the Kealakehe land section and the Kaloko-Honokohau 'a'a flow might be imperilled if routing were proposed through the upper section of the project area. The most severe impacts in these areas would probably be caused by bulldozing for access and service roads. Bulldozing and other construction activities would probably facilitate the introduction and establishment of alien plant species and would also create easier access for alien animals (especially feral ungulates) to native habitats. The use of the upper corridor would also lead to the further fragmentation of the already disturbed native ecosystems. The spread of noxious weeds would also increase, increasing the potential for fire. The upper corridor also contains the greater number of lava tube systems identified in this survey, thus increasing the potential for candidate animal species. In contrast, the lower corridor for the proposed transmission line affects a minimum of known biological resources. Construction of the proposed transmission line through the upper corridor might require mitigation efforts, specifically with regard to the endangered plant *Caesalpinia kavaiensis* which is protected by the Endangered Species Act of 1973 (USFWS 1973) and Hawaii State Law (H.R.S. 195-D). All necessary mitigation actions should be undertaken in cooperation with and reviewed by the U.S. Fish and Wildlife Service and the Hawaii State Department of Land and Natural Resources, the agencies that oversee the protection of endangered species.

RECOMMENDED ACTIONS

Based on the information collected by the survey team and for the reasons expressed above, if the Keahole to Kailua 138 kV Transmission Line is constructed in the lower section of the project area, paralleling the Queen Kaahumanu Highway within the current proposed easement of 150 meters (500 feet) on either side of the highway, a minimum number of sensitive biological resources will be directly affected.

To reduce the threat from the spread of alien plants and animals, we recommend that few new access roads be cut, and that the highway and other existing roads in the lower corridor of the project area be used for access to the new line whenever possible. Construction parking should be restricted to specific areas. Low impact, directed charges should also be considered for digging holes, as well as aerial (helicopter-assisted) stringing of high tension wires for the installation of the proposed 138 kV line. To assist with interpretations or questions, we recommend that a biologist familiar with the resources of the area be included in preconstruction meetings with site engineers. Finally, a follow-up survey focussing on the biological resources within the lava tubes that occur within the selected corridor is strongly recommended.

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GLOSSARY

The following terms are often found in Bishop Museum reports. While not all of the terms may be present in this report, this glossary is meant to provide definitions to terms that may be unfamiliar to the reader, or to clarify terms which have specific definitions in different disciplines.

Alien: (same as **exotic, introduced, or non-native**) a species that is not native, i.e., one introduced accidentally or purposefully by man. In Hawaii, these include Polynesian introductions (such as kukui, coconut, pig, rat, and jungle fowl) and many post-Cook introductions (such as guava, Christmas berry, mosquitoes, pigs, goats, cattle, deer, and sheep). See **Endemic, Indigenous, Native.**

Avian: relating to birds.

Biota: all plants and animals of a given area. A general term for living things.

Canopy: the highest vegetation cover of a community. In a forest, the canopy is made up of the tallest and most numerous trees. In a shrubland, the canopy is the tallest shrub layer. Closed canopies are those where the foliage interlocks to form a continuous layer over the underlying vegetation or ground. Open canopies are those where there are gaps in the foliage, and more light may reach the lower vegetation layers or ground.

Coastal: one of five elevation zones used to classify Hawaiian natural communities. The Hawaiian coastal zone extends from sea level to 30 m. (roughly 100 ft.) elevation but varies with the extent of coastal influence (e.g., waves, sea spray, and cliffs). See **Elevation Zones.**

Codominant: in a natural community, a condition in which two or more plant species constitute at least 50% of the existing vegetation cover in a given area.
See **Dominant, Natural Community.**

Degraded: physically altered in such a way as to decrease the habitat quality for native species or invaded by non-native species. A community is considered degraded if non-native weeds constitute more than 40% of the vegetation cover.

DLNR: Hawaii Department of Land and Natural Resources.

DOFAW: Hawaii Division of Forestry and Wildlife: a division of the State Department of Land and Natural Resources (DLNR).

Dominant: in a vegetated community, the plant species contributing the most canopy cover in a given area. Dominant species may also be the most numerous in a natural community. See **Natural Community.**

Dry: a moisture category describing habitat in areas with less than 50 inches of annual rainfall, or subject to seasonal drought, or bearing generally dry prevailing soil conditions. See **Mesic, Wet.**

Ecosystem: an assemblage of animals and plants and its interaction with the environment. See **Natural Community.**

Elevation Zones: broad regions defined by elevation range and used to classify natural communities (ecosystems). There are five elevation zones defined by the Hawaiian natural community classification: coastal, lowland, montane, subalpine, and alpine. Each is defined separately.

Endangered: any taxon officially recognized by the U.S. Fish and Wildlife Service to be in danger of extinction throughout all or a significant portion of its range. See **Federal Status, Threatened.**

Endemic: naturally restricted to a locality. Most of Hawaii's native plants and animal are endemic (restricted) to the Hawaiian Islands. Many are restricted to a single island, mountain range, or even gulch. See **Alien, Native, Indigenous.**

Exotic: not native. See **Alien.**

Fauna: the animals of a specified region.

Federal Status: official U.S. Fish and Wildlife Service categories for endangered, threatened, and candidate endangered taxa according to the Federal Register:

Listed Endangered (LE)	=	Taxa formally listed as endangered.
Proposed Endangered (PE)	=	Taxa already proposed to be listed as endangered.
Threatened	=	Taxa likely to become endangered within the foreseeable future throughout all or a significant portion of their range.
Category 1 (C1)	=	Candidate taxa for which the USFWS has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.
Category 1* (C1*)	=	Same as C1, possibly extinct.
Category 2 (C2)	=	Candidate taxa for which there is some evidence of vulnerability, but for which there are not enough data to support listing proposals at this time.
Category 3A (3A)	=	No longer candidates for listing: taxa for which the USFWS has persuasive evidence of extinction. If rediscovered, such taxa might acquire high priority for listing.
Category 3B (3B)	=	No longer candidates for listing: names that, on the basis of current taxonomic understanding, do not represent distinct taxa. Such supposed taxa could be reevaluated in the future on the basis of new information.

Federal Status (continued):

Category 3C (3C) = No longer candidates for listing: taxa that have proven to be more abundant or widespread than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in habitat indicate a significant decline in any of these taxa, they may be reevaluated for possible inclusion in categories 1 or 2.

HHP: The Nature Conservancy of Hawaii's Hawaii Heritage Program.

Indicator Species: species that require specific ecological conditions and are therefore used to measure the quality of the habitat. For example, certain native Hawaiian aquatic animals are indicator species of quality streams.

Indigenous: naturally occurring in a given area as well as elsewhere. Indigenous Hawaiian taxa also occur naturally outside of the Hawaiian Islands (e.g., naupaka kahakai (*Scaevola sericea*) is indigenous to Hawaii, found in Hawaii and throughout the South Pacific). See **Alien, Endemic, Native.**

Intact: maintaining at least 60% cover in native species.

Introduced: See **Alien.**

Invertebrate: animals without backbones, including such groups as insects, spiders, shrimps, and snails.

Lowland: one of five elevation zones used to classify Hawaiian natural communities. The Hawaiian lowland zone lies above the coastal zone, up to about 1,000 m. (roughly 3,000 ft.) elevation. There is lowland zone on all of the main islands. See **Elevation Zones.**

Mesic: a moisture category describing habitat in areas with 50-75 inches of annual rainfall, or otherwise provided with sufficient water to result in moist soil conditions. See **Wet, Dry**.

Montane: one of five elevation zones used to classify Hawaiian natural communities. The Hawaiian montane zone lies above the lowland zone and runs from 1,000 m. (roughly 3,000 ft.) to 2,000 m. (roughly 6,000 ft.) elevation. There is a montane zone on Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii. See **Elevation Zones.**

Multizonal: a community typically occupying more than one broad elevation zone. For example, streams may run from montane sources to sea level. See **Elevation Zones.**

NARS: Natural Area Reserves System: state lands designated to protect Hawaiian ecosystems, native plants and animals, and other natural features in perpetuity.

Native: found naturally in an area, not introduced accidentally or purposefully by man; includes both indigenous and endemic taxa. See **Alien, Endemic, Indigenous.**

Natural Community: a natural assemblage of plants and animals that occurs within certain elevation, moisture, and habitat conditions; sometimes used loosely as another term for "ecosystem." However, "ecosystem" includes abiotic environmental factors, so that (natural community + environment) = ecosystem.

Naturalized: non-native plants with established populations in the wild.

Non-native: See **Alien.**

Perennial: lasting or active throughout the year; when referring to streams, including both continuous and interrupted streams with year-long water flow.

Physiognomy: general descriptive term for habitat, including categories such as bog, grassland, shrubland, forest, desert, and cliff.

Priority weed: a non-native plant with known ability to disrupt the vegetation of native ecosystems. Control of such weeds is a high priority. For example, *Clidemia hirta* is a priority weed that has displaced native understory plants in much of Oahu's forests.

Pristine: undisturbed by humans and completely lacking non-native taxa; entirely native.

Protected: legally dedicated to the perpetuation of native resources and managed to mitigate or remove threats to those resources, if necessary. Areas lacking either legal protection or management are considered incompletely protected.

Puu: hill or volcanic cone.

Rare: imperilled with extinction due to low numbers. By the HHP definition, a plant, animal, or natural community with 20 or fewer current (within the last 15 years), viable occurrences, all or most of which are immediately imperilled by such factors as displacement by non-native taxa, direct destruction, or loss of habitat. Other more widespread plant and animal taxa may also be considered rare if imperilled with destruction throughout all or a significant portion of their range. A natural community may also be considered rare if it covers less than 2,000 acres worldwide.

spp.: abbreviation for more than one species.

ssp.: See **Subspecies.**

Subalpine: one of five elevation zones used to classify Hawaiian natural communities. The Hawaiian subalpine zone lies above the montane zone and runs from 2,000 m. (roughly 6,000 ft.) to 3,000 m. (roughly 9,000 ft.) elevation. There is a subalpine zone only on the islands of Maui and Hawaii. See **Elevation Zones.**

Subspecies: (abbreviated ssp.) a taxonomically distinguishable geographic or ecological subdivision of a species. See **Variety.**

Substation: a sampling point along a survey transect of a field survey.

Taxon (plural= **Taxa**): a group of plants or animals making up one of the categories or formal units in taxonomic classification. In this report a taxon can be a species, subspecies, variety, or form. This distinction is important because certain species have endemic Hawaiian subspecies and varieties that are considered rare.

Threatened: any taxon officially recognized by the U.S. Fish and Wildlife Service as likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. See **Federal Status, Endangered.**

UH: University of Hawaii.

Ungulate: a subdivision of hoofed mammals including pigs, goats, cattle, sheep, mouflon, and deer.

USFWS: United States Fish and Wildlife Service.

USGS: United States Geological Survey.

Variety: (abbreviated var.) a taxonomically distinguishable subdivision of a species or subspecies. See **Subspecies.**

Vertebrate: an animal with a backbone; native terrestrial vertebrate species in Hawaii include fish, birds, a bat, and a seal. See **Invertebrate.**

Viable: Capable of persisting and reproducing under favorable conditions.

Weed: an undesirable plant. In native ecosystems all non-native plants are weeds. See **Priority Weed.**

Wet: a moisture category describing habitat in areas with more than 75 inches of annual rainfall, or situated near groundwater or surface water, such that availability of water is not a major limiting factor to plants or animals there. See **Dry, Mesic.**

Appendix A. Vascular Plants Recorded From the Keahole to Kailua Transmission Line Project Area.

The vascular plants marked in the four natural community columns are the native and naturalized vascular plants observed on the field survey. The taxonomy and nomenclature of the flowering plants are according to Wagner et al. (1990). The ferns and fern allies follow C.H. Lamoureux (1988).

Key to natural communities:

1 = 'A'ali'i Lowland Dry Shrubland
2 = 'Ohi'a Lowland Dry Forest
3 = Alien-dominated Vegetation
4 = Sparsely Vegetated Lava Flow

Status codes: **N** = Non-native; **I** = Indigenous; **E** = Endemic; * = Observed on field survey

STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
FERNS AND FERN ALLIES							
	NEPHROLEPIDACEAE						
N	*Nephrolepis multiflora* (Roxb.) Jarrett ex Morton	Kupukupu, ni'ani'au		*	*	*	*
	POLYPODIACEAE						
N	*Phymatosorus scolopendria* (Burm.) Pic.-Ser.	Laua'e		*		*	
	PSILOTACEAE						
I	*Psilotum complanatum* Sw.	Moa		*	*		
	SINOPTERIDACEAE						
E	*Doryopteris decora* Brack.	Kumuniu		*	*		*
FLOWERING PLANTS: DICOTS							
	AMARANTHACEAE (Amaranth family)						
N	*Amaranthus spinosus* L.	Spiny amaranth, pakai kuku		*		*	
	ANACARDIACEAE (Mango family)						
N	*Mangifera indica* L.	Mango				*	
N	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki		*	*	*	*
	APOCYNACEAE (Dogbane family)						
N	*Catharanthus roseus* (L.) G. Don	Madagascar periwinkle			*	*	
	ARALIACEAE (Ginseng family)						
E	*Reynoldsia sandwicensis* A. Gray	'Ohe-o-kai, 'ohe kukuluae'o		*	*		
	ASTERACEAE (Sunflower family)						
N	*Ageratum conyzoides* L.	Maile hohono		*	*		
N	*Bidens cynapiifolia* Kunth	Spanish needle, beggartick				*	
E	*Bidens micrantha* Gaud. ssp. *ctenophylla* (Sherff) Nagata & Ganders	Ko'oko'olau, koko'olau	C2	*	*		

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STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
N	*Bidens pilosa* L.	Spanish needle, beggartick				*	
N	*Emilia fosbergii* Nicolson	Flora's paintbrush		*	*		
E	*Lipochaeta subcordata* A. Gray	Nehe			*		
N	*Pluchea symphytifolia* (Mill.) Gillis	Sourbush		*	*	*	*
N	*Sonchus oleraceus* L.	Sow thistle, pualele		*		*	
N	*Tridax procumbens* L.	Coat buttons				*	
	BIGNONIACEAE (Bignonia family)						
N	*Jacaranda mimosifolia* D. Don	Jacaranda		*			
	CACTACEAE (Cactus family)						
N	*Hylocereus undatus* (Haw.) Britton & Rose	Night-blooming cereus				*	
N	*Opuntia ficus-indica* (L.) Mill.	Prickly pear, panini				*	
	CAPPARACEAE (Caper family)						
E	*Capparis sandwichiana* DC	Maiapilo, pua pilo	C2	*	*	*	*
	CARIACEAE (Papaya family)						
N	*Carica papaya* L.	Papaya, mikana, he'i				*	
	CLUSIACEAE (Mangosteen family)						
N	*Clusia rosea* Jacq.	Autograph tree				*	
	CONVOLVULACEAE (Morning glory family)						
I	*Ipomoea indica* (J. Burm.) Merr.	Koali 'awa, koali 'awahia		*	*	*	*
N	*Ipomoea obscura* (L.) Ker-Gawl.	Morning glory				*	
	CRASSULACEAE (Orpine family)						
N	*Kalanchoe pinnata* (Lam.) Pers.	Air plant, 'oliwa ku kahakai		*	*	*	
	CUCURBITACEAE (Gourd family)						
N	*Coccinia grandis* (L.) Voigt	Scarlet-fruited gourd		*		*	
N	*Momordica charantia* L.	Balsam pear				*	
	EBENACEAE (Ebony family)						
E	*Diospyros sandwicensis* (A. DC) Fosb.	Lama, elama		*	*	*	
	EUPHORBIACEAE (Spurge family)						
N	*Aleurites moluccana* (L.) Willd.	Candlenut, kukui				*	
N	*Chamaesyce hirta* (L.) Millsp.	Hairy spurge				*	
N	*Chamaesyce hyssopifolia* (L.) Small					*	

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STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
N	*Euphorbia heterophylla* L.	Kaliko				*	
N	*Phyllanthus debilis* Klein ex Willd.	Niruri				*	
N	*Ricinus communis* L.	Castor bean, pa'aila, koli				*	
	FABACEAE (Pea family)						
N	*Abrus precatorius* L.	Black-eyed Susan, pukiawe				*	
N	*Acacia farnesiana* (L.) Willd.	Klu, kolu				*	
I	*Caesalpinia bonduc* (L.) Roxb.	Kakalaioa, gray nickers				*	
E	*Caesalpinia kavaiensis* H. Mann	Uhiuhi	LE	*			
N	*Chamaecrista nictitans* (L.) Moench ssp. *patellaria* (DC ex Collad.) H. Irwin & Barneby var. *glabrata* (Vogel) H. Irwin & Barneby	Partridge pea, lauki		*		*	
N	*Desmanthus virgatus* (L.) Willd.	Slender mimosa, virgate mimosa				*	
N	*Desmodium tortuosum* (Sw.) DC	Florida beggarweed				*	
N	*Desmodium triflorum* (L.) DC	Three-flowered beggarweed				*	
E	*Erythrina sandwicensis* Degener	Wiliwili		*			
N	*Indigofera suffruticosa* Mill.	Indigo		*		*	
N	*Leucaena leucocephala* (Lam.) de Wit	Haole koa, koa haole, ekoa		*	*	*	*
N	*Pithecellobium dulce* (Roxb.) Benth.	Manila tamarind, 'opiuma				*	
N	*Prosopis pallida* (Humb. & Bonpl. ex Willd.) Kunth	Algaroba, mesquite, kiawe		*		*	
N	*Samanea saman* (Jacq.) Merr.	Monkeypod, 'ohai				*	
I	*Senna gaudichaudii* (Hook. & Arnott) H. Irwin & Barneby	Uhiuhi, kolomona		*	*	*	
E	*Sophora chrysophylla* (Salisb.) Seem.	Mamane		*	*		
	LAMIACEAE (Mint family)						
N	*Hyptis pectinata* (L.) Poit.	Comb hyptis			*		
I	*Plectranthus parviflorus* Willd.	'Ala'ala wai nui		*	*	*	*
	MALVACEAE (Mallow family)						
N	*Abutilon grandifolium* (Willd.) Sweet	Hairy abutilon, ma'o				*	
I	*Sida fallax* Walp.	'Ilima		*	*	*	*

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STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
N	*Sida spinosa* L.	Prickly sida				*	
	MENISPERMACEAE (Moonseed family)						
I	*Cocculus trilobus* (Thunb.) DC	Huehue		*	*	*	*
	MORACEAE (Mulberry family)						
N	*Ficus microcarpa* L. fil.	Chinese banyan, Malayan banyan				*	
N	*Morus alba* L.	White mulberry, kilika				*	
	MYOPORACEAE (Myoporum family)						
I	*Myoporum sandwicense* A. Gray	Naio, bastard sandalwood		*	*		*
	MYRTACEAE (Myrtle family)						
E	*Metrosideros polymorpha* Gaud. var. *incana* (H. Lev.) St. John	'Ohi'a, 'ohi'a lehua, lehua			*		*
N	*Psidium guajava* L.	Guava, kuawa				*	
	NYCTAGINACEAE (Four-o'clock family)						
N	*Boerhavia coccinea* Mill.					*	
N	*Mirabilis jalapa* L.	Four-o'clock, marvel of Peru, nani ahiahi				*	
	PAPAVERACEAE (Poppy family)						
E	*Argemone glauca* (Nutt ex. Prain) Pope var. *glauca*	Pua kala			*		
	PASSIFLORACEAE (Passion flower family)						
N	*Passiflora foetida* L.	Love-in-a-mist, pohapoha				*	
	PHYTOLACCACEAE (Pokeweed family)						
N	*Rivina humilis* L.	Coral berry				*	
	PIPERACEAE (Pepper family)						
I	*Peperomia leptostachya* Hook. & Arnott	'Ala'ala wai nui		*	*		*
	PLUMBAGINACEAE (Plumbago or leadwort family)						
I	*Plumbago zeylanica* L.	'Ilie'e				*	
	PORTULACACEAE (Purslane family)						
N	*Portulaca oleracea* L.	Pigweed, 'ihi		*	*	*	*
N	*Portulaca pilosa* L.	Pigweed, 'ihi		*	*	*	*

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STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
N	*Talinum triangulare* (Jacq.) Willd.			*	*	*	*
	PROTEACEAE (Protea family)						
N	*Grevillea robusta* A. Cunn. ex R. Br.	Silk oak					*
	RUBIACEAE (Coffee family)						
I	*Canthium odoratum* (G. Forster) Seem.	Alahe'e		*	*	*	*
N	*Morinda citrifolia* L.	Noni		*		*	*
	SANTALACEAE (Sandalwood family)						
E	*Santalum paniculatum* Hook. & Arnott.	'Iliahi, sandalwood			*		
	SAPINDACEAE (Soapberry family)						
I	*Dodonaea viscosa* Jacq.	'A'ali'i		*		*	
	SCROPHULARIACEAE (Figwort family)						
N	*Lophospermum erubescens* D. Don	Larger roving sailor, creeping gloxinia			*		
	SOLANACEAE (Nightshade family)						
E	*Nothocestrum breviflorum* A. Gray	'Aiea	C1			*	
	STERCULIACEAE (Cacao family)						
N	*Melochia umbellata* (Houtt.) Stapf				*		
I?	*Waltheria indica* L.	'Uhaloa, hi'aloa		*	*	*	*
	URTICACEAE (Nettle family)						
E	*Neraudia ovata* Gaud.	Ma'aloa, ma'oloa, 'oloa	C2		*		
	VERBENACEAE (Verbena family)						
N	*Lantana camara* L.	Lantana		*		*	*
N	*Stachytarpheta urticifolia* (Salisb.) Sims			*	*		
	VIOLACEAE (Violet family)						
E	*Isodendrion pyrifolium* A. Gray	Aupaka	3A	*	*		
FLOWERING PLANTS: MONOCOTS							
	AGAVACEAE (Agave family)						
N	*Agave sisalana* Perrine	Sisal, malina				*	
N	*Cordyline fruticosa* (L.) A. Chev.	Ti, ki					*
E	*Pleomele hawaiiensis* Degener & I. Degener	Halapepe	C2	*	*		
	COMMELINACEAE (Spiderwort family)						
N	*Commelina benghalensis* L.	Hairy honohono				*	

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STATUS	TAXON	COMMON NAME	FEDERAL STATUS (a)	COMMUNITY TYPE			
				1	2	3	4
N	*Commelina diffusa* N. L. Burm.	Honohono				*	
	CYPERACEAE (Sedge family)						
E	*Fimbristylis hawaiiensis* Hillebr.		C2		*		
E	*Mariscus fauriei* (Kukenth.) T. Koyama		C1		*		
	POACEAE (Grass family)						
N	*Cenchrus ciliaris* L	Buffelgrass				*	
N	*Dactyloctenium aegyptium* (L.) Willd.	Beach wiregrass				*	
N	*Eragrostis tenella* (L.) P. Beauv ex Roem. & Schult.	Japanese lovegrass		*			
I?	*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult.	Pili, twisted beardgrass				*	
N	*Melinis minutiflora* P. Beauv.	Molasses grass		*			
N	*Panicum maximum* Jacq.	Guinea grass		*		*	
N	*Pennisetum setaceum* (Forssk.) Chiov.	Fountain grass		*	*	*	*
N	*Rhynchelytrum repens* (Willd.) Hubb.	Natal redtop			*	*	*

KEY:

(a) For the island of Hawaii, the state and federal lists of threatened or endangered plants and animals are identical. Key to Federal Status (USFWS 1990):

Listed endangered (LE) = Taxa formally listed as endangered.

