July 2000 (DEIS)
Keopuka Lands Vol. II

KEOPUKA LANDS

Kona Coast   Island of Hawai'i

DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDICES
Volume 2 of 2

Pacific Star LLC
July 2000

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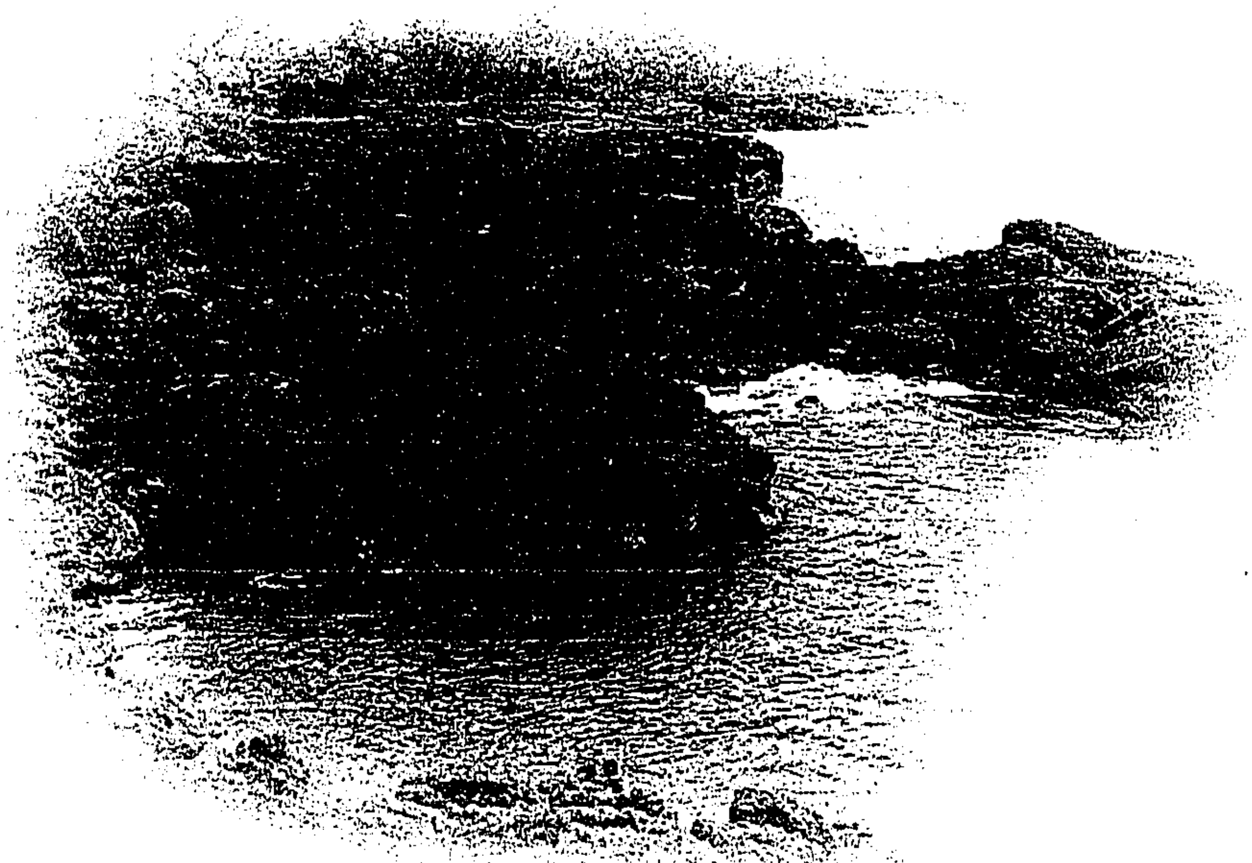

DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDICES
Volume 2 of 2

Pacific Star LLC
July 2000

KEOPUKA LANDS

Kona Coast   Island of Hawai'i

DRAFT ENVIRONMENTAL IMPACT STATEMENT

This document is submitted pursuant to
Chapter 343, Hawaii Revised Statutes

Prepared for Pacific Star, LLC

Prepared by PBR HAWAII

Submitted by:

Wm. Frank Brandt, FASLA, President
PBR HAWAII

July 12, 2000

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APPENDIX A

Agricultural Report

AGRICULTURAL MANAGEMENT PLAN

FOR

KEOPUKA LANDS

Prepared by:
Agricon Hawaii LLC
P.O. Box 95
Kamuela, HI 96743

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History: Agriculturally, the Keopuka Lands were originally used as pasture for cattle, where there was vegetation. Cattle operations ceased approximately 30 years ago. In addition macadamias, avocados, mangos, and coffee were planted in the mauka section and are still cultivated in a casual manner. The property was previously owned by Mr. and Mrs. Fred Richards. Mrs. Richards was a member of the Greenwell family and the Richards acquired the land from her family. The Richards sold the land around the time the cattle operations ceased.