Category 1 (C1) = Candidate taxa for which the USFWS has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

Category 2 (C2) = Candidate taxa for which there is some evidence of vulnerability, but for which there are not enough data to support listing proposals at this time.

Category 3A = Taxa for which the USFWS has persuasive evidence of extinction. If rediscovered, such taxa might acquire high priority for listing.

Appendix B. Invertebrate Animals recorded from the Keahole to Kailua Transmission Line Project Area

Listed below are the native and introduced invertebrate animals observed during the field survey. Scientific names are according to Nishida, et al. (1992); common names follow Hawaiian Entomological Society (1990).

Status codes: **N** = Non-native; **I** = Indigenous; **E** = Endemic; **P** = Purposely Introduced
Source codes: **v** = Voucher specimen(s) collected; **o** = Observation only; * = New record for island

STATUS	TAXON	COMMON NAME	SOURCE
INSECTA			
BLATTARIA		COCKROACHES	
	Blattidae		
N	*Platyzosteria soror* (Brunner, 1865)	whitemargined cockroach	v
COLEOPTERA		BEETLES	
	Aderidae		
N	*Xylophilus marquesanus* Blair, 1935		v
	Anobiidae	**Drugstore beetles**	
N?	*Ozognathus* sp.		v
	Anthribidae	**Fungus weevils**	
N	*Araecerus levipennis* Jordan, 1924	koa haole seed weevil	v
	Bostrichidae		
N	*Amphicerus cornutus* (Pallas, 1772)	powderpost bostrychid	v
	Bruchidae	**Seed beetles**	
N	*Acanthoscelides macrophthalmus* (Schaeffer, 1907)		v*
N	*Mimosestes nubigens* (Motschulsky, 1874)		v
N	*Stator pruininus* (Horn, 1873)	pruinose bean weevil	v
	Carabidae	**Ground beetles**	
N	*Aephnidius opaculus* (Zimmerman, 1832)		v*
	Chrysomelidae	**Leaf beetles**	
N	*Chaetocnema confinis* Crotch, 1873	sweetpotato flea beetle	v*
N	*Diachus auratus* (Fabricius, 1801)	bronze leaf beetle	v
N	*Lema trilineata daturaphila* (Kogan & Goeden, 1970)		v
	Coccinellidae	**Ladybird beetles**	
N	*Azya orbigera* Mulsant, 1850		v*
P	*Coelophora inaequalis* (Fabricius, 1775)	common Australian lady beetle	v
P	*Cryptolaemus montrouzieri* Mulsant, 1853	mealybug destroyer	v
P	*Curinus coeruleus* (Mulsant, 1850)	dark blue lady beetle	v

STATUS	TAXON	COMMON NAME	SOURCE
P	*Olla v-nigrum* Mulsant, 1866		v
P	*Scymnus* sp.		v
	Cucujidae	**Flat bark beetles**	
P	*Cryptamorpha desjardinsi* (Guerin-Meneville, 1829)		v
	Curculionidae	**Snout beetles**	
N	*Oxydema fusiforme* Wollaston, 1873		v
	Dermestidae	**Carpet beetles etc.**	
I	*Orphinus terminalis* (Sharp, 1885)		v*
	Elateridae	**Click beetles**	
N	*Conoderus exsul* (Sharp, 1877)		v
	Nitidulidae	**Sap beetles**	
N	*Carpophilus mutilatus* Erichson, 1843		v*
	Scarabaeidae	**Scarab beetles**	
N	*Adoretus sinicus* Burmeister, 1855	Chinese rose beetle	v
N	*Aphodius lividus* (Olivier, 1789)		v
	Scolytidae	**Bark beetles**	
E?	*Hypothenemus* sp.		v
	Staphylinidae	**Rove beetles**	
N	*Philonthus discoideus* (Gravenhorst, 1802)		v
N	*Philonthus longicornis* Stephens, 1832		v
	Tenebrionidae	**Darkling beetles**	
N	*Adelina plana* (Fabricius, 1801)		v*
N	*Alphitobius laevigatus* (Fabricius, 1781)	black fungus beetle	v
N	*Blapstinus dilatatus* LeConte, 1851		v
DIPTERA		FLIES	
	Calliphoridae	Blow flies	
N	*Chrysomya rufifacies* (Macquart, 1843)	hairy maggot blow fly	v
	Ceratopogonidae	**Biting midges**	
E	*Forcipomyia hardyi* Wirth & Howarth, 1982		v
	Culicidae	**Mosquitoes**	
N	*Aedes albopictus* (Skuse, 1894)	forest day mosquito	v
	Lauxaniidae	**Lauxaniid flies**	
N	*Homoneura unguiculata* (Kertesz, 1913)		v
	Scenopinidae	**Window flies**	
N	*Scenopinus lucidus* Becker, 1902		v*
	Syrphidae	**Flower flies**	

STATUS	TAXON	COMMON NAME	SOURCE
P	*Allograpta exotica* (Wiedemann, 1830)		v
	Tachinidae	**Tachinid flies**	
P	*Trichopoda pilipes* (Fabricius, 1805)	Trinidad stink bug tachinid	v
	Tephritidae	**Fruit flies**	
N	*Dioxyna sororcula* (Wiedemann, 1830)		v*
HETEROPTERA		BUGS	
	Alydidae	Broad-headed bugs	
N	*Alydus pilosulus* (Herrich-Schaeffer, 1848)		v
	Lygaeidae	**Chinch bugs etc.**	
N	*Clerada apicicornis* Signoret, 1862		v
E	*Nysius communis* Usinger, 1942		v
E	*Nysius nemorivagus* White, 1881		v
N	*Remaudiereana nigriceps* (Dallas, 1852)		v
	Pentatomidae	**Stink bugs**	
N	*Nezara viridula* (Linnaeus, 1758)	southern green stink bug	v
N	*Plautia stali* Scott, 1874	oriental stink bug	v
	Reduviidae	**Assassin bugs**	
N	*Zelus renardii* Kolenati, 1856	leafhopper assassin bug	v
	Tingidae	**Lace bugs**	
P	*Teleonemia scrupulosa* Stal, 1868	lantana lace bug	v
HOMOPTERA			
	Cixiidae	Cixiid planthoppers	
E	*Oliarus niger* Giffard, 1925		v
E	*Oliarus* spp.		v
	Flatidae	**Flatid planthoppers**	
N	*Melormenis basalis* (Walker, 1851)	West Indian flatid	v
HYMENOPTERA		BEES, WASPS, ANTS	
	Anthophoridae	Carpenter bees	
N	*Xylocopa sonorina* Smith, 1874	Sonoran carpenter bee	v
	Apidae	**Honey bees**	
P	*Apis mellifera* Linnaeus, 1758	honey bee	v
	Bethylidae	**Bethylids**	
E	*Sierola* spp.		v
	Evaniidae	**Ensign wasps**	
N	*Evania appendigaster* (Linnaeus, 1758)	larger ensign wasp	v
	Formicidae	**Ants**	

STATUS	TAXON	COMMON NAME	SOURCE
N	*Anoplolepis longipes* (Jerdon, 1851)	longlegged ant	v
N	*Camponotus variegatus* (F. Smith, 1858)	Hawaiian carpenter ant	v
	Megachilidae	**Leafcutting bees**	
E	*Megachile diligens* F. Smith, 1879		v
	Sphecidae	**Sphecid wasps**	
P	*Ampulex compressa* (Fabricius, 1781)	emerald cockroach wasp	v
N	*Chalybion bengalense* (Dahlbom, 1845)		v
N	*Isodontia mexicana* (Saussure, 1867)		v*
N	*Trypoxylon bicolor* Smith, 1856		v
	Vespidae	**Paper wasps etc.**	
N	*Pachodynerus nasidens* (Latreille, 1812)	keyhole wasp	v
N	*Polistes aurifer* Saussure, 1852	golden paper wasp	v
LEPIDOPTERA		BUTTERFLIES & MOTHS	
	Cosmopterigidae	Cosmopterigid moths	
E	*Hyposmocoma* spp.		v
	Crambidae		
N	*Herpetogramma licarsisalis* (Walker, 1859)	grass webworm	v
E	*Tamsica* sp.		v
	Geometridae	**Measuringworms etc.**	
N	*Semiothisa abydata* (Guenee, 1857)		v*
	Immidae		
N	*Imma* sp.		v
	Noctuidae	**Noctuid moths etc.**	
N	*Achaea janata* (Linnaeus, 1758)	croton caterpillar	v
N	*Elaphria nucicolora* (Guenee, 1852)		v
N	*Pandesma anysa* Guenee, 1852		v*
	Nymphalidae	**Brush-footed butterflies**	
N?	*Danaus plexippus* (Linnaeus, 1758)	monarch butterfly	o
N	*Vanessa cardui* (Linnaeus, 1758)	painted lady	o
	Oecophoridae	**Oecophorid moths**	
N	*Stoeberhinus testaceus* Butler, 1881		v
	Papilionidae	**Swallowtails**	
N	*Papilio xuthus* Linnaeus, 1767	citrus swallowtail	o
	Pterophoridae	**Plume moths**	
N	*Megalorhipida defectalis* (Walker, 1864)		v
MANTODEA		MANTIDS	

STATUS	TAXON	COMMON NAME	SOURCE
	Mantidae	Mantids	
N	*Hierodula patellifera* (Serville, 1839)		v*
ODONATA		DRAGONFLIES	
	Libellulidae	Common skimmers	
I	*Pantala flavescens* (Fabricius, 1798)	globe skimmer	o
ORTHOPTERA		GRASSHOPPERS, CRICKETS & KATYDIDS	
	Acrididae	Short-horned grasshoppers	
N	*Oedaleus abruptus* (Thunberg, 1815)	small bandedwing grasshopper	v*
N	*Schistocerca nitens* (Thunberg, 1815)	vagrant grasshopper	v*
N	*Trimerotropis pallidipennis* (Burmeister, 1838)	large bandedwing grasshopper	v*
	Gryllidae	**Crickets**	
N	*Modicogryllus conspersus* (Schaum, 1862)	small field cricket	v
	Tettigoniidae	**Long-horned grasshoppers**	
N	*Conocephalus saltator* (Saussure, 1859)	longhorned grasshopper	v

Appendix C. Vertebrate Animals Recorded from the Keahole to Kailua Transmission Line Project Area

The vertebrate animals listed below have been recorded from visual and/or audio identifications in the Keahole to Kailua Transmission Line Project Area. The list includes species detected during the 1992 field survey and from previous field surveys in the same area.

Status codes: **N** = Non-native; **I** = Indigenous; **E** = Endemic
Source codes:

- **D** = Detected via visual and/or audio identification during the 1992 field survey in or near the project area
- **S** = Sign of scat or bones observed during the 1992 field survey (indicated probable presence)
- **X** = Cited in published literature and/or unpublished reports/acccounts as previously detected in the project area or areas nearby
- **P** = Cited in published literature and/or unpublished reports/accounts as a possible inhabitant of the project area

STATUS	SCIENTIFIC NAME (a)	COMMON NAME (a)	FEDERAL STATUS (b)	SOURCE
REPTILES				
	GECKOS - Gekkonidae			
N	Unidentified species	Unidentified gecko		D
	SKINKS - Scincidae			
N	*Cryptoblepharus boutoni poecilopleurus*	Snake-eyed Skink		D
BIRDS				
	GROUSE & PTARMIGAN - Phasianidae			
N	*Francolinus francolinus*	Black Francolin		X
N	*Francolinus pondicerianus*	Gray Francolin		X
N	*Francolinus erckelii*	Erckel's Francolin		D
N	*Francolinus* sp.	Unidentified francolin		D
N	*Gallus gallus*	Red Junglefowl		X
N	*Phasianus colchicus*	Ring-necked Pheasant		X
N	*Callipepla californica*	California Quail		X
	PLOVERS - Charadriidae			
I	*Pluvialis fulva*	Pacific Golden-Plover, Kolea		D
	PIGEONS & DOVES - Columbidae			
N	*Streptopelia chinensis*	Spotted Dove		D
N	*Geopelia striata*	Zebra Dove		D
	PARAKEETS & PARROTS - Psittacidae			

STATUS	SCIENTIFIC NAME (a)	COMMON NAME (a)	FEDERAL STATUS (b)	SOURCE
N	*Psittacula* sp.	Unidentified parrot		X
	OWLS - Tytonidae			
N	*Tyto alba*	Barn Owl		D
	OWLS - Strigidae			
E	*Asio flammeus sandwichensis*	Short-eared Owl, Pueo		D
	MOCKINGBIRDS & THRASHERS - Mimidae			
N	*Mimus polyglottos*	Northern Mockingbird		D
	STARLINGS - Sturnidae			
N	*Acridotheres tristis*	Common Myna		D
	SILVEREYES - Zosteropidae			
N	*Zosterops japonicus*	Japanese White-eye		D
	WARBLERS & SPARROWS - Emberizidae			
N	*Cardinalis cardinalis*	Northern Cardinal		D
N	*Paroaria capitata*	Yellow-billed Cardinal		D
N	*Sicalis flaveola*	Saffron Finch		D
	CANARIES, SISKINS, & ALLIES - Fringillidae			
N	*Carpodacus mexicanus*	House Finch		D
N	*Serinus mozambicus*	Yellow-fronted Canary		D
	OLD WORLD SPARROWS - Passeridae			
N	*Passer domesticus*	House Sparrow		D
	WAXBILLS & ALLIES - Estrildidae			
N	*Estrilda caerulescens*	Lavender Waxbill		X
N	*Lonchura malabarica*	Warbling Silverbill		D
N	*Lonchura punctulata*	Nutmeg Mannikin		D
MAMMALS				
	COMMON BATS - Vespertilionidae			
E	*Lasiurus cinereus semotus*	Hawaiian Hoary Bat, ʻOpeʻapeʻa	LE	X
	OLD WORLD RATS & MICE - Muridae			
N	*Rattus rattus rattus*	Roof Rat		P
N	*Rattus norvegicus norvegicus*	Norway Rat		P
N	*Rattus exulans hawaiiensis*	Polynesian Rat		P

STATUS	SCIENTIFIC NAME (a)	COMMON NAME (a)	FEDERAL STATUS (b)	SOURCE
N	*Rattus norvegicus norvegicus*	Norway Rat		P
N	*Rattus exulans hawaiiensis*	Polynesian Rat		P
N	*Rattus* sp.	Unidentified rat		S
N	*Mus domesticus*	European House Mouse		P
	CIVETS & ALLIES - Viverridae			
N	*Herpestes auropunctatus auropunctatus*	Small Indian Mongoose		D
	CATS - Felidae			
N	*Felis catus*	Feral Cat		D
	HOLLOW-HORNED RUMINANTS - Bovidae			
N	*Capra hircus hircus*	Feral Goat		S

KEY:

(a) Scientific and common names of reptiles are listed according to McKeown (1978).
Scientific and common names of birds are listed according to the American Ornithologists' Union (1983).
Scientific and common names of mammals are listed according to Tomic (1986).

(b) For the island of Hawaii, the state and federal lists of threatened or endangered plants and animals are identical.
Key to Federal Status (USFWS 1991):
LE = Taxa formally listed as endangered

APPENDIX E

Appendix E

Cultural and Historic Resources: Archaeological Sensitivity Study

Report 1118-050192

Archaeological Sensitivity Study Keahole-Kailua and Keahole-Keamuku Transmission Line Sites

Districts of North and South Kona, and South Kohala Island of Hawaii

PHRI

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Archaeological Sensitivity Study Keahole-Kailua and Keahole-Keamuku Transmission Line Sites

Districts of North and South Kona, and South Kohala Island of Hawaii

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INTRODUCTION

CH2M Hill has contracted with Paul H. Rosendahl, Ph.D., Inc. (PHRI) to conduct necessary archaeological studies associated with the planning and construction of two new 138kV transmission lines. The project area is on the leeward Kona coast, north of the town of Kailua-Kona, in the Districts of North and South Kona, and South Kohala, on the island of Hawaii (Figure 1, at end).

The new transmission lines have been proposed in response to growing electrical demands and to provide a more reliable electrical power system. One proposed transmission line would originate at the Keahole Power Station, directly east (inland) of Keahole Airport and Queen Kaahumanu Highway, and would extend southward, terminating at the Kailua substation in Kailua-Kona (Keahole-Kailua line). The second line (Keahole-Keamuku line) would also originate at the Keahole Power Station but would extend northward to the Keamuku Substation, near the intersection of Waikoloa Road and Mamalahoa Highway. The specific locations of the corridors for the new transmission lines will be determined at a later date, based on the results of the current study and other specialist studies.

SCOPE OF WORK

The objectives of the present sensitivity study were to map areas of archaeological sensitivity, based on site densities, and to identify possible broad corridors for the proposed transmission lines (corridors that would avoid all sites or affect the fewest number of sites). Preferred corridors will be chosen by CH2M Hill after consultation with various specialists, including biologists, geophysicists, specialists in visual analysis, and archaeologists.

The current study constitutes Phase I of the current project. Phase II will consist of a full archaeological inventory survey of the preferred alignments. The general objective of the inventory survey would be to provide information sufficient for the preparation of an Environmental Assessment (EA) or an Environmental Impact Study (EIS). The basic objectives of the inventory survey would be fourfold: (a) to locate and document all sites and site complexes present within the preferred alignments; (b) to evaluate the potential general significance of all identified archaeological remains; (c) to determine the possible impacts of the proposed development upon the identified remains; and (d) to define the general scope of any subsequent further data collection and/or other mitigation work that might be necessary.

PROJECT AREA DESCRIPTION

Keahole Power Plant is directly inland of Keahole Airport and Queen Kaahumanu Highway, approximately 8,500 ft from the shore, at an elevation of c. 200 ft. Two existing 69kV overhead powerlines currently connect the power plant with the Kailua Substation. From the Keahole Power Plant, the first line parallels the *mauka* (inland) edge of Queen Kaahumanu Highway and extends south for approximately 6.8 miles to the Kailua Substation. The Kailua Substation is in Kailua-Kona, at an elevation of c. 60 ft. The second line extends east from the Keahole Power Plant across undeveloped lands to the *mauka* edge of Mamalahoa Highway, and then turns south, paralleling the highway to the Kailua Substation, a distance of c. 11 miles.

Powerlines also extend north from the Keahole Power Plant. One alignment extends north following an alignment several hundred feet inland of Queen Kaahumanu Highway. Near the northern boundary of the current project area, the line turns inland several thousand feet and then turns northward and continues out of the project area. A second alignment extends east from Keahole Power Plant to Mamalahoa Highway, where it runs in a northerly direction adjacent (*mauka*) to the highway, up to the Keamuku Substation, an overall distance of about 22 miles. The Keamuku Substation is 11 miles from the shore, in the southwest corner of the intersection of Waikoloa Road and Mamalahoa Highway, at an elevation of 2,600 ft.

The project area is in the dry leeward coastal zone that extends from Mahukona on the north to Kailua-Kona on the south. This includes portions of the Districts of South Kohala, and North and South Kona. Major topographic features in the project area (from the north and continuing in a clockwise direction) include the Kohala Mountains, the Waimea Plain, Mauna Kea, Mauna Loa, Mt. Hualalai, Kailua Bay, Honokohau Bay, Keahole Point, Kiholo Bay, Anaehoomalu Bay, and Kawaihae Bay.

The Hawaiian Islands were formed from shield volcanoes; consequently, lava flows are ubiquitous. Two major geologic phenomena are present in the project area: the Kau Volcanic Series, including basaltic flows from Mauna Loa; and the Hualalai Volcanic Series. The latest flow from the Kau Volcanic Series was the 1859 lava flow which poured from a vent on the northwest face of Mauna Loa and coursed north of Puu Waawaa and Puu Anahulu, ultimately entering the sea south of Anaehoomalu Bay. The 1800 and 1800-01 flows from Hualalai are the most recent from the Hualalai Volcanic Series.

The climate of the island of Hawaii is subtropical with two easily recognizable seasons. One season, which can be characterized as "summer" runs from May through October, and "winter" runs from November through April. "Summer" has warmer, drier weather with few, if any, major storms, and predictable dessicating northeasterly tradewinds. "Winter" Kona storms are marked by a strong southwesterly wind bringing heavy, sometimes destructive rains. Temperature ranges on the island are not great. Winter temperatures average 70-75 degrees F, and summer averages are 80-85 F, with an annual mean of about 77 degrees F at sea level. Elevation in the project area ranges from 2,600 ft at the Keamuku Substation, to 2,000 ft along the Mamalahoa Highway, to 1,280 ft at Palani Junction, to 200 ft at the Keahole Power Plant, to 60 ft at the Kailua Substation.

Three environmental zones are in the project area: coastal, transitional, and upland forest. The extent of each zone is predicated on various environmental variables including available moisture, soil, topography, and a number of other parameters. A marked contrast was noted between the northern and southern extremes of the project area, as will be discussed briefly below.

In the northern reaches of the project area, the coast was the most hospitable zone, supporting relatively thicker stands of native and introduced vegetation to form "oases." Compared with areas further south, the coastal zone here is narrower, generally extending less than 150 ft inland, and is no more than 40 ft in elevation. Rainfall along the coast is minimal, averaging 5-10 inches annually. In the north end of the project area, the transitional zone, also known more descriptively as the barren zone, is extremely arid, supports very limited vegetation, and has thin to non-existent volcanic soils of Late Pleistocene or Recent age. Terrain in this area is comprised primarily of rugged, gently sloping pahoehoe flows. Extremely broken aa flows are also present. Vegetation is extremely restricted on the lava flows, consisting of native *pili* grass (*Heterpogon contortus*), fountain grass (*Pennisetum setaceum*), *'ilima* (*Sida fallax* [Walp]), and occasional *kiawe* (*Prosopis pallida*) trees. More developed vegetation communities are within *kipuka*, areas of older flows that escaped destruction and are completely or mostly encircled by more recent lava flows. The transitional zone begins at c. 40 ft elevation and continues upslope to roughly 2,500 ft. Rainfall in the transitional zone averages 10-50 inches annually, with the amount increasing with elevation. The upland forest zone receives more precipitation (60+ inches) annually and has some soil development which sustains a greater variety

and density of flora. Beneath the soil is the prehistoric Kaniku lava flow. For the northern portion of the project area, more than half of the available moisture occurs as heavy rains during winter storms. This is in marked contrast to the precipitation patterns described below for the southern portion of the project, especially around Kailua-Kona.

Moving southward through the project area, environmental conditions improve somewhat. Cordy (1985) describes some specific environmental parameters for the multiple *ahupua'a* of Kalaoa (1-5) and Ooma (1-2), where the Keahole Power Station is located. In this area the coastal zone extends inland from the shore for approximately 160 ft (50 m) to the 20 ft elevation level. Shoreline shrubs and trees are present. The transitional zone begins at 160 ft (50 m) from shore and continues for 8,000 ft (2,400 m), up to 430 ft in elevation. The area immediately behind the shoreline and extending upslope to roughly 120 ft in elevation is devoid of vegetation. Grass and then lantana predominate above that elevation. Thin organic soil appears at the upper end of the barren zone, overlying the lava flows, and increases in thickness up through the upland forest. The upland forest ranges from 430 to 3,400 ft in elevation, continuing from 8,000 to 20,000 ft behind the shoreline. The vegetation community here exhibits a transition from *koa-haole* (*Leucaena glauca*), Christmas-berry (*Schinus terebinthifolius*), and a dense shrub understory to a mature forest on the upper slopes.

Environmental conditions further south of Ooma-Kalaoa *ahupua'a* are less harsh than conditions to the north. This is attributed to a number of factors: (a) the ameliorating presence of Mt. Hualalai, which "catches" the morning dew, and late afternoon rainstorms from offshore clouds driven inland, increasing the amount of precipitation, (b) most of the rain comes during the summer, when insolation is at a maximum for peak agricultural production, (c) there is fertile soil suitable for agriculture; and (d) there are relatively constant temperatures.

Instead of the tripartite environmental zonation employed above, four environmental zones have been identified for the area above Kailua-Kona (Newman 1970:128-130; Kelly 1983:73-4): coastal (*kula*), seaward slope (*kaluulu*), upland slope (*apaa*), and upland jungle (*amau*). Only three of the zones are found in the project area; the upper end of the upland slope zone and the upland jungle zone are above the project. The coastal zone extends from sea level to 500 ft AMSL (above mean sea level). It receives an annual rainfall of 30-50 inches, with more than 60% coming in the summer. The seaward slope is 500-1,000 ft AMSL and receives 40-55 inches of precipitation annually. Similar to the pattern noted for the coastal zone, the majority of moisture comes during the summer. The upland slope continues from 1,000 to 2,500 feet AMSL. The reversed rainfall pattern is more exaggerated for this zone, with more than twice as much of the annual moisture (55-80 inches) coming during the summer. The upland jungle continues upslope from 2,500 to 4,000 ft AMSL. Though there is a more even distribution of the 80+ inches of precipitation annually, the pattern that more rain falls in the summer still holds. Once above the 4,000 ft elevation level the pattern reverts to that noted to the north, with more precipitation taking place during the winter.

The area around Kailua-Kona is the heart of the Kona Field System. The field system was informally described by foreign visitors in the late 1700s and early to mid-1800s. The system was first described by modern archaeologists in the 1970s when Newman initially described the portion of the complex behind Kealakekua Bay (Newman 1970). This was followed by a formal nomination to the Hawaiian Register of Historic Places, at which time the system was given a State Site number (50-10-37-6601). To date, there has been no rigorous definition of the Kona Field System. Currently no scientific study documenting the lateral extent or the associated archaeological remains of the system is available. Numerous researchers have been involved in projects within the Kona Field System, but no one has systematically collected the data which would allow this intriguing phenomenon to be adequately described. At present the best locational information indicates that the Kona Field System is as a rectangle measuring 3 miles by 18 miles (Hommon and Rosendahl 1983:35-36). The northern extent of the system is generally the *ahupua'a* of Honokohau (see Figure 1, at end), and the southern end is in the vicinity of Hookena. The actual boundaries are not depicted in the state files; only a large-scale map generally depicting the boundaries is present. Hommon and Rosendahl note: "The boundary and the stippled area enclosed by the boundary are not precisely defined, nor are they based on precise data concerning the actual extent of the Kona Field System" (1983:36).

FINDINGS

The current project area crosses numerous *ahupua'a*. Prior to the field work for this project, PHRI files were searched to identify all in-house projects conducted in these *ahupua'a*. Additionally, the resources of the Department of Land and Natural Resources - State Historic Preservation Division (DLNR-SHPD) were consulted in order to identify prior archaeological or other work done within the project area (by consultants, governmental agencies, etc.). DLNR-SHPD files included historic maps, land court awards, and other documents describing the locations of sites or potential sites. The various archaeological projects were marked on project-wide maps to identify areas which have been subjected to inventory survey or which have undergone more intensive investigations such as data recovery or preservation. The project maps also identified areas lacking archaeological coverage.

A sensitivity map reflecting archaeological site density was requested by CH2M Hill. Consultation with DLNR-SHPD staff indicated that a sensitivity map incorporating both site significance and the environmental zones present in the project area was an appropriate approach. The sensitivity criteria utilized were project-specific and were not necessarily applicable on a more general scale. The coastal zone and the *makai* (seaward) portion of the transitional zone, extending 1,500 to 2,000 ft inland from the shore, were considered as having high sensitivity based on the high density of sensitive and significant cultural remains documented by numerous projects. The upper portion of the transitional zone and the upland zone were considered of moderate sensitivity based on the low site density and the low overall probability that these areas would contain clusters of significant sites or features. Areas considered to be of low sensitivity include the recent lava flows from Mauna Loa and Mt. Hualalai, which would have destroyed any evidence of prehistoric use of the area.

Sites or features considered to be culturally significant or possibly significant were marked on the map. Prehistoric or contact period cultural sites or features considered to be of high sensitivity include: trails, burials, refuge caves, *heiau*, fishponds, modified anchialine ponds, and petroglyphs. Historic period sites and features considered to be of high sensitivity include burials, trails, and petroglyphs. Areas known to contain natural phenomena such as lava tubes and/or collapsed tubes (sinks) were viewed as possibly sensitive due to the possibility they might contain culturally sensitive or significant materials such as burials or refuge caves. The vast majority of existing sites were not plotted on the map. These sites include permanent and temporary habitations, a wide array of agricultural features, midden scatters, quarries, cairns, and sites of unknown function. It was hoped that possible associations between site type and environmental variables could be identified.

The Kona Field System, which is on the Hawaii Register of Historic Places, is a significant cultural property. In terms of management decisions, agricultural features are not considered significant; only habitations, burial features, possible burial features, *heiau*, and other assorted feature types are treated individually as worthy of further investigation. For the purposes of this study the affected portions of the Kona Field System are very unlikely to contain culturally sensitive and significant sites or features, except for burials.

CONCLUSION

SITE LOCATIONAL PATTERNING

A number of models depicting prehistoric site patterns have been proposed for various portions of the Kona Coast of Hawaii. These models will guide this discussion.

As a result of proposed development, the *ahupua'a* of Kaupulehu has since the early 1970s been the scene of intensive archaeological work. Rosendahl (1973) produced a settlement pattern model for Kaupulehu after salvage work on the Queen Kaahumanu Highway. This model was later expanded by Hommon (1976). Rosendahl and Hommon postulated a coastal occupation associated with the exploitation of the rich and varied marine resources in the area. The inhabitants lived in small hamlets most typically associated with small bays or fishponds and surrounded by palm and banana trees. Larger coastal villages are thought to have provided the necessities (water, food, and shelter) for travelers between Kailua and Kawaihae. Immediately inland was a largely uninhabited barren area crossed by foot trails. Sites within this area were limited to temporary habitations, for travelers along the trail, and cairns, possibly serving as markers. The relatively lusher upland slopes were the locus of the primary occupation. Occupants working the extensive dryland agricultural field system lived in numerous hamlets spread across the zone (Rosendahl 1973:61; Hommon 1976). Where recent lava flows are present upland prehistoric sites are found exclusively within *kipukas*. Hommon's expansion of the model provided a temporal dimension with earliest occupation associated with the coast and later expansion to the uplands as the agricultural system became more productive and eventually assumed a major role in the overall subsistence of the Hawaiians. Hommon also posited a well-developed trade network functioning between the coastal and inland areas. This overall patterning is generally reflected in other areas with similar environmental conditions.

In a more recent investigation within Kaupulehu, Bower et al. (1992) inventoried the parcel *mauka* of the Queen Kaahumanu Highway, including the upper portion of the transitional zone continuing up through the upland forest. No coastal land was included in the survey. The division between the upper transitional zone and the upland forest was estimated at 1,400 ft elevation. The results of the survey appear to substantiate the Rosendahl/Hommon model. Permanent habitations outnumbered temporary habitations. The temporary habitations appear to date earlier (c. 1200 AD) than the permanent habitations. In general the habitation sites were on relatively more level portions of the parcel. Burials were in lava tubes or were incorporated in platform structures. Some agricultural features (mounds and modified outcrops) were dated to the late contact or historic period. Interestingly, the majority of the features encountered were pahoehoe quarries. Two factors argue that the pahohehoe excavations served to provide the raw material for use in the *mauka-makai* trail system which extends throughout the area: (a) their proximity to the trails, and (b) they are within homogeneous expanses of pahoehoe suitable for producing blocks of uniform size and thickness. The most intense occupation occurred during the post-contact period, based on the function of the pahoehoe excavations/quarries as a source for the fill/paving material for the wide, developed trails. Numerous cairns are thought to mark these trails. Late historic occupation of the area probably occurred in response to the demand for food to supply trading ships anchored offshore.

In the *ahupua'a* of Kukio 1-2, which abuts Kaupulehu to the south, Cordy (1981) conducted an investigation of the coastal zone. No generalizations were made regarding the inland portion. Cordy placed initial occupation at 1650 AD. He found evidence for only a small population (18-24 individuals maximum) inhabiting 3-4 permanent habitations, and exploiting marine resources. Interestingly, he made no mention of a trade system or use of a trail system.

Later reinvestigation of Kukio included both coastal and inland areas (Bower et al. 1992). Bower documented permanent occupation along the coast with temporary habitations found near the boundary between the coastal and transitional zones, away from the permanent habitations. Clusters of temporary habitations were found at more desirable loci (e.g., grassy areas or lava tubes) alongside the trails in the transitional zone. The earliest dated occupation within Kukio was 1200 AD. Marine resource exploitation was evident. Burials were found primarily in tubes, with a few deposited in cracks or buried in beach sands. The trail system developed post-1400 AD for trading salt and fish with inland areas and with the agricultural areas to the south (Kona Field System). The fishponds were developed post-1400 AD, possibly in concert with the trail system. Population increased with time with the greatest density occurring between 1400-1820 AD. No evidence of an intensive agricultural field system was found in the upland area of Kukio (Bower 1992). This was attributed to the marginal nature of the environment. It was postulated that marine resources from the coast and wood, feathers, and other miscellaneous resources from the uplands were transported along the trails, to be traded to the south for foodstuffs.

In 1985 Cordy created a synthetic overview of Ooma 1-2 Ahupua'a and Kalaoa 1-5 Ahupua'a. The pattern described above for site location was substantiated. Permanent habitations were located along the shore, and included single and multiple features associated with shallow cultural deposits. Temporary habitations were on the boundary between the coast and transitional zone or where permanent habitations were not present. Cultural deposition was shallow or absent. Interestingly, two *heiau* were also documented. The coastal zone exhibited the highest site density. Within the transitional zone the site density was much lower. The most important feature type within this area consisted of several *mauka-makai* trails and Mamalahoa Trail paralleling the coast. Temporary habitations, such as C-shapes and caves, and cairns were noted along the trails. Very shallow deposits and numerous small features were interpreted as evidence of recurrent short-term use. Very few permanent habitations were recorded in the transitional zone. The upland forest contained the second densest site distribution due to the upland agricultural field system beginning at the 450-800 ft level, and possibly continuing further uphill. Sweet potato was the primary crop. As noted earlier, the Kona Field System, as currently defined, ends at Palani Junction, roughly 1.5 miles to the south. It is possible (perhaps even logical) to assume that Cordy's documented agricultural system is simply a continuation of the Kona Field System. Both permanent and temporary houses were recorded within the field system.

SUMMARY

Based on the above discussion, attributes of the three sensitivity levels can be briefly described. Low sensitivity areas are associated with the recent lava flows (AD 1800-01 and 1859) from Mt. Hualalai and Mauna Loa. These flows cross all three environmental zones. While no correlation with a specific environmental zone, elevation, or vegetation is possible, the location of these flows has been precisely plotted. For a number of reasons these flows contain only a limited number and variety of sites and features. Sites within this area would be expected to include trails or wagon roads, cairns, historic ranching features such as walls and/or enclosures, and pahoehoe quarries. Obviously all these sites would post-date the lava flows.

Moderate sensitivity areas are associated with the upper portion of the transitional zone and the upland forest zone. Generally speaking the area of moderate sensitivity is located above the 500 ft elevation level and is associated with older aa and pahoehoe flows. The vegetation communities present are primarily native and mixed forest and mixed grassland. Site density is markedly higher than that noted for low sensitivity areas. These sites would date to both prehistoric and historic periods and would include temporary habitation features, agricultural features, and burial caves, as well as trails, cairns, quarries, and ranching features.

High sensitivity areas are defined here by proximity to the coast, by the portion of the transitional zone immediately inland from the coast, lower than c. 500 ft elevation, and certain areas associated with natural phenomena, like lava tubes and sinkholes. This area is mostly sandy beach, older pahoehoe, sinkhole caves, and lava tubes. Vegetation is a beach-adapted community along the coast and a sparse mosaic community of *kiawe* thickets and mixed grasslands. Similar to the situation above, the sites in the high sensitivity areas date to both prehistoric and historic periods. Site types include permanent and temporary habitations, fishponds, rock art, ceremonial structures and features, burial caves, recreation features, agricultural features, aa and pahoehoe quarries, trails, cairns and other markers, and ranching features.

Table 1.

PREVIOUS ARCHAEOLOGICAL WORK BY AHUPUA'A

LANIHAU 1-2		
	Lanihau 2 coastal	D. Borthwick and H. Hammatt 1989. Preliminary Rpt
	Lanihau coastal	P. Jensen and M. Rosendahl 1983. PHRI-84 Survey and Testing
	Lanihau coastal	P. Rosendahl 1980. ARA 80-11 Survey
	Lanihau coastal	P. Rosendahl 1979. ARA 79-15 Survey
	Lanihau coastal	H. Hammatt and D. Shideler 1989. Survey
	Lanihau coastal	H. Hammatt 1989. Data Recovery Plan
	Lanihau 2 coastal	R. Schilt 1981. Survey
	Lanihau 2 coastal	L. Soehren 1977. Survey
	Lanihau 1 coastal	P.H. Rosendahl 1972. Survey
	Lanihau coastal	P.H. Rosendahl 1981. Test Excavations
	Lanihau 2 coastal	M. Rosendahl 1988. Survey
	Lanihau coastal	M. Smith and M. Yent 1990. Mapping and Testing
	Lanihau coastal	L. Soehren 1976. Survey
	Lanihau coastal	E. Neller 1980. Survey
	Lanihau coastal	M. Yent 1987. Field Inspection Powerline Route
	Lanihau coastal	P.H. Rosendahl 1980. ARA Reconnaissance Survey
	Lanihau coastal	J.E. Reinecke 1930. Survey
	Lanihau coastal	K. Emory 1970. Overview
KEAHUOLU		
	Keahuolu coastal	L. Soehren 1983. Survey
	Keahuolu coastal	P.H. Rosendahl 1988. Field Inspection
	Keahuolu coastal	P.H. Rosendahl 1979. Survey
	Keahuolu coastal	P.H. Rosendahl 1972. Survey
	Keahuolu coastal	P. Jensen 1990. 771 Inventory Survey
	Keahuolu coastal	T. Donham 1990. 596 Survey
	Keahuolu coastal	L. Soehren 1976. Survey
	Keahuolu coastal	E. Neller 1980. Survey
	Keahuolu coastal	J.E. Reinecke 1930. Survey
	Keahuolu inland	Burgett and Rosendahl 1992. Inventory Survey
	Keahuolu inland	T. Donham 1990. Inventory Survey
	Keahuolu coastal	K. Emory 1970. Overview
KEALAKEHE		
	Kealekehe inland	A. Sinoto 1983. Survey
	Kealekehe inland	A. Walker and A. Haun 1987. Survey
	Kealekehe inland	H. Hammatt et al. 1987. Survey and Testing
	Kealekehe inland	W. Bonk 1987. Survey
	Kealekehe coastal	K. Emory and L. Soehren 1971. Survey
	Kealekehe coastal	J.E. Reinecke 1930. Survey
	Kealekehe inland	Burgett and Rosendahl 1992. Inventory Survey
	Kealekehe inland	T. Donham 1990. Inventory Survey
	Kealekehe coastal	K. Emory 1970. Overview
HONOKOHAU 1-2		
	Honokohau 2 inland	L. Soehren 1976. Survey
	Honokohau 2 inland	A. Sinoto 1975. Survey
	Honokohau 2 inland	T. Donham 1990. Survey
	Honokohau coastal	K. Emory and L. Soehren 1971. Survey
	Honokohau 2 coastal	P.H. Rosendahl 1979. Evaluation of Sites
	Honokohau coastal	J.E. Reinecke 1930. Survey
	Honokohau coastal	K. Emory 1970. Overview
	Honokohau	H.K. Springer 1989. Ethnography/Regional Overview

Table 1. (cont.)

KALOKO	
Kaloko inland	H. Hammatt 1980. Reconnaissance Survey
Kaloko inland	J. Kennedy 1984. Survey
Kaloko inland	W. Barrera Jr. 1983. Survey
Kaloko inland	P.H. Rosendahl 1989. Survey
Kaloko inland	W. Barrera Jr. (no date). Survey
Kaloko inland	L. Soehren 1980. Survey
Kaloko coastal	K. Emory and L. Soehren 1971. Survey
Kaloko coastal	E. Ladd 1968. "A Salvage Report"
Kaloko	W. Barrera Jr. post 1984 Arch Survey
Kaloko	R. Cordy, R. Renger, R. Hitchcock, J. Tainter 1977. Generalized Model
Kaloko	R. Cordy J. Tainter, R. Renger, R. Hitchcock 1988. Generalized Model
Kaloko coastal	J.E. Reinecke 1930. Survey
Kaloko coastal	K. Emory 1970. Overview
Kaloko	H.K. Springer 1989. Ethnography/Regional Overview
KOHANAIKI	
Kohanaiki inland	H. Hammatt 1980. Reconnaissance Survey
Kohanaiki inland	J. Kennedy 1984. Survey
Kohanaiki inland	W. Barrera Jr. 1988. Interim report on survey
Kohanaiki inland	W. Barrera Jr. (no date). Survey
Kohanaiki coastal	T. Donham 1986. Survey
Kohanaiki coastal	C. O'Hare and S. Goodfellow 1992. Mitigation Program
Kohanaiki coastal	P.H. Rosendahl 1985. 191 Survey
Kohanaiki coastal	P.H. Rosendahl 1987. 269 Field Inspection
Kohanaiki	W. Barrera Jr. post 1984. Survey
Kohanaiki coastal	J.E. Reinecke 1930. Survey
Kohanaiki coastal	K. Emory 1970. Overview
Kohanaiki	H.K. Springer 1989. Ethnography/Regional Overview
OOMA 1-2	
Ooma 1 coastal	L. Soehren 1980. Survey
Ooma 2 coastal	M. Rosendahl 1989. Survey
Ooma 2 coastal	A. Walker 1990. Survey
Ooma coastal	H. Hammatt et al. 1980. Excavations
Ooma coastal	P.H. Rosendahl and P. Kirch 1975. Survey
Ooma 2 coastal	T. Donham 1987. Survey and Testing
Ooma 2 coastal	W. Barrera Jr. 1987. Survey
Ooma 2 coastal	R. Cordy 1986. Fieldcheck
Ooma coastal	W. Barrera Jr. 1987. Survey
Ooma coastal	J.E. Reinecke 1930. Survey
Ooma coastal	K. Emory 1970. Overview
Ooma	H.K. Springer 1989. Ethnography/Regional Overview
KALAOA-OOMA	
Kalaoa-Ooma coastal	W. Barrera Jr. 1989. Data Recovery
Kalaoa-Ooma coastal	S. Clark 1984. Survey
Kalaoa-Ooma coastal	J.E. Reinecke 1930. Survey
Kalaoa-Ooma	R. Cordy 1985. Overview
Kalaoa-Ooma coastal	K. Emory 1970. Overview
Kalaoa-Ooma	H.K. Springer 1989. Ethnography/Regional Overview

Table 1. (cont.)