The mauka portion of the property contains approximately 30 acres of avocado, macadamia, mango, and coffee. All but 10 acres of macadamia are not presently under commercial cultivation. The lands below the macadamia orchards are thick with brush, primarily Christmas berry. As the elevation declines, rainfall diminishes, and the soils change to a'a and pahoehoe lava, the vegetation thins to primarily bare lava.

The macadamia orchards are currently maintained by four farmers, Sanford Higashi, George Hirai, Wayne Kukita, and Canscio Acol. Chemical cultivation practices are primarily herbicide spraying with Roundup to control weeds and fertilizing with varying formulas and amounts of a nitrogen-phosphorus-potassium fertilizer. Higashi also applies dolomite (calcium and magnesium) every third year. The balance of the operations, such as tree pruning, brush removal, and harvesting are accomplished by hand. Fences were installed around the macadamia orchards to keep the pigs out. These fences have not been maintained and are currently not effective.

Identification of Soil Types and General Climate Conditions

Soil Types:
The soils in the upper one-half of the property are organic soils and volcanic ash over a'a lava and dense rock. This section of the property contains macadamia, coffee, avocado and mango. Only the macadamia orchards are maintained as commercially viable operations. These crops transition into Christmas berry, ohia, kukui, Guinea grass, koa haole and various weed species including morning glory and lantana.

The classifications for these soils are:

- Kainaliu extremely stony silty clay loam, 12 to 20 percent slope.
- Kaimu extremely stony peat, 7 to 25 percent slope.

The soils in the lower one-half of the property are pahoehoe and a'a lava with small pockets of organic matter deposited by decaying plants. Vegetation is sparse.

The classifications for these soils are:

- Lava flows, A'a.
- Lava flows, Pahoehoe.

Climatic Conditions:
The rainfall in this area varies from approximately 50 inches at the upper boundary to 15 to 25 inches at the shoreline. Due to the recent drought conditions actual rainfall has been much lower. In the current year there has been no recorded rainfall as of May 4, 2000.

The normal winds in this area are typical of the Kona district with distinct day and night patterns. The daytime winds usually are light (0 to 10 miles per hour) and somewhat variable but with a prevailing west to east on shore direction. The night winds generally flow from east to west down the slope and are light (0 to 5 miles per hour). During the winter low-pressure systems occasionally can increase the wind velocity to in excess of 50 miles per hour. These strong winds are generally associated with storm systems that affect the entire state. The direction of these storm winds is usually southerly and/or westerly.

Solar patterns for the property vary according to elevation. The upper elevations are usually clear and sunny in the morning with cloud cover by mid-day. Skies become clear again with sunshine by late afternoon. At the lower elevations (500 feet to sea level) clear skies and sunshine are predominant.

Agricultural Requirements for Farming Macadamia and Managing Open Space/Buffer Areas

Agricultural Requirements for Farming Macadamia

Soil: Commercially productive macadamia trees require a soil structure of sufficient permeability that promotes root development and water percolation through the soil. Nutrient rich soils are an advantage, however, nutrients can be provided with the use of commercial fertilizers.

Water: A well-distributed annual rainfall of between 60 and 70 inches is required to grow macadamia trees that produce a commercial crop. Where rainfall is below this level, irrigation will be required. The macadamia tree is very tolerant of drought conditions. However, production can decrease by as much as 50% and insect damage will increase when the availability of water is insufficient.

Fertilizer: In most areas, the application of a chemical or an organic fertilizer 4 to 6 times per year to the soil under the macadamia trees is required. Rates of application vary with the age of the tree. Generally, application rates increase with tree age.

Weed Control: Throughout the year grass and weeds under the trees and in other areas within and around the perimeter of the orchard must be controlled. Grass and weeds under the trees hinder harvesting and can compete for nutrients and water. Although most grasses grow poorly under the shade of the trees, weeds will grow prolifically.

Weed control is generally accomplished by the application of herbicide such as Roundup in conjunction with mowing. In very rocky orchards and in mature orchards, mowing is normally not an alternative.

Pest Control: Pigs, rats and insects are the main pests that impact macadamia production. Pigs are controlled by fencing or hunting. Rats are controlled by the use of bait blocks of various compositions placed along orchard edges. The Eaton Bait Block is the most effective. Zinc phosphide is the only infield rat poison cleared for use in macadamia. It is no longer used by the macadamia industry due to the materials poor long-term control of rats. The most effective time to apply rat poison in any form is between crop cycles when nuts are scarce. Insects are best controlled through sanitation within the orchard and around the perimeter. This is best accomplished by controlling weeds with mowing.

The primary insects that impact macadamia production are tropical nut borer (*Hypothenemus obscurus*), southern green stink bug (*Nezara viridula*), koa seedworm (*Cryptophlebia illepida*), and litchi fruit moth (*Cryptophlebia ombrodelta*).

Pruning: Sucker pruning of trunk suckers prevents a diversion of tree nutrients to these non-productive branches on the tree. These suckers normally grow from the trunk below the graft and are therefore not genetically true to the grafted variety.

Following harvesting the tree is pruned to remove low branches that interfere with orchard cultivation and to remove any branches that have the potential to compete with the central trunk. Material removed through pruning is either removed from the orchard or chipped on site to add organic matter to the orchard floor.