KALAOA 1-5		
	Kalaoa 4 inland	L. Thompson 1991. 1094 Data Recovery Interim
	Kalaoa 4 inland	L. Telea and M. Rosendahl 1987. Reconnaissance Survey
	Kalaoa 4 inland	P. Jensen 1991. Mitigation Plan
	Kalaoa 4 inland	A. Walker 1990. Inventory Survey
	Kalaoa 4 inland	A. Walker 1988. Data Recovery
	Kalaoa 5 inland	P. Jensen 1990. Mitigation Plan
	Kalaoa 5 inland	A. Walker 1989. Inventory Survey
	Kalaoa 4 inland	L. Soehren 1982. Letter Report
	Kalaoa 4 inland	L. Soehren 1985. Survey
	Kalaoa 5 inland	F. Ching 1988. Final Report
	Kalaoa inland	H. Hammatt et al. 1980. Excavations
	Kalaoa 3 inland	R. Cordy 1987. Field check
	Kalaoa coastal	P. Rosendahl and P. Kirch 1975. Survey
	Kalaoa coastal	W. Bonk 1979. Survey
	Kalaoa 5 coastal	R. Cordy 1986. Field check
	Kalaoa coastal	W. Barrera Jr. 1987. Survey
	Kalaoa 1-4 coastal	S. Clark 1984. Survey
	Kalaoa coastal	W. Barrera Jr. 1987. Survey
	Kalaoa coastal	W. Barrera Jr. 1979. Keahole Airport Emergency Service Roads Survey
	Kalaoa 1-4 coastal	E.Rogers-Jordane 1978. Reconnaissance Survey Keahole Point
	Kalaoa 1-4 coastal	S.D. Clark 1984. Reconnaissance Natural Energy Lab
	Kalaoa 1-4 coastal	W. Barrera Jr. 1985. Reconnaissance Survey Keahole Point
	Kalaoa coastal	G. Lee 1991. Kalaoa Cave Petroglyphs Survey
	Kalaoa coastal	J.E. Reinecke 1930. Survey
	Kalaoa coastal	K. Emory 1970. Overview
	Kalaoa	H.K. Springer 1989. Ethnography/Regional Overview
HAMANAMANA		
	Hamanamana coastal	W. Barrera Jr. 1987. Survey
	Hamanamana coastal	S. Clark 1984. Survey
	Hamanamana coastal	P.H. Rosendahl 1973. Salvage
	Hamanamana coastal	F. Ching 1971. Surface Inventory
	Hamanamana coastal	J.E. Reinecke 1930. Survey
	Hamanamana coastal	K. Emory 1970. Overview
	Hamanamana	H.K. Springer 1989. Ethnography/Regional Overview
HALEOHIU		
	Haleohiu coastal	P.H. Rosendahl 1973. Salvage
	Haleohiu coastal	F. Ching 1971. Surface Inventory
	Haleohiu coastal	J.E. Reinecke 1930. Survey
	Haleohiu coastal	K. Emory 1970. Overview
	Haleohiu	H.K. Springer 1989. Ethnography/Regional Overview
MAKAULA		
	Makaula coastal	P.H. Rosendahl 1973. Salvage
	Makaula coastal	F. Ching 1971. Surface Inventory
	Makaula coastal	J.E. Reinecke 1930. Survey
	Makaula coastal	K. Emory 1970. Overview
	Makaula	H.K. Springer 1989. Ethnography/Regional Overview
KAU		
	Kau coastal	P.H. Rosendahl 1973. Salvage
	Kau coastal	F. Ching 1971. Surface Inventory
	Kau coastal	J.E. Reinecke 1930. Survey
	Kau	H.K. Springer 1989. Ethnography/Regional Overview
PUUKALA		
	Puukala coastal	P.H. Rosendahl 1973. Salvage
	Puukala coastal	F. Ching 1971. Surface Inventory
	Puukala coastal	J.E. Reinecke 1930. Survey
	Puukala	H.K. Springer 1989. Ethnography/Regional Overview

Table 1. (cont.)

AWALUA-OHIKI	
Awalua-Ohiki coastal	P.H. Rosendahl 1973. Salvage
Awalua-Ohiki coastal	F. Ching 1971. Surface Inventory
Awalua-Ohiki coastal	J.E. Reinecke 1930. Survey
Awalua-Ohiki	H.K. Springer 1989. Ethnography/Regional Overview
KAULANA	
Kaulana coastal	P.H. Rosendahl 1973. Salvage
Kaulana coastal	F. Ching 1971. Surface Inventory
Kaulana coastal	J.E. Reinecke 1930. Survey
Kaulana coastal	K. Emory 1970. Overview
Kaulana	H.K. Springer 1989. Ethnography/Regional Overview
MAHAIULA	
Mahaiula coastal	P.H. Rosendahl 1973. Salvage
Mahaiula coastal	F. Ching 1971. Surface Inventory
Mahaiula coastal	J.E. Reinecke 1930. Survey
Mahaiula coastal	K. Emory 1970. Overview
Mahaiula	H.K. Springer 1989. Ethnography/Regional Overview
MAKALAWENA	
Makalawena coastal	T. Donham 1986. 245 Survey
Makalawena coastal	P.H. Rosendahl 1973. Salvage
Makalawena coastal	F. Ching 1971. Surface Inventory
Makalawena coastal	J.E. Reinecke 1930. Survey
Makalawena coastal	L. Soehren 1963. Archaeology and Historic Overview
Makalawena coastal	K. Emory 1970. Overview
AWAKEE	
Awakee coastal	P. Jensen 1990. Summary of Previous Findings
Awakee coastal	T. Donham 1987. Survey
Awakee coastal	P.H. Rosendahl 1973. Salvage
Awakee coastal	F. Ching 1971. Surface Inventory
Awakee coastal	J.E. Reinecke 1930. Survey
Awakee coastal	K. Emory 1970. Overview
MANINIOWALI	
Maniniowali	L. Soehren 1982. Survey
Maniniowali coastal	L. Soehren 1982. Survey
Maniniowali coastal	R. Cordy 1986. Possible Grading Violations
Maniniowali coastal	A. Sinoto and J. Pantaleo 1990. Land Exchange CRM Plan
Maniniowali coastal	P.H. Rosendahl 1973. Salvage
Maniniowali coastal	F. Ching 1971. Surface Inventory
Maniniowali coastal	J.E. Reinecke 1930. Survey
Maniniowali coastal	K. Emory 1970. Overview
KUKIO 1-2	
Kukio 1	P. Jensen and A. Haun 1989. Mitigation Plan
Kukio coastal	L. Soehren 1982. Survey
Kukio coastal	A. Sinoto and J. Pantaleo 1990. Land Exchange CRM Plan
Kukio 1	P. Bower and A. Walker 1991. Data Recovery Interim Report
Kukio 1 and 2 coastal	P.H. Rosendahl 1973. Salvage
Kukio 1 and 2 coastal	F. Ching 1971. Surface Inventory
Kukio 1 and 2 coastal	J.E. Reinecke 1930. Survey
Kukio 1 and 2 coastal	K. Emory 1970. Overview
Kukio 1 and 2	H.K. Springer 1989. Ethnography/Regional Overview

Table 1. (cont.)

KAUPULEHU	
Kaupulehu inland	J. Head and S. Goodfellow 1991. Survey
Kaupulehu inland	L. Soehren 1980. Survey
Kaupulehu inland	P. Griffin 1989. Survey
Kaupulehu coastal	R. Sullivan and S. Goodfellow 1991. Mitigation Plan
Kaupulehu coastal	M. Rosendahl 1986. Field Inspection
Kaupulehu coastal	L.A. Carter 1985. Reconnaissance
Kaupulehu coastal	E. Komori 1981. Reconnaissance
Kaupulehu coastal	P.H. Rosendahl 1973. Salvage
Kaupulehu coastal	F. Ching 1971. Surface Inventory
Kaupulehu coastal	J.E. Reinecke 1930. Survey
Kaupulehu coastal	L. Soehren 1963. Archaeology and Historic Overview
Kaupulehu coastal	K. Emory 1970. Overview
Kaupulehu	H.K. Springer 1989. Ethnography/Regional Overview
PUUWAAWAA	
Puuwaawaa inland	H. Hammatt, D. Borthwick, D. Shideler 1989. Survey
Puuwaawaa inland	D. Borthwick 1989. Addendum to Survey
Puuwaawaa coastal	H. Ahlo 1985. Survey
Puuwaawaa coastal	J. Kennedy 1989. Survey
Puuwaawaa coastal	H. Ahlo 1982. Survey
Puuwaawaa coastal	R.J. Hommon and H.M. Ahlo 1984. Reconnaissance Survey
Puuwaawaa coastal	P.H. Rosendahl 1973. Salvage
Puuwaawaa coastal	F. Ching 1971. Surface Inventory
Puuwaawaa coastal	J.E. Reinecke 1930. Survey
Puuwaawaa coastal	K. Emory 1970. Overview
PUUANAHULU	
Puuanahulu inland	A. Walker and L. Kalima 1990. Inventory Survey
Puuanahulu inland	P.H. Rosendahl 1989. Field Inspection
Puuanahulu coastal	A. Walker 1990. Survey
Puuanahulu coastal	R. Brock 1972. Survey
Puuanahulu coastal	P.H. Rosendahl 1973. Salvage
Puuanahulu coastal	F. Ching 1971. Surface Inventory
Puuanahulu coastal	J.E. Reinecke 1930. Survey
Puuanahulu coastal	K. Emory 1970. Overview
WAIKOLOA	
Waikoloa inland	E. Rogers-Jourdane 1976. Reconnaissance Survey
Waikoloa inland	E. Rogers-Jourdane 1978. Phase I Survey
Waikoloa coastal	P. Jensen and T. Kato 1991. Mitigation Program
Waikoloa coastal	P. Kirch 1973. Survey
Waikoloa coastal	P. Jensen 1989. Inventory Survey
Waikoloa coastal	P. Kirch 1973. Reconnaissance Survey
Waikoloa coastal	F. Ching 1971. Surface Inventory
Waikoloa coastal	J.E. Reinecke 1930. Survey
MOEAUOA	
Moeauoa 2 coastal	L. Soehren 1977. Survey
Moeauoa 2 coastal	L. Soehren et al. 1990. Excavations
Moeauoa coastal	J.E. Reinecke 1930. Survey
KEAHOLE	
Keahole coastal	F. Ching et al. 1969. Preliminary Report
Keahole coastal	P.H. Rosendahl 1979. Field Inspection
Keahole coastal	P.H. Rosendahl 1978. Preliminary Report
Keahole coastal	H. McEldowney 1977. Inspection and Monitoring
Keahole coastal	B. Davis 1977. Survey
Keahole coastal	J.E. Reinecke 1930. Survey

Table 1. (cont.)

ANAEHOOMALU	
Anaehoomalu coastal	P. Jensen 1990. Preservation Plan
Anaehoomalu coastal	P. Jensen 1990. Data Recovery Program
Anaehoomalu coastal	R. Brock 1972. Survey
Anaehoomalu coastal	W. Barrera Jr. 1970. Survey
Anaehoomalu coastal	R. Cordy 1987. Archaeological and Archival Overview
Anaehoomalu coastal	T. Dye 1977. Salvage
Anaehoomalu coastal	W. Barrera Jr. 1971. Pacific Anthro Records No. 15
Anaehoomalu coastal	P. Jensen 1990. Data Collection and Site Preservation Program
Anaehoomalu coastal	P. Jensen 1991. Mitigation Program for Interpretive Development and Site Preservation
Anaehoomalu coastal	P. Jensen 1989. Inventory Survey
Anaehoomalu coastal	W. Barrera Jr. 1973. Excavations Beach Midden
Anaehoomalu coastal	P. Kirch 1973. Reconnaissance Survey
Anaehoomalu coastal	F. Ching 1971. Surface Inventory
Anaehoomalu coastal	J.E. Reinecke 1930. Survey
Anaehoomalu coastal	K. Emory 1970. Overview
LALAMILO	
Lalamilo coastal	P. Kirch 1973. Reconnaissance Survey
Lalamilo coastal	G. Lee 1990. Kaeo Trail Prelim Report
Lalamilo coastal	F. Ching 1971. Surface Inventory
Lalamilo coastal	J.E. Reinecke 1930. Survey
KALAHUIPUAA	
Kalahuipuaa coastal	P. Kirch 1973. Reconnaissance Survey
Kalahuipuaa coastal	J.E. Reinecke 1930. Survey
KAPALAOA	
Kapalaoa coastal	W. Barrera Jr. 1980. Survey
LAHUIPUAA	
Lahuipuaa coastal	F. Ching 1971. Surface Inventory

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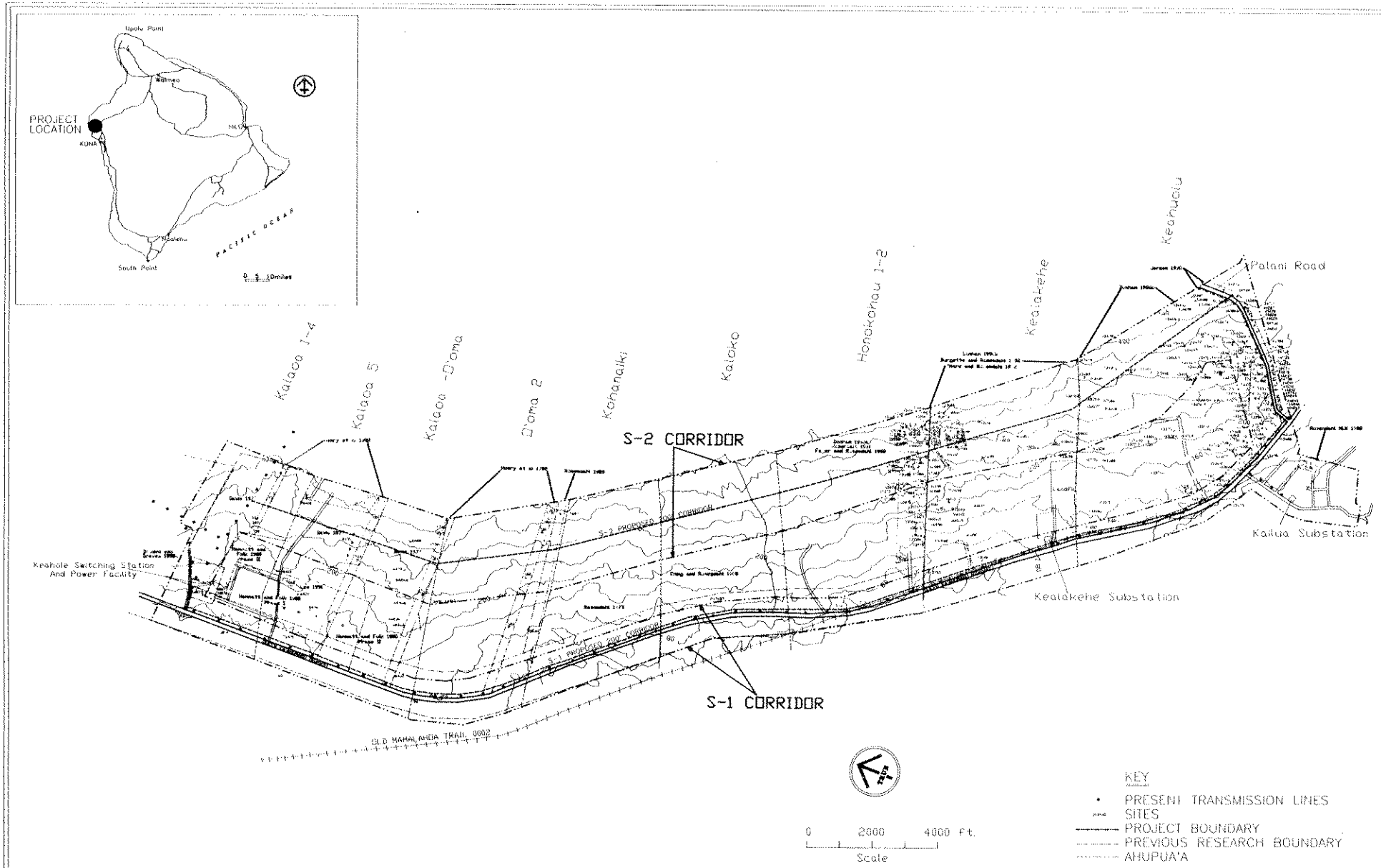

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Archaeological Sensitivity Study Proposed Corridors for Transmission Lines
PHRI Project 91-1118

FIGURE 1.
Project Area and Site Locations

APPENDIX F

Appendix F

Cultural and Historic Resources: Phased Archaeological Inventory Study

Report 1118-022393

Phased Archaeological Inventory Survey
Phase I - Site Identification
Keahole-Kailua 69kV
Transmission Line Project

North Kona District
Island of Hawaii

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Report 1118-022393

Phased Archaeological Inventory Survey
Phase I - Site Identification
Keahole-Kailua 69kV
Transmission Line Project

North Kona District
Island of Hawaii

by

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SUMMARY

At the request of Mr. Al Lono Lyman, senior project manager for CH2M Hill, Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted Phase I, Site Identification, of a Phased Archaeological Inventory Survey of the Keahole-Kailua 69kV Transmission Line project area. The project area is located in the North Kona District of the Island of Hawaii. The overall objective of the Phase I work was to provide information sufficient for preliminary project and land-use planning. The specific objective of the Phase I work was to determine the presence/absence of any sites of such high significance as to seriously constrain or prevent future development; the specific objective of the second phase (Phase II) work will be to record sites in the project area to current inventory-level standards.

The current project included a 100% surface survey of all portions of the project area except **(a)** the portions within the Lands of Keahuolu and Kealakehe that have already been surveyed to inventory level (Donham 1990a, b) and **(b)** portions currently undergoing data recovery field work (O'Hare and Rosendahl in prep.). An attempt was made, to relocate the sites within the previously surveyed areas, in order to accurately determine their locations.

Findings from the survey, in conjunction with the findings from previous surveys in the Lands of Kealakehe and Keahuolu, identified a total of 25 sites with 60 component features. Identified formal feature types were cairn *(ahu)*, cupboard, filled crack, lava tube, modified blister, modified outcrop, mound, pahoehoe excavation, rock ring, terrace, trail, and wall. Functional interpretations for the identified sites were agriculture, boundary, habitation, indeterminate, marker, quarry, storage, and transportation.

Of the 25 sites identified during the current survey, 21 were assessed as significant for information content, with a recommendation for further data collection. Two sites (13194 and 13195) recorded by O'Hare and Rosendahl (in prep.), were assessed as significant for information content, with a recommendation of no further work. The two remaining sites, a portion of the Mamalahoa Trail (Site 00002) and a *mauka-makai* trail (Site 15324), were assessed as significant for information and cultural values and were recommended for further data collection followed by preservation "as is." Because there is some latitude in placing the proposed the power line poles within the project area, it is anticipated that all sites and features identified during the current study can be preserved.

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BACKGROUND

At the request of Mr. Al Lono Lyman, senior project manager for CH2M Hill, Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted Phase I, Site Identification, of a Phased Archaeological Inventory Survey of the Keahole-Kailua 69kV Transmission Line project area. The project area is located in the North Kona District of the Island of Hawaii. The overall objective of Phase I work was to provide information sufficient for preliminary project and land-use planning. The specific objective of the Phase I work was the identification (presence/absence determination) of any sites of such high significance as to seriously constrain or prevent future development; the specific objective of any second phase (Phase II) work will be to record sites in the project area to current inventory-level standards.

Field work for the current project was conducted between February 9 and 12, 1993 by Project Supervisor Jack D. Henry, B.S., Field Archaeologist Mike Stubing, B.A., and Field Technician Chris Kitchens. Hawaii Projects Manager Donna K. Graves, M.A., and Hawaii Projects Director Alan T. Walker, B.A., provided overall guidance for the project. Approximately ten labor-days were expended on the field work portion of the project.

This report is the final report for the present project; it includes project objectives and a Scope of Work, describes field methods, procedures, and findings, and presents general significance assessments and recommended general treatments for cultural remains within the project area.

SCOPE OF WORK

The basic purpose of an inventory survey is to identify—to discover and locate on available maps—all sites and features of potential archaeological significance present within the specified project area. An *inventory survey* is an initial level of archaeological investigation. It is extensive, rather than intensive, in scope and is conducted with the primary aim of determining the presence or absence of archaeological resources within the specified project area. A survey of this type indicates both the general nature and variety of archaeological remains present, and the general distribution and density of such remains. It permits a general significance assessment of the archaeological resources, and facilitates formulation of realistic recommendations and estimates for any subsequent *mitigation* work that might be necessary or appropriate. Such work could include intensive data collection involving detailed recording of sites and features, and selected test excavations. It might also include subsequent data recovery research excavations, construction monitoring, interpretive planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The basic objectives of a full inventory survey would be fourfold: **(a)** to identify (find and locate) all sites and site complexes present within the parcel; **(b)** to evaluate the potential general significance of all identified archaeological remains; **(c)** to determine the possible effects of proposed development upon the identified remains; and **(d)** to define the general scope of any subsequent intensive data collection and/or other mitigation work that might be necessary or appropriate.

Based on a review of readily available background literature, basic familiarity with the general project area, and extensive familiarity with the current requirements of review authorities, and based on discussions with Dr. Ross Cordy, chief archaeologist with the Hawaii State Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD), the following tasks were determined to constitute an adequate and appropriate scope of work for the phased inventory survey:

Phase I - Site Identification

1. Review available background archaeological and historical literature relevant to the immediate project area;

2. Conduct variable coverage (partial to 100%), variable intensity (25-50 ft intervals) ground survey, with the actual extent and intensity of coverage to be based on the adequacy of previous archaeological investigations. The objective of the ground survey will be to identify and plot the locations of all sites in the project area; and

3. Prepare a Preliminary Report summarizing **(a)** all identified sites and **(b)** tentative general significance assessments and recommended general treatments for all sites.

Phase II was to commence only upon authorization by the client, following review of the Phase I findings.

Phase II - Data Collection

1. Conduct additional detailed historical documentary research, as appropriate, on the basis of the Phase I findings, including interviews with local informants;

2. Conduct detailed recording (written descriptions, maps, and photographs) and surface collections at all sites identified during Phase I field work;

3. Conduct limited subsurface testing of selected sites and features identified within the project area **(a)** to determine the presence or absence of potentially significant buried cultural features or deposits, and **(b)** to obtain suitable samples for age determination analysis; and

4. Analyze background and field data, and prepare appropriate reports (Interim and Final Reports).

The significance of all archaeological remains identified within the project area was assessed in terms of **(a)** the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60), and **(b)** the criteria for evaluation of traditional cultural values prepared by the national Advisory Council on Historic Preservation. DLNR-SHPD uses these criteria to evaluate eligibility for both the Hawaii State and National Registers of Historic Places.

To assist the client with decisions regarding the subsequent treatment of resources, the general significance of all archaeological remains identified during the survey was also evaluated in terms of potential scientific research value, interpretive value, and cultural value (PHRI Cultural Resources Management [CRM] value modes; discussed in detail in the Conclusion section).

PROJECT AREA DESCRIPTION

The Keahole-Kailua 69kV Transmission Line project area comprises an alignment on the inland (east) side of Queen Ka'ahumanu Highway and Kaiwi street rights-of-way *(Figure 1)*. It extends from the Kailua Substation to the Keahole Switching Station and Power Facility. The width of the alignment varies from 50-100 ft, depending on the width of the rights-of-way of the two roads.

Vegetation within the project area consists primarily of fountain grass (*Pennisetum staceum* [Forsk.] Chiov.) and native *pili* grass (*Heteropogon contortus* [L.] Beauv.), scattered shrubs such as *'ilima* (*Sida fallax* Walp.), *noni* (*Morinda citrifolia*), and *koa-haole* (*Leucaena glauca*), and *kiawe* trees (*Prosopis pallida* [Humb. and Bonpl. ex. Willd]).

The project area ranges in elevation from c. 80 to 160 ft above mean sea level (AMSL). Rainfall in the general vicinity of the project area averages 20-30 inches per year, and the mean annual temperature ranges from 70 to 75 degrees F Armstrong 1983).

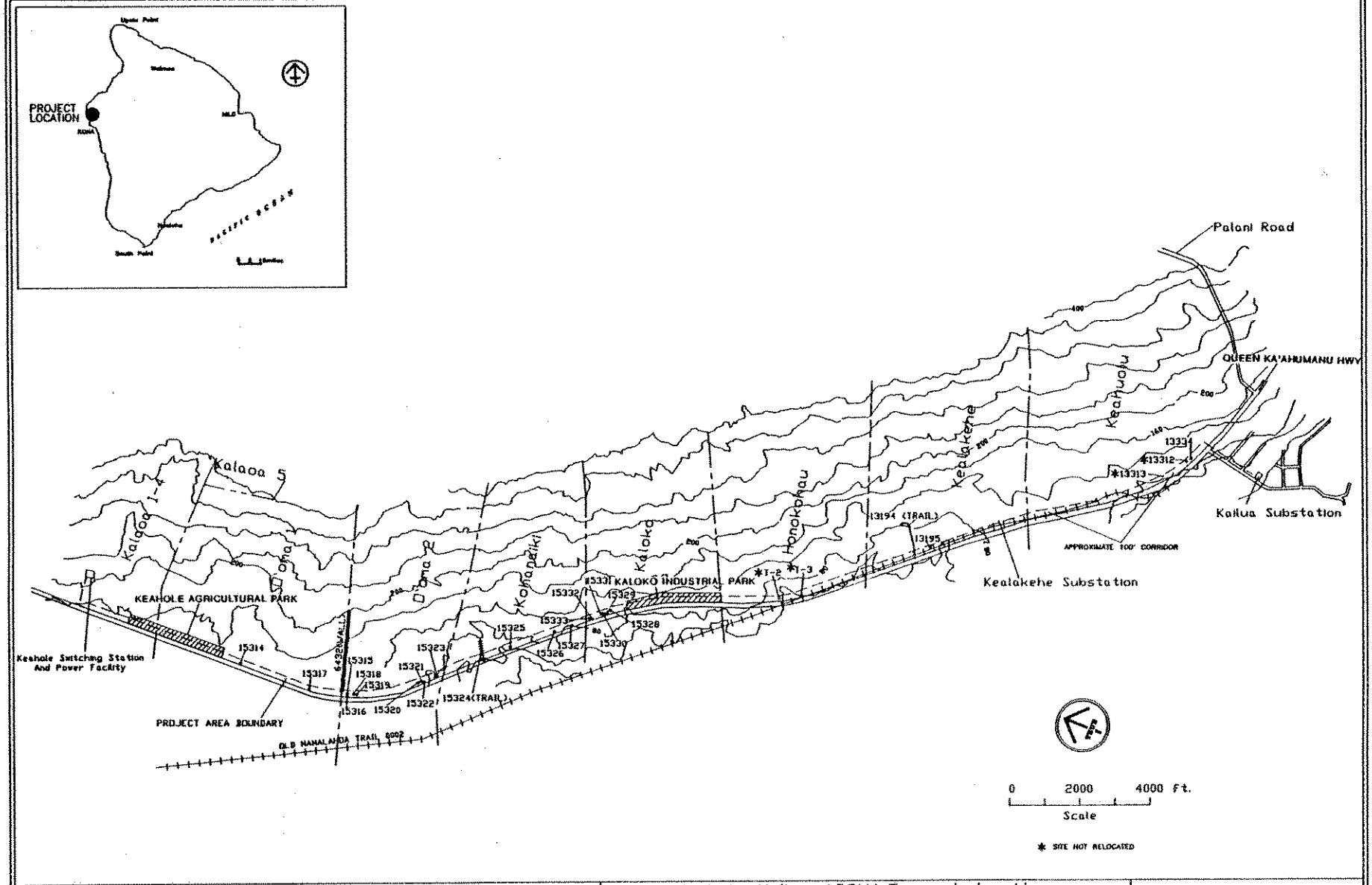
The project area generally conforms to the description of the general vicinity presented in Detailed Land Classification, Island of Hawaii (Baker et al. 1965):

> The lower elevations of this land are characterized mainly by almost bare, relatively unweathered aa and pahoehoe flows (Lithosols) from Hualalai and Mauna Loa volcanos. Precipitation is low, and soil material is generally lacking (Baker et al. 1965:5).

There is an access road along most of the transmission line corridor, generally located beneath, or just east of, the power lines. Numerous bulldozer tracks and push piles were found in association with this access road. In several locations, modern agricultural and industrial activities have encroached well within the transmission line right-of-way, effectively eliminating any archaeological resources which may have once existed. These modern activities include the construction of the Kaloko Industrial Park, in the Land of Kaloko, and construction of the agricultural park in the Lands of Kalaoa 1-4 and Kalaoa-Ooma. Modern trash, including metal cans, paper, and plastic was scattered in abundance along the corridor.

PREVIOUS ARCHAEOLOGICAL RESEARCH

Several previous archaeological investigations have been conducted within portions of the current project area (Table 1). These investigations include work by Ching and Rosendahl (1968), Rosendahl (1973), Davis (1977), Hammatt and Folk (1980), Donham (1990a and 1990b), Burgett and Rosendahl (1992), Henry and Graves (1992), O'Hare and Rosendahl (in prep.), and Robins et al. (in prep.).



PHRI PAUL H. ROSENDAHL, Ph.D., INC. ARCHAEOLOGICAL • HISTORICAL • CULTURAL RESOURCE MANAGEMENT STUDIES & SERVICES	305 MOHOULI STREET HILO, HAWAII 96720 (808) 969-1703, 961-6996(FAX)	Keahole–Kailua 138kV Transmission Line Project Survey (Phase I) PHRI Project 91–1118

FIGURE 1.
Project Area and
Site Locations

Previous research has resulted in the identification of nine archaeological sites within the current transmission line corridor project area. These sites include a burial platform (Site T-2) and a *mauka-makai* trail (Site T-3), recorded by Ching and Rosendahl (1968); an *ahupua'a* boundary wall (Site 6432), recorded by Davis (1977) and by Henry and Graves (1992); a complex (Site 13334), terrace (Site 13312), and pecking marks (Site 13313), recorded by Donham (1990b); a *mauka-makai* trail (Site 13194) and two cairns (Site 13195), recorded by O'Hare and Rosendahl (in prep.); and a portion of the Mamalahoa Trail (Site 00002) identified by Robins et al. (in prep.).

SETTLEMENT PATTERNS

Previous archaeological work has resulted in the creation of models of prehistoric settlement and land utilization for leeward West Hawaii. These models, created by Rosendahl (1973), Davis (1977), and Cordy (1985), generally postulate similar prehistoric patterns of settlement based on three environmental zones. The zones include a Coastal Zone, a Barren or Transitional Zone, and an Uplands Zone. The transmission line corridor will be located entirely within the Barren Zone. For this reason the Coastal or Uplands Zones will not be discussed here.

According to the environmental model proposed by Rosendahl (1973), Davis (1977), and Cordy (1985), the archaeological remains present within the Barren Zone would primarily evidence a transitory occupation. Such evidence would include temporary habitation structures, markers, and *mauka-makai* trails extending from the coast to the uplands.

Henry and Graves (1992) examined the northern portion of the current project area in light of the above environmental model to assess the model's accuracy. Their findings generally conformed to the expectations predicted by the model, although

Table 1.

SUMMARY OF PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS

Year	Researcher	Level of Study	Ahupua'a
1968	Ching and Rosendahl	Reconnaissance	Kalaoa 1-4 Kalaoa-Ooma
1973	Rosendahl	Data Recovery	Kalaoa 1-4 Kalaoa-Ooma Ooma 2 Kohanaiki
1977	Davis	Reconnaissance	Kalaoa 1-4
1980	Hammatt and Folk	Survey/Excavation	Kalaoa 1-4 Kalaoa-Ooma
1990a	Donham	Inventory	Kealakehe
1990b	Donham	Inventory	Keahuolu
1992	Burgett and Rosendahl	Inventory	Kealakehe Keahuolu
1992	Henry and Graves	Assessment Study	North Kona
In prep	O'Hare and Rosendahl	Data Recovery	Kealakehe
In prep	Robins et al.	Inventory	Honokohau

they did not conform to them precisely. Based on their study, Henry and Graves revised the model, indicating that while the Barren Zone is likely to evidence temporary habitation and transportation features, as previously postulated, agricultural features may also be present. Such features would include modified outcrops and mounds, rather than elements of a formal agricultural field-system. It was also determined that lava tubes and caves would also be present within the Barren Zone. Therefore, based on Henry and Graves work, it was expected that the current survey would identify feature types such as burial caves, refuge caves, enclosures, cairns (*ahus*), trails, modified outcrops, and mounds.

FIELD METHODS AND PROCEDURES

Field methods for the current study consisted the following; **(a)** variable intensity pedestrian survey of the portion of the current project area that extends from the Keahole Switching Station and Power Facility in the Land of Kalaoa 1-4, south to the southern boundary of the Land of Honokohau, and **(b)** site relocation within the previously surveyed Lands of Kealakehe and Keahuolu.

The pedestrian survey consisted of a single sweep through the project area, with crew members spaced at 15 m intervals. The sweep was oriented parallel to the Queen Ka'ahumanu Highway. When sites or features were identified, flagging tape inscribed with the PHRI project number (92-1118), temporary site number (1118-#), date, and recorder's initials was affixed to the southwest corner of the site. Metal site tags bearing the same project specific information as above were also left at the sites. Sites and features were briefly summarized on standardized PHRI forms; tentative general significance assessments and recommended general treatments were detailed on the forms.

The locations of all identified or relocated sites were plotted as accurately as possible on maps provided by the client. These maps indicated the apparent location of the existing power poles but lacked the associated pole numbers that were present on the poles in the field. It was intended that the sites be plotted on the map in relation to the existing power poles, but the poles on the map did not correspond exactly to poles in the field. Because of this discrepancy, the locations of the sites were plotted as closely as possible to their location to numbered poles in the field. Measurements were taken from each site to the nearest numbered power pole, using a 100 m tape.

In the Lands of Kealakehe and Keahuolu, site relocation was undertaken to positively determine the locations of all previously identified sites. To assist in this task, field maps from the prior inventory surveys (Donham 1990a,b and O'Hare and Rosendahl in prep.), were consulted. When a site was relocated, its location was plotted as accurately as possible, and measurements to the nearest power pole were taken. When a previously recorded site was not found in its reported location, field personnel examined the areas to the north, south and east, to determine if it had merely been mis-plotted. However, if the site could not be found, it was assumed that it had been destroyed, or was considerably outside the current project area boundaries. Because the ground visibility was almost unrestricted, all sites present within the current project area have been identified or relocated.

FINDINGS

During the present study, 25 sites consisting of 60 component features were identified within the overall project area. Within the previously unsurveyed portion of the project area, 22 sites consisting of 34 component features were identified. Within the previously surveyed Lands of Kealakehe and Keahuolu, three sites consisting of 26 component features were relocated. Previous archaeological investigations within the current project area as a whole had identified nine archaeological sites. Of these nine sites, only five were relocated during the current study. Detailed locational information for all sites and features is presented in Table 2.

The survey of the current project area also identified extensive modern disturbance. An existing access road extends along most of the transmission line corridor, generally located beneath or just east of the power lines. Numerous bulldozer tracks and push piles were found in association with this access road. In several locations, modern agricultural and industrial activities have encroached well within the transmission line right-of-way, precluding the survival of any archaeological resources that may once have existed. These modern activities include the construction of the Kaloko Industrial Park, in the Land of Kaloko, and the agricultural park present in the Lands of Kalaoa 1-4 and Kalaoa-Ooma. Modern trash, including metal cans, paper, and plastic was scattered in abundance along the corridor.

The identified sites consist of single and multiple components, and their condition ranges from poor to excellent. The sites comprise the following formal feature types: cairn (*ahu*) (5), cupboard (2), filled crack (2), lava tube (1), modified blister (6), modified outcrop (31), mound (1), pahoehoe excavation (2), rock ring (1), terrace (4), trail (3), and wall (2). A summary of identified sites and features is presented in Table 3.

Probable functions were determined for all identified sites and features. Functional feature types encountered include agriculture (68.33% of total), indeterminate (6.66%), marker (6.66%), transportation (5.0%), boundary (3.33%), habitation (3.33%), quarry (3.33%), and storage (3.33%).

Of the five relocated sites, one is a historic *ahupua'a* boundary wall, previously recorded by Davis as Site 6432 (1977), and subsequently identified by Henry and Graves (1992). Davis' site description states that the wall separates the Lands of Kalaoa and Kalaoa-Ooma. However, it appears from Davis' field map, as well as in the findings of Henry and Graves study (1992) and those of the current project, that the wall actually divides the Lands of Kalaoa-Ooma and Ooma 2.

Portions of the Mamalahoa Trail (Site 00002) were also relocated during the current study (Ching and Rosendahl 1968; Donham 1990a, b; O'Hare and Rosendahl, in prep.; and Robins et al., in prep.). Portions of the trail are evident adjacent to the existing power lines in the Lands of Honokohau, Kealakehe and Keahuolu.

O'Hare and Rosendahl's work (in prep.) within the Kealakehe Planned Community project area, within the Land of Kealakehe, resulted in the identification of two sites to be located within the present project (O'Hare and Rosendahl). These sites include a *mauka-makai* trail (Site 13194), and two *ahu* (Site 13195). Both sites were relocated during the current survey, and their approximate locations were recorded.

Donham's 1990 inventory survey of the Queen Liliuokalani Trust Property project area, in the Land of Keahuolu, resulted in the identification of three sites reported to be present within the proposed corridor (1990b). These sites include a large complex (Site 13334), a terrace (Site 13312), and pecking marks (Site 13313). Attempts were made to relocate these sites during the current project, however, only the complex, Site 13334, was found.

Of the nine previously recorded sites, the four that could not be relocated were the previously mentioned Sites 13312 and 13313, recorded by Donham (1990b), and two sites recording during Ching and Rosendahl's 1968 survey of the Kailua-Kawaihae Road corridor. These were a burial platform (T-2) and a *mauka-makai* trail (T-3), both in the Land of Honokohau (1968:9-10). According to recommendations made at the time, both sites were archaeologically salvaged, with Site T-2 being moved, in accordance with Chapter 276, Revised Laws of Hawaii 1955 (ibid:15). There has been extensive modern disturbance along the highway corridor within the Land of Honokohau, and it is appears that the portion of Site T-3 within the current project area has been destroyed.

Table 2.

SITE LOCATIONS

Site No.	Distance from Nearest Power Pole	Distance/Direction From Power Line	Ahupua'a
15314	45 m south of PP 115*	11 m east	Kalaoa-Ooma
15317	43 m south of PP 110	42 m east	Kalaoa-Ooma
6432	10 m north of PP 106	East-west through corridor	Kalaoa-Ooma/ Ooma II
5315	33 m south of PP 106	38 m east	Ooma II
15316	30 m south of PP 106	12 m east	Ooma II
15318	45 m north of PP 104	30 m east	Ooma II
15319	5 m south of PP 103	39 m east	Ooma II
15320	51 m north of PP 95	40 m east	Ooma II
15321	32 m north of PP 95	34 m east	Ooma II
15322	32 m north of PP 95	24 m east	Ooma II
15323	28 m east of PP 93		Ooma II
15324	16 m south of PP 87 through corridor	East-west Kohanaiki	
15325	37 m north of PP 84	25 m east	Kohanaiki
15326	11 m north of PP 80	15 m east	Kohanaiki
15327	5 m north of PP 79	9 m east	Kohanaiki
15328	16 m north of PP 75	24 m east	Kaloko
15329	36 m north of PP 75	23 m east	Kaloko
15330	18 m south of PP 76	30 m east	Kaloko
15331	15 m north of PP 76	33 m east	Kaloko
15332	22 m south of PP 77	13 m east	Kaloko
15333	53 m north of PP 77	22 m east	Kaloko
13194	20 m north of PP 58	10 m east	Kealakehe
13195	45 m north of PP 41	30 m east	Kealakehe
13334	PP 11 to PP 15	10 m east	Keahuolu
00002	PP 58 heading south	10 m east	Honokohau/ Kealakehe/ Keahuolu

** PP = Power Pole*

Table 3.

SUMMARY OF IDENTIFIED SITES AND FEATURES

SIHP Site No.	PHRI Temp. No.	Formal Site/Feature Type	Tentative Functional Interpretation	*CRM Value Mode Assess. R	I	C	+Field Work Recommended DR	SC	EX
00002	1118-16	Trail	Transportation	H	H	H	+	-	-
06432	1118-4	Wall	Boundary	L	L	L	+	-	-
15314	1118-1	Mod. blister	Habitation	M	L	L	+	-	+
15315	1118-2	Mod. outcrop	Agriculture	L	L	L	+	-	-
15316	1118-3	Mod. outcrop	Agriculture	L	L	L	+	-	-
15317	1118-5	Pahoehoe ex.	Quarry	L	L	L	+	-	-
15318	1118-6	Mod. outcrop	Agriculture	L	L	L	+	-	-
15319	1118-7	Mod. lava tube	Habitation	M	L	L	+	-	-
15320	1118-8	Mod. outcrop	Agriculture	L	L	L	+	-	-
15321	1118-9	*Ahu*	Marker	L	L	L	+	-	-
15322	1118-10	Pahoehoe ex.	Quarry	L	L	L	+	-	-
15323	1118-11	*Ahu*	Marker	L	L	L	+	-	-
15324	1118-12	Trail	Transportation	H	H	H	+	-	-
15325	1118-13	Complex (3)	Boundary/Storage Indeterminate	M	L	L	+	-	-
A		Wall							
B		Cupboard							
C		Terrace							
15326	1118-14	Mod. outcrop	Agriculture	L	L	L	+	-	-
15327	1118-15	*Ahu*	Marker	L	L	L	+	-	-

Mod. = Modified
Ex. = Excavation

**Cultural Resource Management Value Mode Assessment:*
—*Nature:* *R* = *scientific research*
I = *interpretive*
C = *cultural*
—*Degree:* *H* = *high*
M = *moderate*
L = *low*

+*Recommended Field Work Tasks:*
DR = *detailed recording (scaled drawings, photographs, and written descriptions)*
SC = *surface collections*
EX = *test excavations*

Table 3. (cont.)

SIHP Site No.	PHRI Temp. No.	Formal Site/Feature Type	Tentative Functional Interpretation	*CRM Value Mode Assess. R	I	C	+Field Work Recommended DR	SC	EX
15328	1118-17	Complex (3)	Agriculture	L	L	L	+	-	-
A		Mod. outcrop							
B		Mod. outcrop							
C		Mod. outcrop							
15329	1118-18	Complex (2)	Indeterminate	L	L	L	+	-	-
A		Filled crack							
B		Filled crack							
15330	1118-19	Complex (4)	Agriculture/ Indeterminate	L	L	L	+	-	-
A		Mod. outcrop							
B		Mod. outcrop							
C		Mod. outcrop							
D		Rock ring							
15331	1118-20	Complex (2)	Agriculture	L	L	L	+	-	-
A		Mound							
B		Mod. outcrop							
15332	1118-21	Cupboard	Storage	L	L	L	+	-	-
15333	1118-22	Complex (4)	Agriculture	L	L	L	+	-	-
A		Mod. blister							
B		Mod. outcrop							
C		Mod. outcrop							
D		Mod. outcrop							
13194	652-21	Trail	Transportation	M/H	H	M/H	-	-	-
13195	652-22	Historic *ahu*(2)	Marker	L	L	L	-	-	-
13334	596-100	Complex (23)	Agriculture	M	L	L	+	-	+
		Terrace (3)							
		Mod. outcrop (16+)							
		Mod. Blister (4+)							

CONCLUSION

DISCUSSION

The findings from the current survey, during which 25 sites with 60 component features were identified, generally conformed to the expectations presented in the Settlement Pattern section of this document. Despite the fact that the current project area consists primarily of lava flows where there is little soil development, more than 68% of all identified features were interpreted as agricultural. It is unlikely the identified agricultural features represent central components of an agricultural field-system; they may embody fringe elements of such a system. These findings indicate that the Barren or Transitional Zone, in which the current project area is located, may be more diverse in terms of aboriginal utilization than previously estimated.

Most of the features with agricultural functions were modified outcrops. Because this formal type currently describes a wide range of cultural modifications and is frequently assigned subjectively, it may be necessary to re-evaluate this formal type in future studies and to perhaps formulate a more detailed typology. Such a typology would help to define functions more precisely.

Due to the limited size of the current project area, in conjunction with the excellent ground-visibility, it is likely that all major sites have been located. The relatively low density of sites throughout the project area should allow for considerable leeway in the placement of the proposed power poles.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

To facilitate outside review, general significance assessments and recommended general treatments for all identified sites are summarized in Table 4. Significance categories used in the site evaluation process are based on the National Register criteria for evaluation, as outlined in the Code of Federal Regulations (36 CFR Part 60). The DLNR-SHPD uses these criteria for evaluating cultural resources. Sites determined to be potentially significant for information content (Category A, Table 4) fall under Criterion D, which defines significant resources as ones which "...have yielded, or may be likely to yield, information important in prehistory or history." Sites potentially significant as representative examples of site types (Category B) are evaluated under Criterion C, which defines significant resources as those which "...embody the distinctive characteristics of a type, period, or method of construction...or that represent a significant and distinguishable entity whose components may lack individual distinction."

Sites with potential cultural significance (Category C) are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP), entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (Draft Report, August 1985). The guidelines define cultural value as "...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth." The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value."

Based on the above federal criteria, 23 of the 25 identified sites are assessed as significant solely for information content. 21 of these 23 sites are recommended for further data collection. The remaining two sites that are significant for information value (Sites 13194 and 13195) have been documented to the extent that no further work is recommended (O'Hare and Rosendahl in prep.). For the final two sites (Sites 00002 and 15324), further data collection (specifically, detailed recording and additional historical documentary research), followed by preservation "as is" is recommended.

To assist the client with decisions regarding the subsequent treatment of the identified sites, the general significance of the sites was also evaluated in terms of potential scientific research, interpretive, and/or cultural values (PHRI Cultural Resources Management [CRM] value modes. *Research value* refers to the potential of archaeological resources for producing information useful in the understanding of cultural history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. *Interpretive value* refers to the potential of archaeological resources for public education and recreation. *Cultural value*, within the framework for significance evaluation used here, refers to the potential of archaeological resources for the preservation and promotion of cultural and ethnic identity and values. CRM assessments are given in Table 3.

Since it is possible to adjust the placement of the proposed transmission line power poles and access roads, and thus to preserve sites and features by avoiding them, site

Table 4.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
6432	+	-	-	-	+	-	-	-
15314	+	-	-	-	+	-	-	-
15315	+	-	-	-	+	-	-	-
15316	+	-	-	-	+	-	-	-
15317	+	-	-	-	+	-	-	-
15318	+	-	-	-	+	-	-	-
15319	+	-	-	-	+	-	-	-
15320	+	-	-	-	+	-	-	-
15321	+	-	-	-	+	-	-	-
15322	+	-	-	-	+	-	-	-
15323	+	-	-	-	+	-	-	-
15325	+	-	-	-	+	-	-	-
15326	+	-	-	-	+	-	-	-
15327	+	-	-	-	+	-	-	-
15329	+	-	-	-	+	-	-	-
15330	+	-	-	-	+	-	-	-
15331	+	-	-	-	+	-	-	-
15332	+	-	-	-	+	-	-	-
15333	+	-	-	-	+	-	-	-
15334	+	-	-	-	+	-	-	-
13334	+	-	-	-	+	-	-	-
Subtotal	**21**	**0**	**0**	**0**	**21**	**0**	**0**	**0**
13194	-	+	-	-	-	+	-	-
13195	-	+	-	-	-	+	-	-
Subtotal	**0**	**2**	**0**	**0**	**0**	**2**	**0**	**0**
00002	+	-	-	+	+	-	-	+
15324	+	-	-	+	+	-	-	+
Subtotal	**2**	**0**	**0**	**2**	**2**	**0**	**0**	**2**
Total	**23**	**2**	**0**	**2**	**23**	**2**	**0**	**2**

General Significance Categories:

A = Important for information content, further data collection necessary (PHRI=research value);

X = Important for information content, no further data collection necessary (PHRI=research value, SHPD=not significant);

B = Excellent example of site type at local, regional, island, state, or national level (PHRI=interpretive value); and

C = Culturally significant (PHRI=cultural value)

Recommended General Treatments:

FDC = Further data collection necessary (further survey and testing, and possibly subsequent data recovery/mitigation excavations);

NFW = No further work of any kind necessary, sufficient data collected, no preservation potential (possible inclusion into landscaping suggested for consideration);

PID = Preservation with some level of interpretive development recommended (including appropriate related data recovery work); and

PAI = Preservation "as is," with no further work (and possible inclusion into landscaping), or minimal further data collection necessary

preservation with no further data collection at this time constitutes appropriate and acceptable mitigation of potentially damaging construction impacts.

If the proposed transmission line construction is permitted to proceed, PHRI recommends that it be subject to the following conditions, based on the findings of the Phase I - Site Identification survey field work. These conditions will ensure the continued physical protection and preservation of identified sites. The recommended conditions are **(a)** that the placement of power poles be such that no identified sites and features are affected, **(b)** that any modifications to the existing access road, or the creation of new access road(s), pose no threat, either directly or indirectly, to the identified sites and features, and **(c)** that all development activities related to construction of the transmission line be subject to archaeological monitoring by a qualified archaeologist.

The above recommendations and suggested conditions have been made solely on the basis of the site identification field work described in this document. There is always the possibility, however remote, that potentially significant, unidentified cultural remains might be encountered in the course of future development activities. In such situations, archaeological consultation should be sought immediately.

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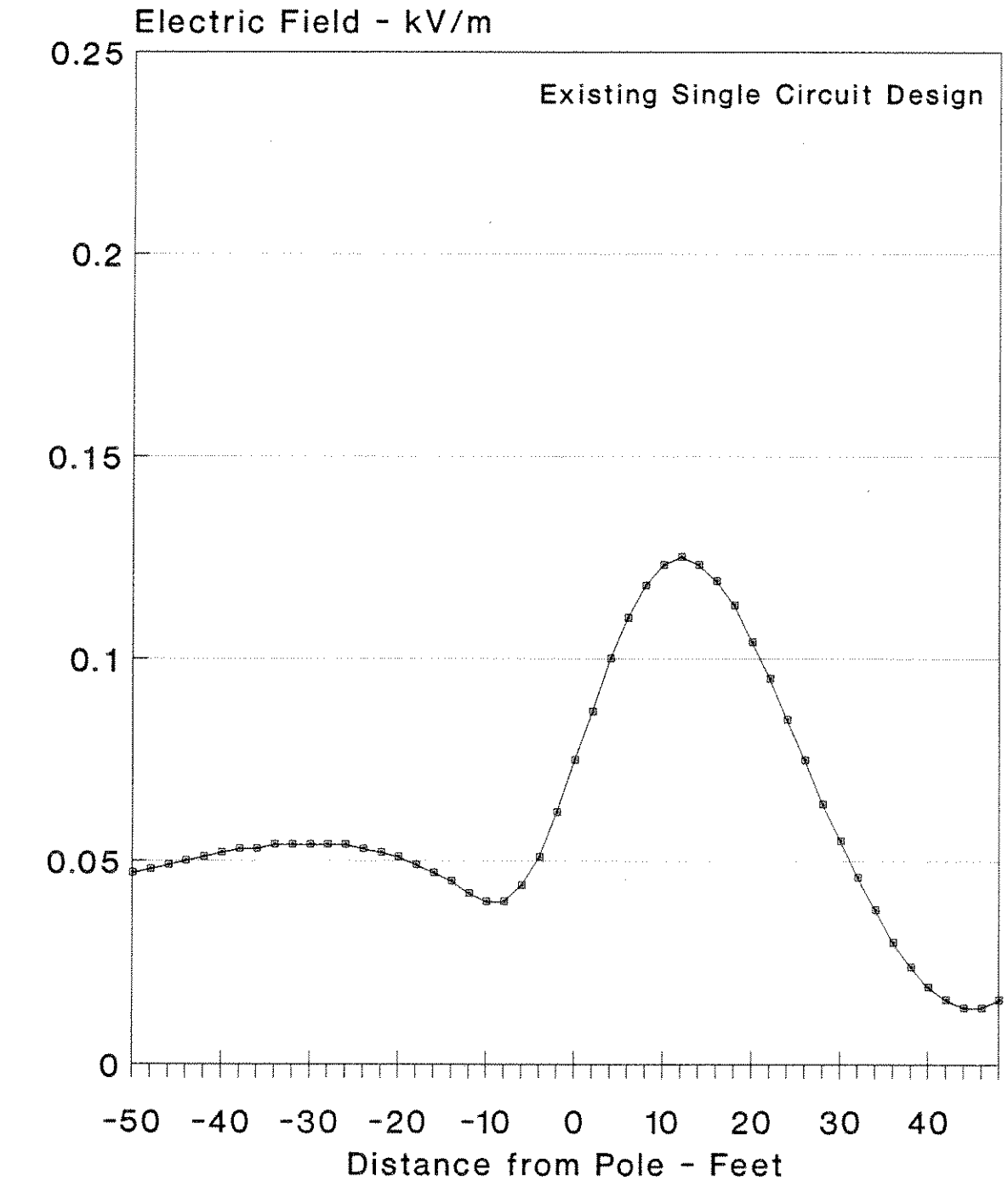
APPENDIX G

Appendix G
Electric and Magnetic Fields: Plots of Calculated Values

Appendix G
Electric and Magnetic Fields: Plots of Calculated Values

Enertech Consultants, a scientific research and consulting services firm in Campbell, California, calculated the electric and magnetic field values used in the following plots, which Enertech prepared in March 1993. These plots of the electric and magnetic field values support the discussion of electric and magnetic fields in Chapter 5 and the citations of electric and magnetic field values in Chapters 1 and 4. The assumptions and methods used to derive the calculated values are discussed in the electric and magnetic fields section of Chapter 5.

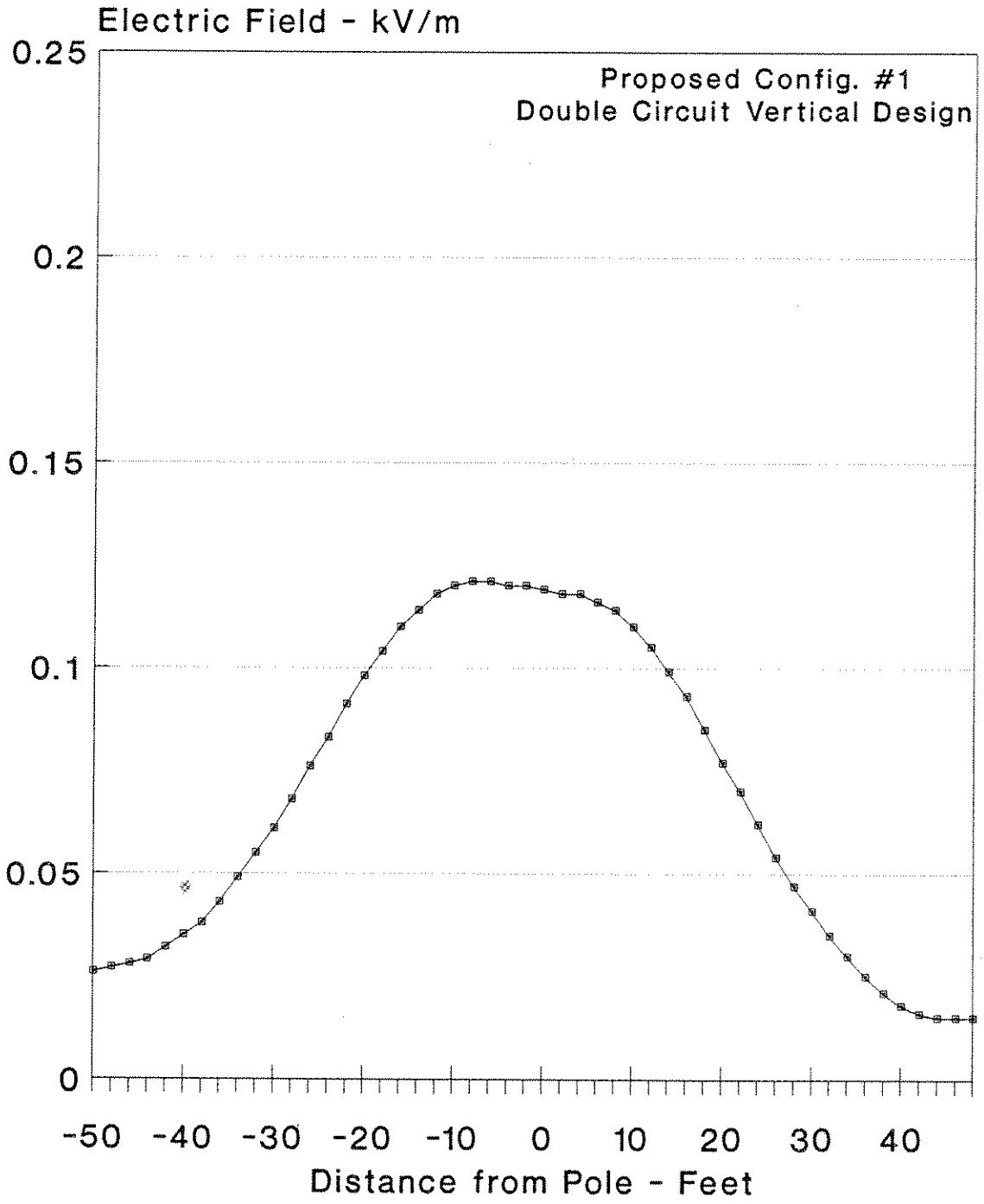
Keahole - Kailua 69 kV Transmission Line



69/12 kV

FIGURE G-1

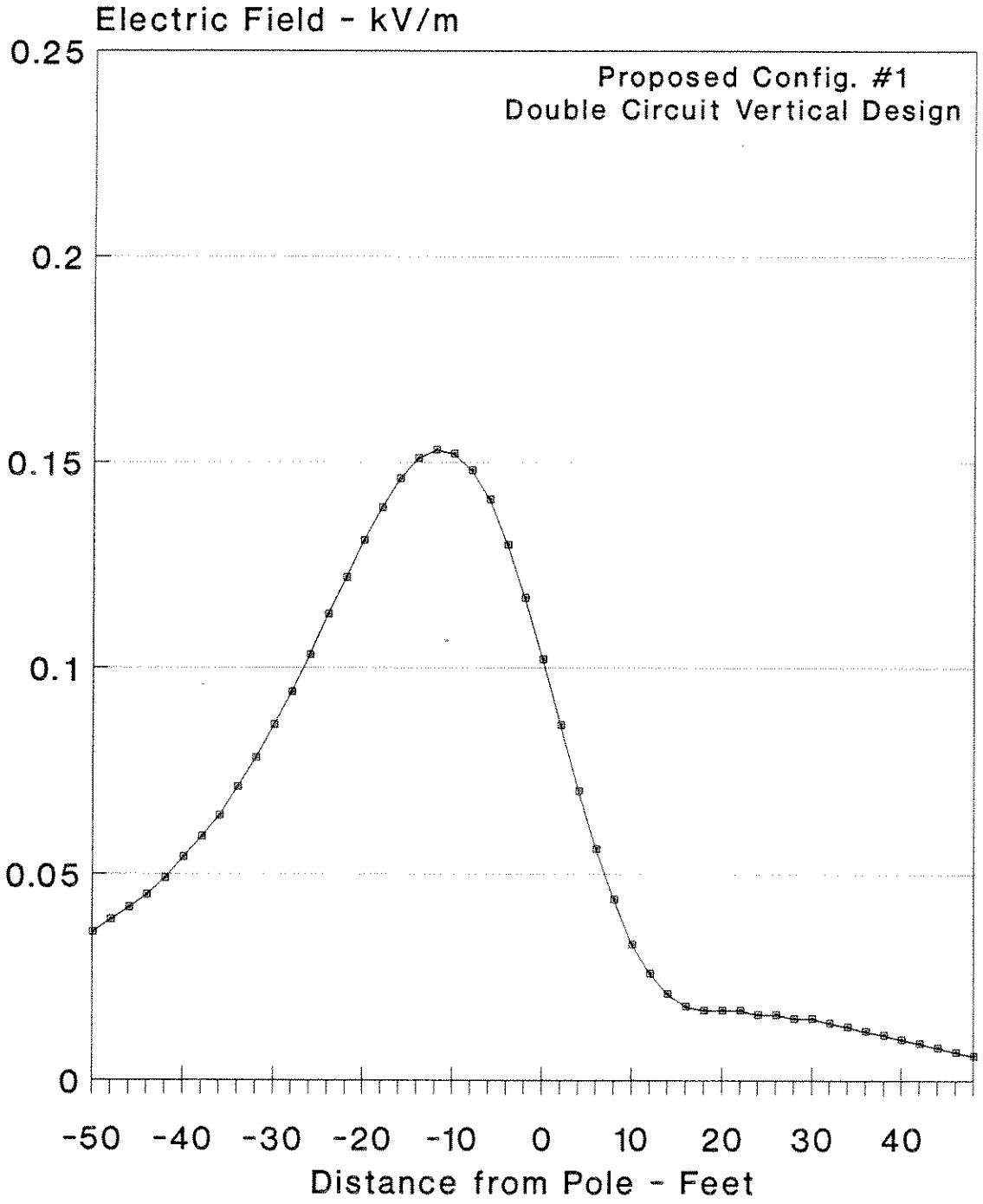
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV with LIKE Phasing

FIGURE G-2

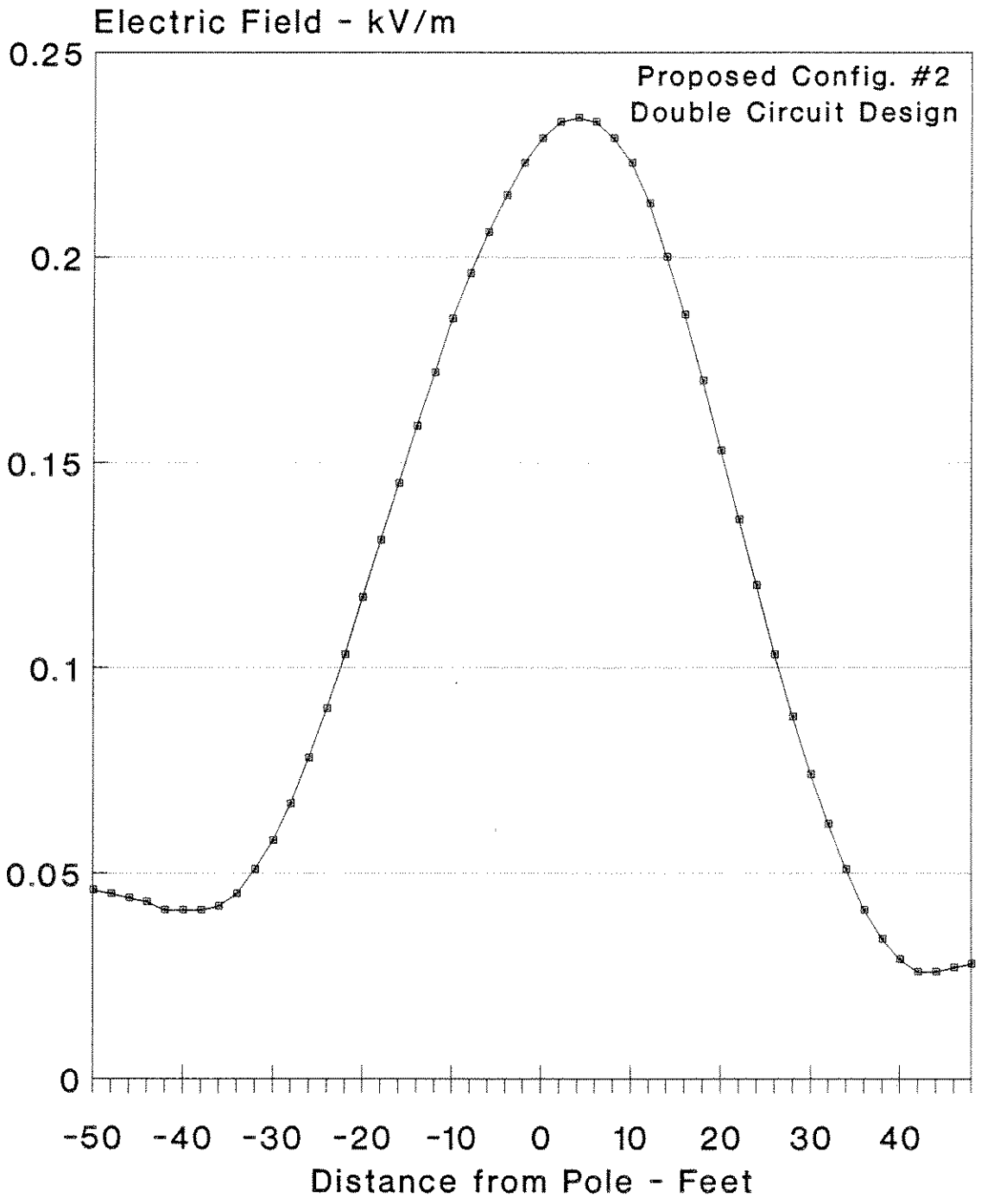
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV with UNLIKE Phasing

FIGURE G-3

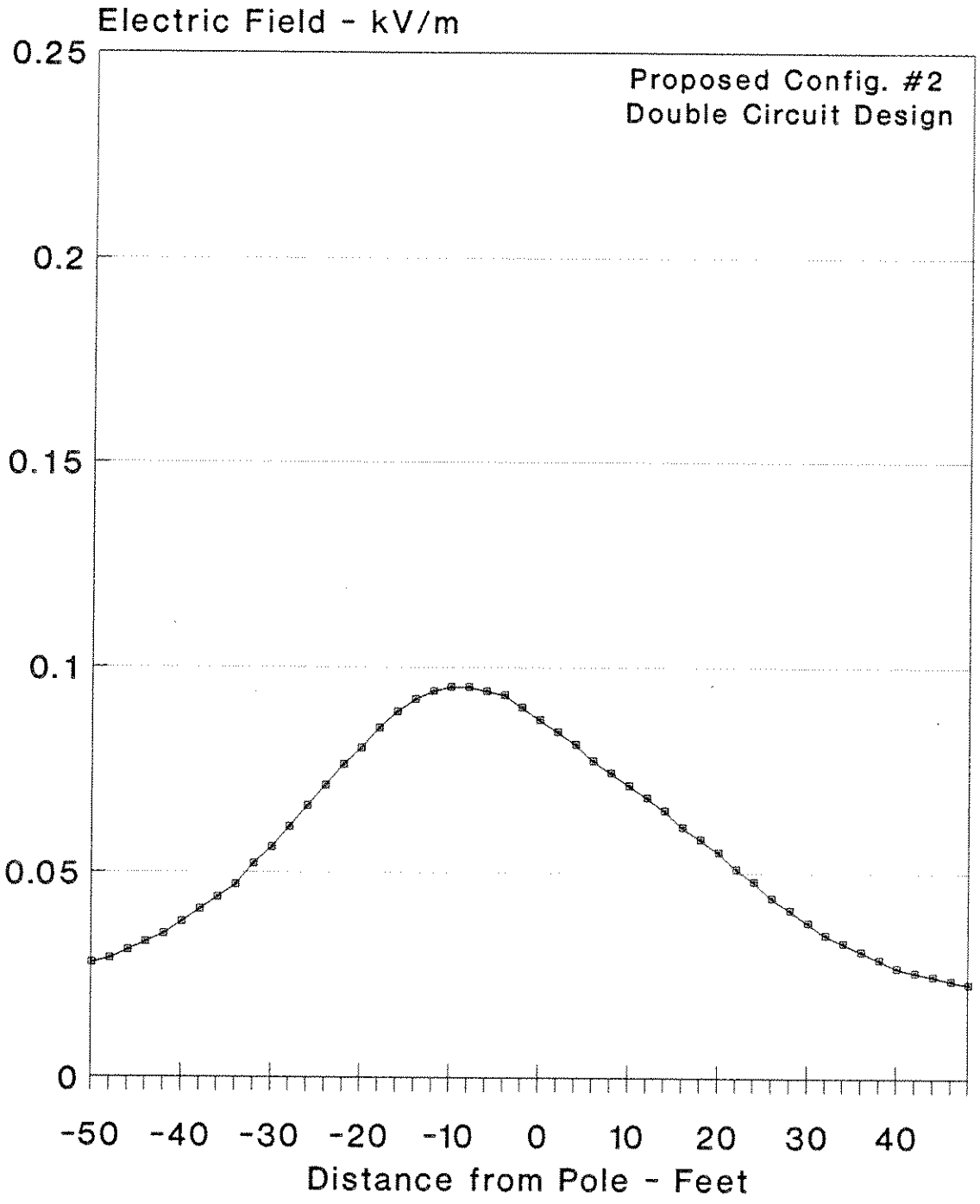
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV with LIKE Phasing

FIGURE G-4

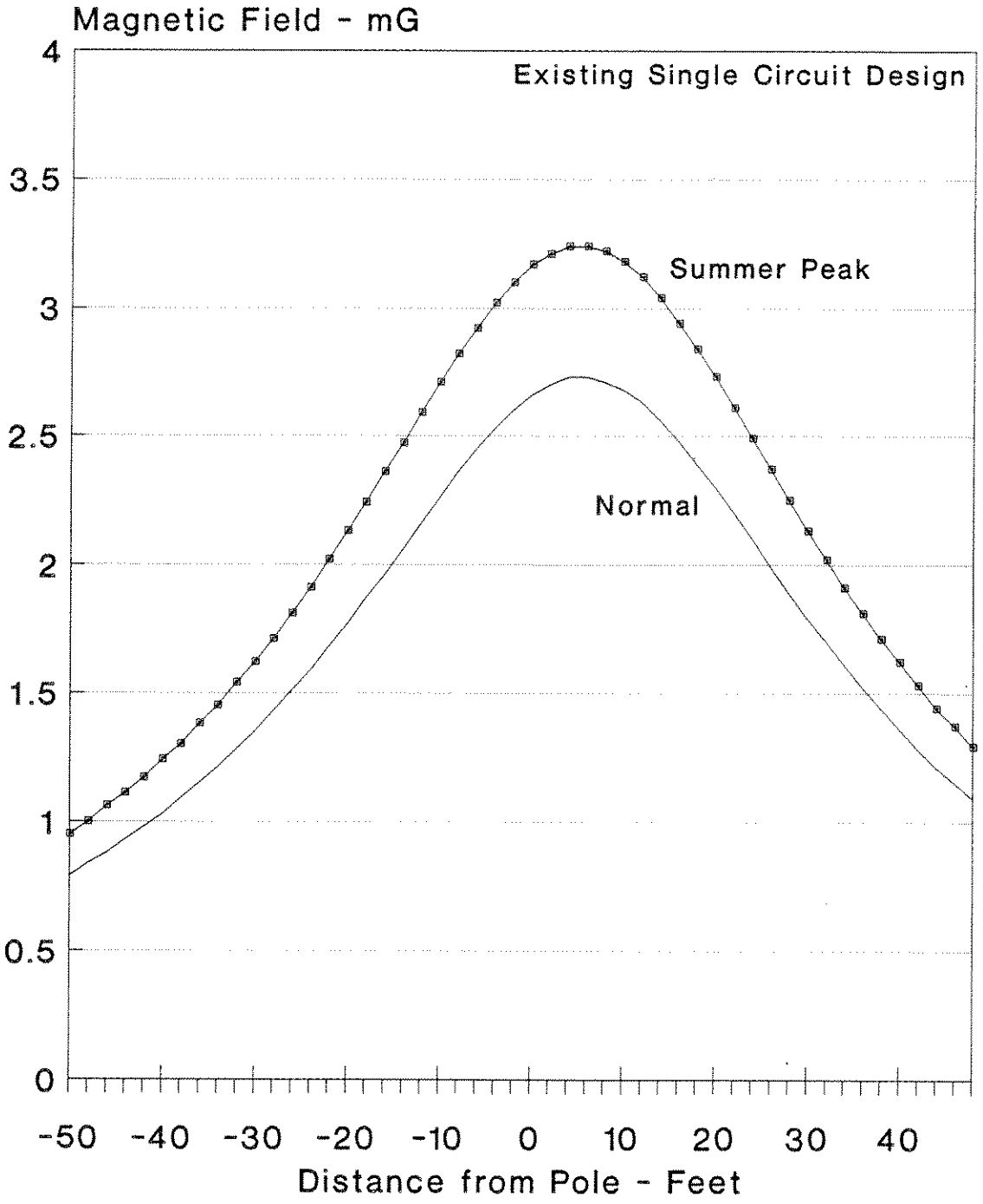
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV with UNLIKE Phasing

FIGURE G-5

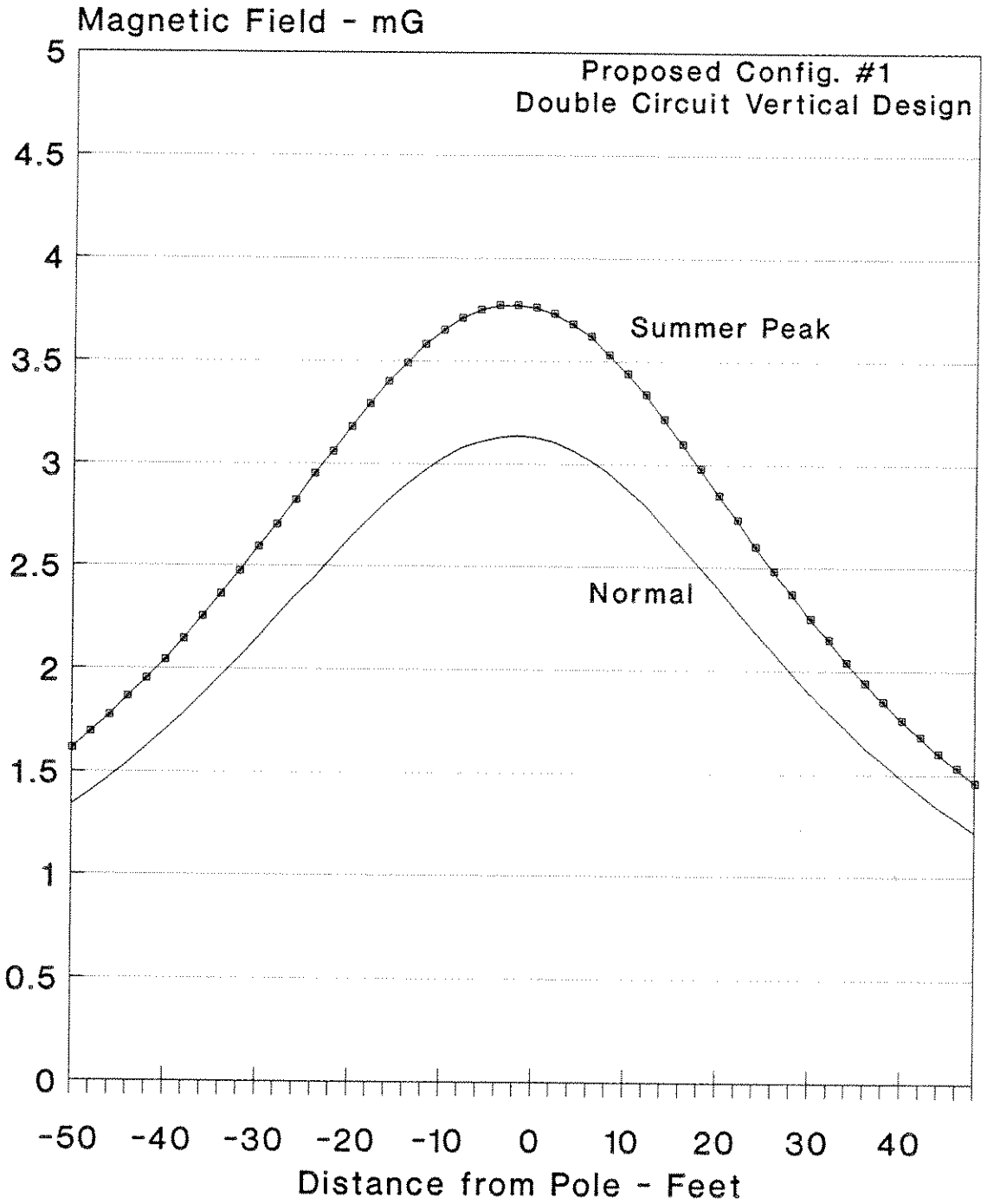
Keahole - Kailua 69 kV Transmission Line



69/12 kV @ Normal & Summer Peak Load

FIGURE G-6

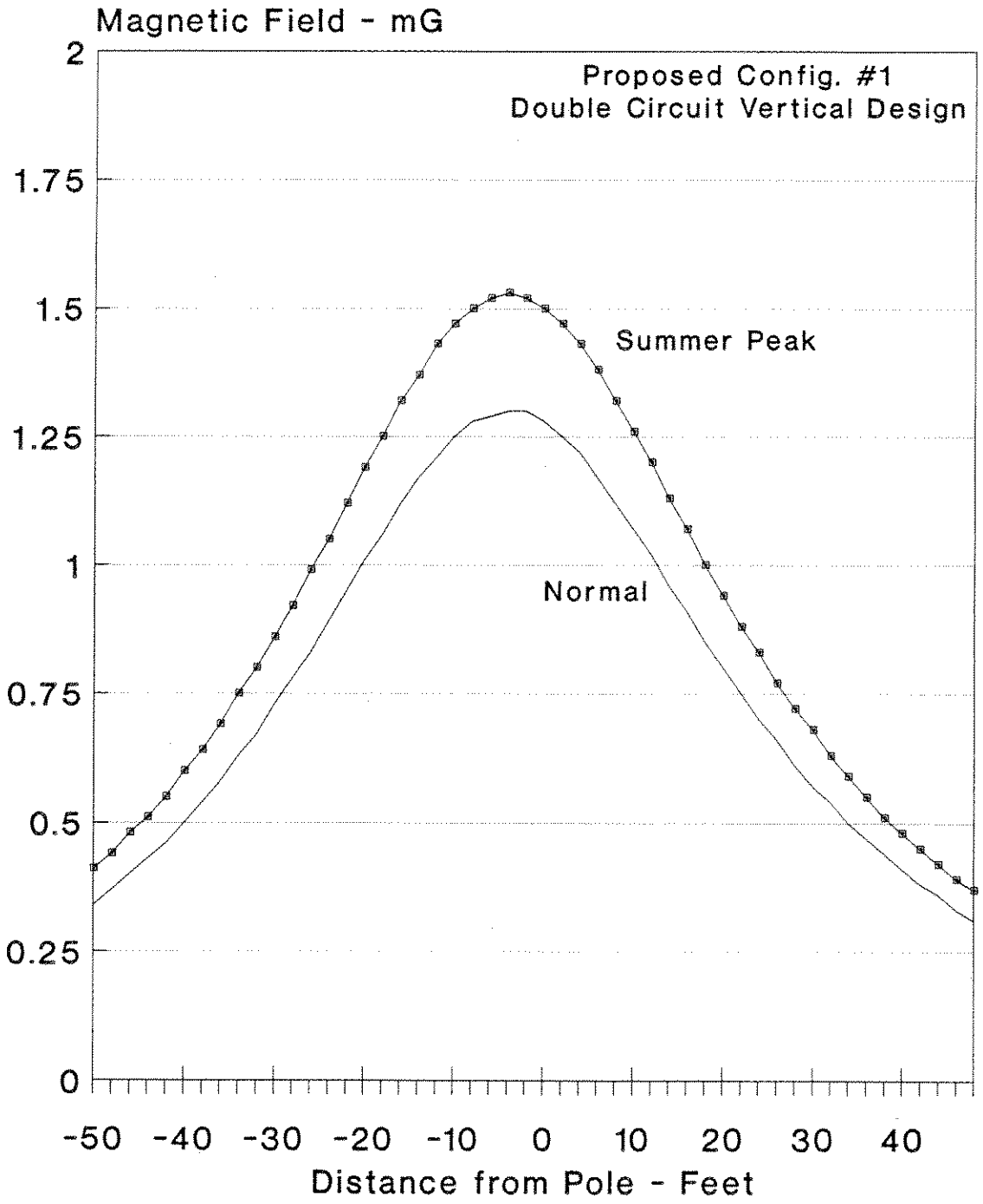
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Normal & Summer Peak Load with LIKE Phasing

FIGURE G-7

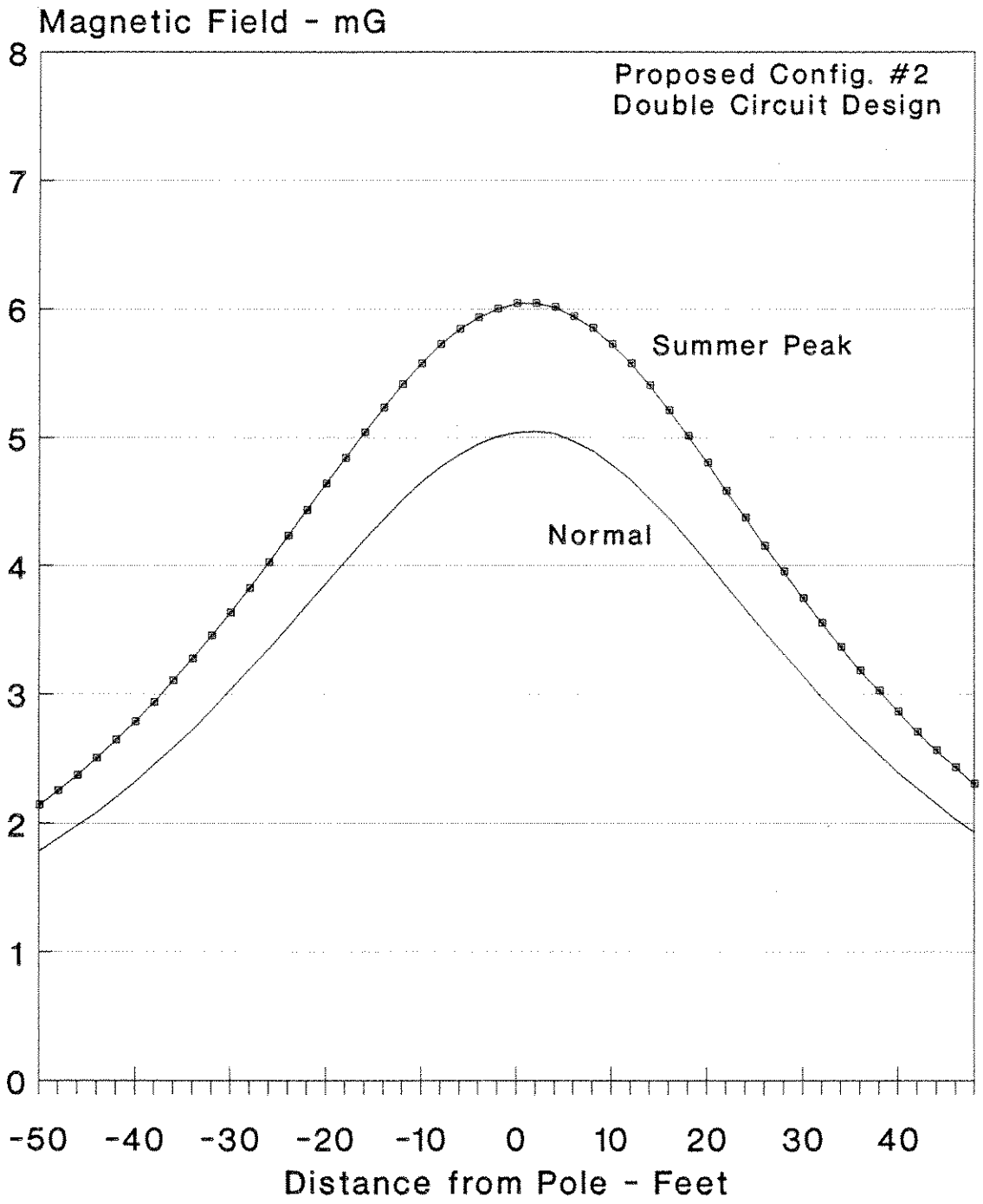
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Normal & Summer Peak Load with UNLIKE Phasing

FIGURE G-8

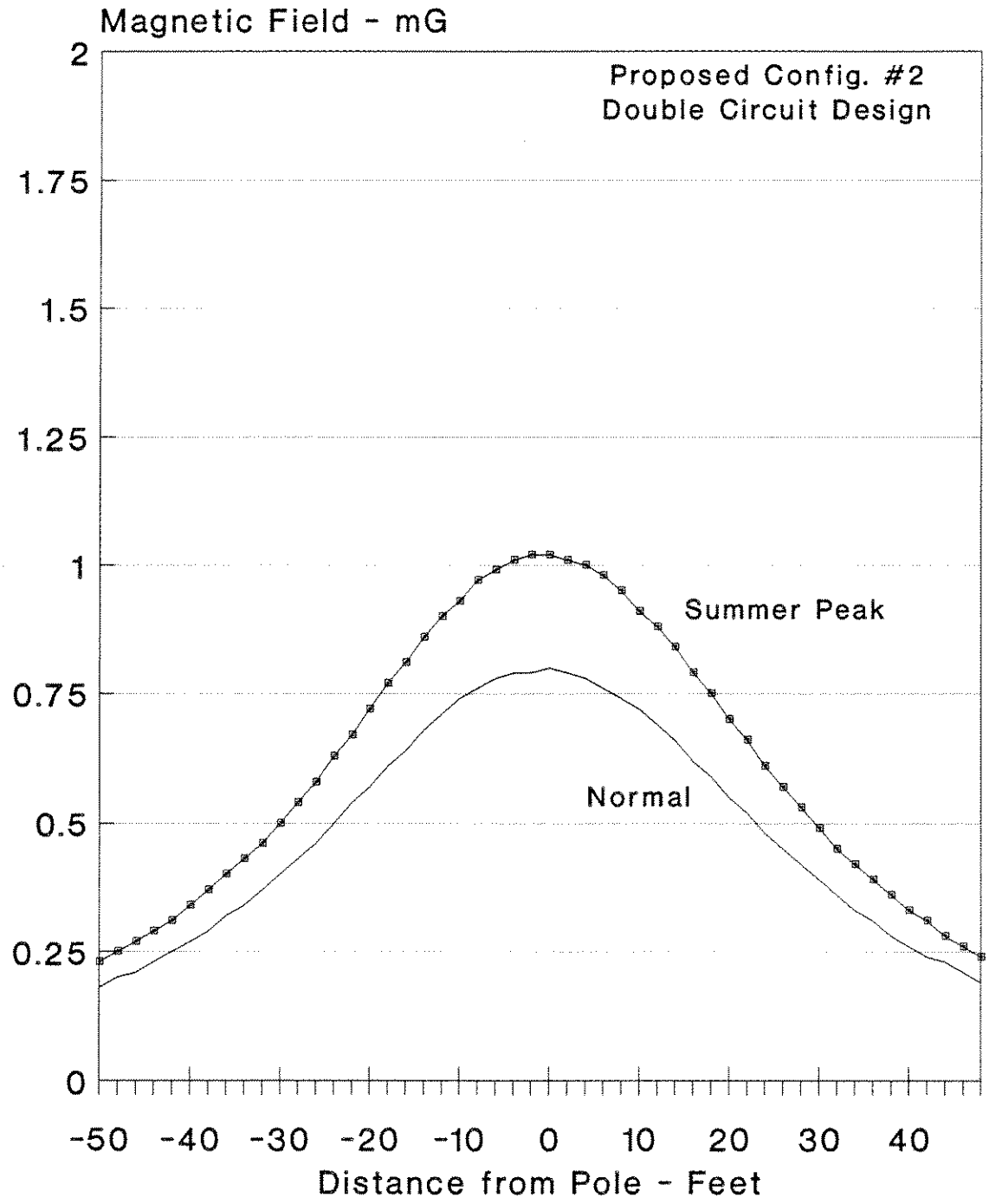
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Normal & Summer Peak Load with LIKE Phasing

FIGURE G-9

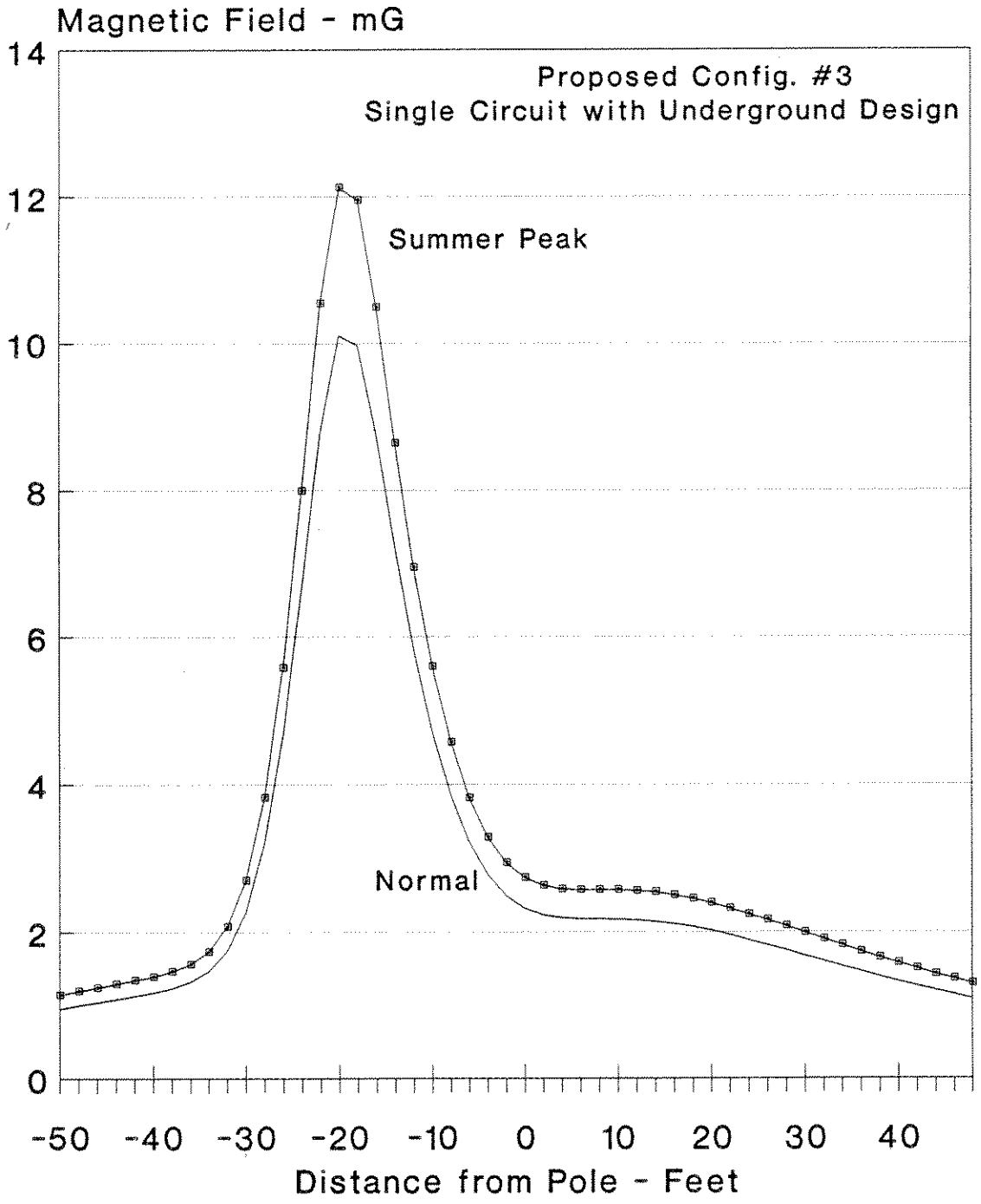
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Normal & Summer Peak Load with UNLIKE Phasing

FIGURE G-10

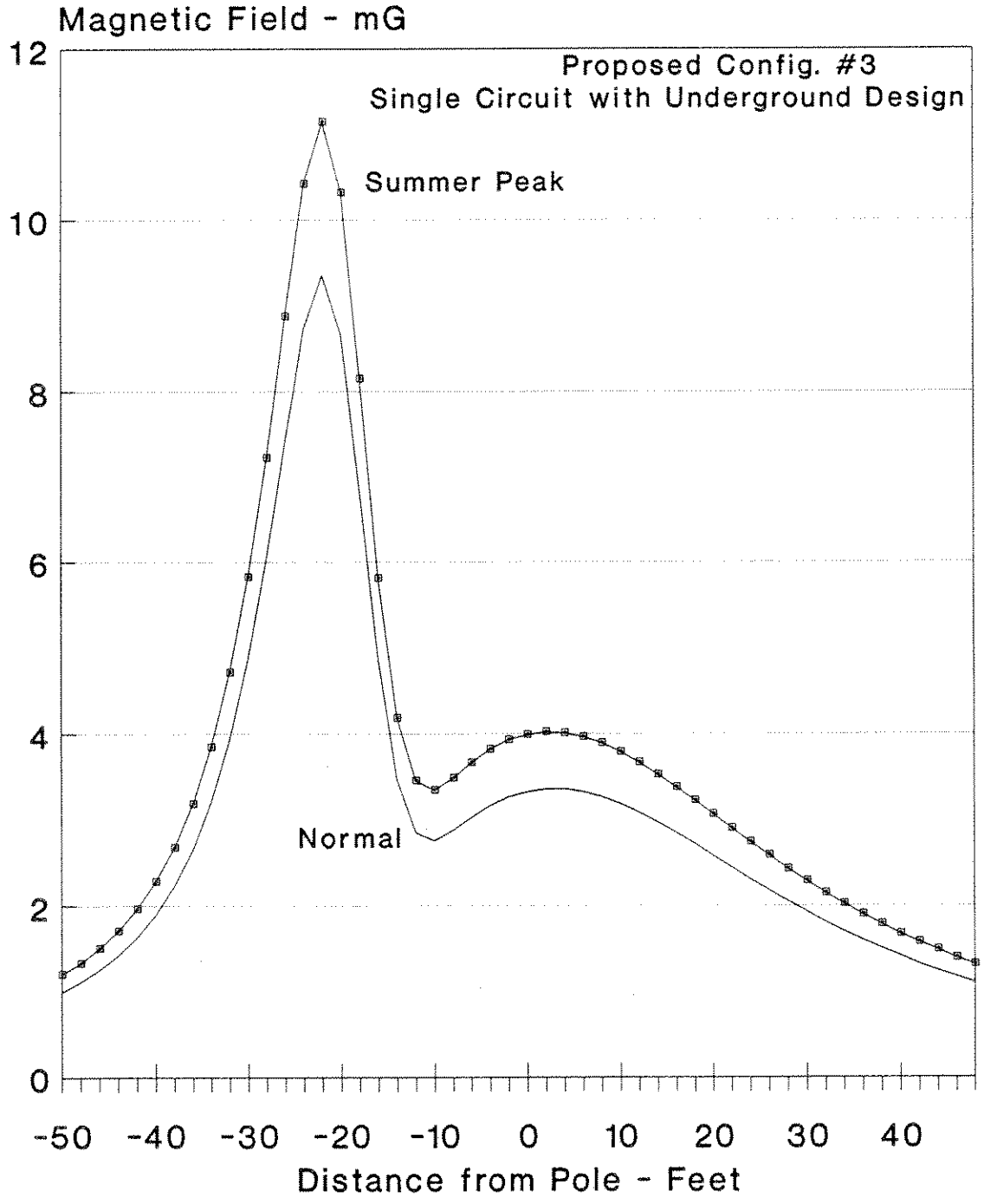
Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Normal & Summer Peak Load with LIKE Phasing

FIGURE G-11

Keahole - Kailua 69 kV Transmission Line



2-69/12 kV @ Summer Peak Load with UNLIKE Phasing

FIGURE G-12

APPENDIX H

Appendix H
EISPN Comments and Responses

JOHN WAIHEE
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813
Telephone: 587-3822

November 20, 1992

Mr. Don Horiuchi
Department of Land and
Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

Subject: Environmental Assessments (EA) for Keahole-Kailua Transmission Line Project, West Hawaii Power Facility, Keahole Generating Station Expansion Project, the Keahole Generating Station Meteorological Tower Project

We have reviewed the EA's for the subject projects and our comments are as follows:

1. With respect to the Keahole-Kailua Transmission Line Project EA, we find that the seven alternative corridors, as shown in Figure 7, appear to be located within the State Land Use Agricultural, Conservation, and Urban Districts. We suggest that the draft EIS include a map showing the seven alternative corridors in relation to the State Land Use Districts.

2. With respect to the West Hawaii Power Facility, we confirm that the facility site is within the State Land Use Agricultural District. However, based on Figure 1, it is unclear where the boundaries of the facility site are in relation to the County's landfill site (Do they overlap? Are they adjacent to one another?). We suggest that a map which clearly delineates the boundaries of the facility site be provided in the draft EIS.

   Additionally, due to the illegibility of the surrounding Land Use District boundaries, particularly in regards to the northern portion of the map, we suggest that a map with clearer boundary representations be included in the draft EIS.

3. With respect to the Keahole Generating Station Expansion and Proposed Meteorological Tower EA's, we confirm that both sites, identified as TMK No.: 7-3-49:36, are designated within the State Land Use Conservation District. We suggest that the draft EIS's for both projects include a map showing the sites in relation to the State Land Use Districts.

   For your information, the Office of State Planning has filed a boundary amendment petition with the Commission (LUC Docket No. A92-685) for State-owned lands immediately surrounding the parcel on the mauka side of Queen Kaahumanu Highway for urban expansion.

We have no other comments to offer at this time. Thank you for the opportunity to review this matter.

Should you have any questions, please feel free to contact me or Bert Saruwatari of our office at 587-3822.

Sincerely,

Bert Saruwatari

for ESTHER UEDA
Executive Officer

EU:th

cc: Al Lono Lyman
Clyde H. Nagata

Engineers
Planners
Economists
Scientists

January 12, 1993

PDX33045.DO

Ms. Esther Ueda, Executive Officer
State of Hawaii
Department of Business, Economic Development & Tourism
Land Use Commission
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813

Dear Ms. Ueda:

Subject: Environmental Impact Statement for the Keahole-Kailua 69 kV Transmission Line Project

This is in response to your letter of November 20, 1992 to the State of Hawaii Department of Land and Natural Resources.

The Environmental Impact Statement (EIS) will contain a regional "Land Regulation" map showing the State Land Use Agricultural, Conservation, and Urban Districts and a separate regional map showing the seven alternative corridors.

A map showing the State Land Use districts and all seven alternative corridors is attached for your information. This letter and the accompanying map will be made a part of the EIS.

Please feel free to contact Bennett Mark, Assistant Project Manager, or myself at 943-1133 should you have any questions concerning the EIS for this project.

Sincerely,

CH2M HILL

Albert L. Lyman
Senior Project Manager

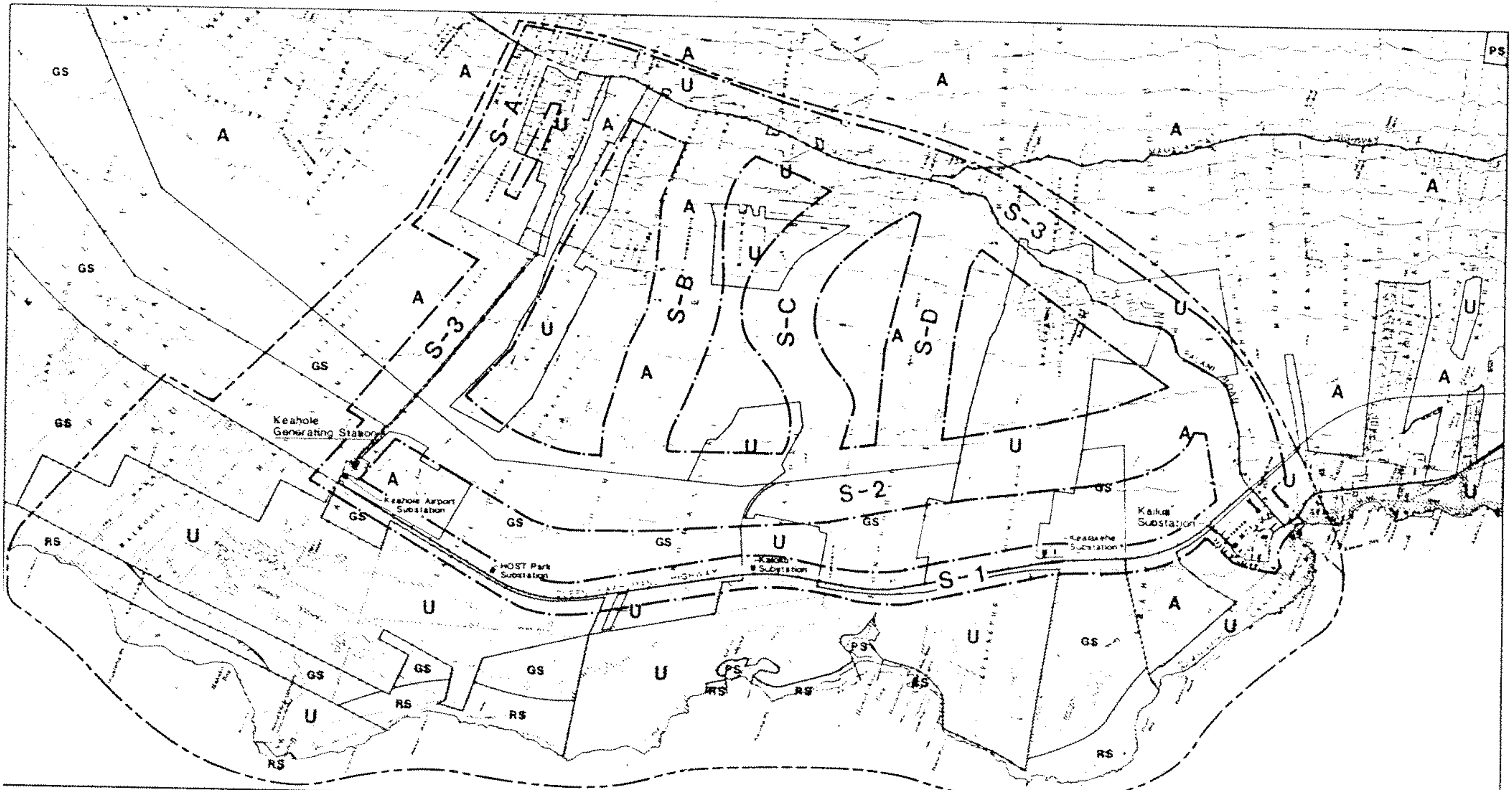
BM/dsr

Attachment

Honolulu Office
HNL71/004.51

1585 Kapiolani Blvd., Suite 1312
Honolulu, HI 96814-4530

808.943.1133
FAX 808.941.8225



Study Area Boundary
Corridor Boundary
Power Facility
Switching or Substation
69 kV Line

STATE LAND USE CLASSIFICATION

A Agricultural District

U Urban District

Conservation District

PS Protected Subzone

GS General Subzone

RS Resource Subzone

County Special Management Area

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

Hawaii Electric Light Company, Inc.

LAND REGULATION

NORTH 0 2000 4000 8000 FEET 0 .5 1 MILE

FIGURE

JOHN WAIHEE
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813
Telephone: 587-3822

January 25, 1993

Mr. Albert L. Lyman
Senior Project Manager
CH2M Hill
1585 Kapiolani Blvd., Suite 1312
Honolulu, Hawaii 96814-4530

Dear Mr. Lyman:

Subject: Environmental Impact Statement (EIS) for the Keahole-Kailua 69 kV Transmission Line Project

We have received your letter dated January 12, 1993 responding to our comments of November 20, 1992 regarding the EA for the subject project.

We have reviewed the Land Regulation map showing the State Land Use Districts and the seven alternate corridors. It appears that the map does not include the urban areas redistricted under LUC Docket Nos. A87-618/Isemoto Contracting Co., Ltd., SJA Partnership, and March E. Taylor; A89-646/Liliuokalani Trust, and A91-665 Kamaaina Eight. We suggest that clarification on the location of these areas be obtained from our office during the preparation of the draft EIS.

Should you have any questions on this matter, please feel free to call me or Bert Saruwatari of our office at 587-3822.

Sincerely,

ESTHER UEDA
Executive Officer

EU:th

cc: Don Horiuchi, DLNR

Engineers
Planners
Economists
Scientists

March 19, 1993

PDX33045.D1

Ms. Esther Ueda, Executive Officer
State Land Use Commission
Room 104, 335 Merchant Street
Honolulu, Hawaii 96813

Dear Ms. Ueda:

Subject: Environmental Impact Statement (EIS) for the Keahole-Kailua 69 kV Transmission Line Project

This is in response to your letter of January 25, 1993 regarding the revisions necessary to our Land Regulation Map. We met with Bert Saruwatari of your office on January 27, 1993 and have reviewed the areas that had been redistricted. The maps in the draft EIS that we are preparing have been revised to reflect the changes.

Thank you for your assistance. If there are any questions please call me at 943-1133.

Sincerely,

CH2M HILL

Al Lono Lyman
Senior Project Manager

CH2M HILL
HNL71/020.51
Honolulu Office
1585 Kapiolani Blvd., Suite 1312
Honolulu, HI 96814-4530
808.943.1133
Fax 808.941.8225

WAIMANA ENTERPRISES, INC.

October 26, 1992

Department of Land and Natural Resources
Office of Conservation and
Environmental Affairs
1151 Punchbowl Street, Rm. 131
Honolulu, Hawaii 96813
Attn: Mr. Don Horiuchi

Re: HELCO's Applications for meteorological tower & transmission line

Dear Mr. ~~Horiuchi~~ Don:

Waimana Enterprises, Inc. respectfully request to be a consulting party and participate in the preparation of the Environmental Assessment and/or Environmental Impact Statement in the following HELCO applications:

(1) Keahole Generating Station Installation of Meteorological Tower; and

(2) Keahole-Kailua Transmission Line.

Thank you for your attention to this matter.

Truly Yours,

Sandie

Sandra-Ann Y.H. Wong

RECEIVED
'92 OCT 27 PM 1:11
DLNR
OCEA

Pauahi Tower Suite 1520 • 1001 Bishop Street • Honolulu, Hawaii 96813
(808) 599-4441 Facsimile (808) 599-4653

Engineers
Planners
Economists
Scientists

January 12, 1993

PDX33045.DO

Sandra-Ann Y.H. Wong
Waimana Enterprises, Inc.
Pauahi Tower Suite 1520
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Ms. Wong:

Subject: Environmental Impact Statement for the Keahole-Kailua 69 kV Transmission Line Project

This is in response to your letter of October 26, 1992, to the State of Hawaii Department of Land and Natural Resources requesting to be consulted party in the preparation of the Environmental Impact Statement (EIS). As you have requested, you will be included as a consulted party.

Please feel free to contact Bennett Mark, Assistant Project Manager, or myself at 943-1133 should you have any questions concerning the EIS for this project.

Sincerely,

CH2M HILL

Albert L. Lyman
Senior Project Manager

BM/dsr

Honolulu Office
HNL71/002.51

1585 Kapiolani Blvd., Suite 1312
Honolulu, HI 96814-4530

808.943.1133
FAX 808.941.8225

File:KOC1012.DOC

KONA OUTDOOR CIRCLE

76-6280 Kuakini Highway
Kailua-Kona, Hawaii 96740

12 October 1992

Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Attn: Mr. Don Horiuchi

Dear Sir:

Subject: Keahole-Kailua Transmission Line

The Kona Outdoor Circle (KOC) wishes to be a consulted party for the subject EIS. As the KOC is dedicated to keeping Kona "clean, green and beautiful", we are vitally concerned about additional degradation of the view plane along the Queen Kaahumanu Highway for both residents and visitors coming to Kailua-Kona.

This view plane between the Keahole Airport and the Kailua Substation is vital, not only for today, but the future developments planned (K to K plan along the makai side and the Queen Liliokolani development along the mauka side) adjacent to this portion of the Queen Kaahumanu Highway. The number 2 alternative, "underground pipes containing cables ....", is clearly the most environmentally benign.

An additional alternative (No. 4) would be even more desirable and that would be to relocate the existing overhead 69 KV transmission line to the underground trench with the new line. Would you kindly pass this request to HELCO for their consideration?

Simple construction cost estimates for the three (or four) alternatives do not provide the public with information that would allow them to take an informed position on any alternative. It would be more helpful if the alternatives were estimated also in terms of the projected rate increases for each class of rate payer.

Will these figures be made available?

Your consideration of this request is appreciated.

Sincerely,

Nan Madson

Nan Madson, President
Kona Outdoor Circle

cc. OEQC, HELCO, [redacted]

CH2M HILL
Engineers
Planners
Economists
Scientists

January 12, 1993

PDX33045.DO

Nan Madson, President
Kona Outdoor Circle
76-6280 Kuakini Highway
Kailua-Kona, Hawaii 96740

Dear Ms. Madson:

Subject: Environmental Impact Statement for the Keahole-Kailua 69 kV Transmission Line Project

This is in response to your letter of October 12, 1992 to the State of Hawaii Department of Land and Natural Resources requesting to be a consulted party in the preparation of the Environmental Impact Statement (EIS). As you have requested, you will be included as a consulted party.

This EIS will discuss visual resources, the view planes you mention in your letter, and possible view impacts on future developments.

The transmission line alternatives, including the underground alternatives, will be discussed in the EIS, along with each alternative's cost estimate.

The cost of electrical service which is passed on to each ratepayer, is regulated by the State of Hawaii Public Utilities Commission (PUC). Hawaii Electric Light Company (HELCO) must charge each ratepayer in accordance with the rates set by the PUC. A discussion of the role and the method by which the PUC sets rates, and the factors which it must consider when setting rates, will be included in the EIS.

This discussion will relate the cost estimate for each alternative and how each alternative's cost may be passed on to the individual ratepayer.

Honolulu Office
HNL71/003.51

1585 Kapiolani Blvd., Suite 1312
Honolulu, HI 96814-4530

808.943.1133
FAX 808.941.8225

Please feel free to contact Bennett Mark, Assistant Project Manager, or myself at 943-1133 should you have any questions concerning the EIS for this project.

Sincerely,

CH2M HILL

Albert L. Lyman
Senior Project Manager

BM/dsr

Engineers
Planners
Economists
Scientists

March 30, 1993

PDX33045.D1

Nan Madson, President
Kona Outdoor Circle
76-6280 Kuakini Highway
Kailua-Kona, HI 96740

Dear Ms. Madson:

Subject: Keahole-Kailua 69 kV Transmission Line Project

This letter responds to your request for information about the relative costs and rate impacts of underground and overhead alternatives for the proposed Keahole-Kailua 69 kV Transmission Line Project.

HELCO estimates that:

- Overhead alignment would cost approximately $2,500,000
- Placing the new line underground would cost $11,900,000
- Placing both existing lines (69 kV and 12 kV) and the new line underground would cost $16,700,000

It is very difficult to estimate the effect on rates of individual construction projects. Rates are established based on HELCO's total company costs. The total company costs are comprised of some costs which are increasing and other costs which are decreasing. The impact on rates of a specific project will vary over the life of the project. Also, please keep in mind that the costs will be borne by all HELCO ratepayers, regardless of whether or not the ratepayers are served by these lines.

However, the following estimates are provided for comparison purposes. At the same time that other factors are increasing or decreasing billings, this new overhead line will increase a 600 kwh residential bill by $.26 per month. Based on the same assumptions, placing the new line underground will have an incremental impact of approximately

$1.06 per month. Placing the new line as well as the existing 69 kV and 12 kV lines underground will have an incremental impact of $1.49. These monthly costs are averages over the life of the line and are only one factor which affects your rates. Also, these estimates do not include costs of operating and maintaining the lines.

If you have any further questions, please feel free to contact Bennett Mark, Assistant Project Manager, or myself at 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Mr. Lagundimao/HECO
Mr. Tanigawa/HELCO