Leaf Blowing: Leaves that fall from the tree throughout the year must be blown out from under the tree canopy prior to the harvest season in order facilitate harvesting. These leaves can be blown into the rows between the trees and used as compost.

<u>Agricultural Requirements for Managing Open Space/Buffer Areas</u>

Weed Control: Unwanted weed, brush, and grass species should be eliminated where it is practical as seeds from these plants will spread throughout the property and these unwanted plants will compete for space with desired plant species. This condition will be enhanced with the introduction of irrigation to the property. A combination of mechanical and chemical control should be used.

Pest Control: Rats and feral animals, such as mongoose, cats, goats and pigs, should be controlled to the extent practical. Rats eat the seeds of native plants. This retards or prevents natural propagation these native plants. Rats can be trapped or poisoned with bait. Feral cats are major predators of both exotic and native birds, and carry diseases that can infect domestic cats. Feral cats should be trapped and taken to the Humane Society. Goats and pigs destroy both native and domestic plants and are very detrimental to the propagation of any plant species in areas that are not protected by fences.

Goats and pigs should be trapped or hunted. Other plant pests, such as insects, are usually specific to a species. However, plant pests should not be a problem in the open areas and buffer zones.

Plant Dissemination: Native plants adapted to the area should be planted where feasible to provide shade, attractive greenery and flowers. Native species that are adaptable to the climate and soil types on this property are numerous, and many of these are available for purchase in local nurseries as well as in the State nurseries. Exotic trees and bushes can be planted, either mixed with native plants or in selected and separate locations. The selection of suitable species will be dependent upon the overall master plan for the property.

Water: For the commercial production of any crop, including the existing macadamia, a water source for irrigation is required. For the establishment of plants in open space areas and buffer zones, irrigation will be required until root systems adequately develop to allow these plants to survive on rainfall. As an alternative to an irrigation system, plants can be planted with deliquescent materials that will hold water in the soil around the root system for a limited period of time. Watering to supplement rainfall can be provided by hand with a tank truck. However, the preferred method of providing water on a temporary basis is with the installation of a drip irrigation system. Water storage can be provided with small tanks or 50-gallon drums. Drip irrigation systems can be operated with battery or solar powered timers.

<u>Agrichemicals Used in Farming</u>

The agrichemicals used in the commercial farming of macadamia are listed below. The agrichemicals used for plants designated for open space areas and buffer zones will be dependent upon the species called upon in the master plan. Generally, the agrichemicals listed below will cover the open space areas and buffer zones requirement.

Herbicides:

- Roundup Ultra. Mfg. Monsanto Company. Active ingredient: Glyphosate, N-(phosphonomethyl) glycine, in the form of its isopropylamine salt - 41%.
- Amine 4. Mfg. Platte Chemical Company. Active ingredient: Dimethylamine salt of 2,4-Dichlorophenoxyacetic acid - 46.5%.

Additives (used with herbicides):

- Brewer Excel 90-NF. Mfg. Brewer Environmental Services. Active ingredients POE Nonylphenol - 55%. Isopropanol - 4.5%.

Fertilizers:

- N-P-K (Nitrogen-Phosphorus-Potassium) mixed dry blended fertilizers. Mfg. ConAgra Fertilizer Company. Typical composition: 2% to 28% total Nitrogen as N. 6% to 25% Phosphorus as P205. 3% to 30% Potassium as K20.

- Granusol 2GB-5 (sometimes uses with N-P-K fertilizers to provide micronutrients). Mfg. American Minerals. Composition: 38% to 39% Calcium Carbonate. 9% to 10% Iron Oxide as Fe. 9% to 10% Magnesium Oxide. 8% to 9% Copper Oxide as Cu. 8% to 9% Manganous Oxide as Mn. 6% to 7% Zinc Oxide. 3% to 4% Silicon Dioxide as Si02 (Quartz). 1% to 2% Strontium Oxide. 1% Aluminum Oxide.

Pesticides (rat poison):

- Hopkins Zinc Phosphide Pellets. Mfg. Hopkins Company. Active ingredient: Zinc Phosphide, percentage unknown.

- Eaton Bait Block. Mfg. Eaton Company. Active ingredient: Diaphinon 99%.

Notes on Agrichemicals:

- Roundup is the preferred herbicide for weed control in macadamia. It is safe to use. It is systemic (translocates to the roots to kill the entire plant), which allows for minimal use of the material. It is not residual. The active ingredient of Roundup is adsorbed (adhesion by electrical charge) by soil and organic matter rendering the active ingredient unavailable as a herbicide. Decomposition of the active ingredient takes place through microbial activity within the soil and organic matter. The residual elements are carbon, hydrogen, oxygen, nitrogen, and phosphate.

- There are numerous other agrichemicals cleared for use in macadamia that are not recommended for use in this area primarily due to the area's climate and soil types.

<u>Best Management Practices for Farming Macadamia and Managing Open Space/Buffer Areas</u>

<u>Best Management Practices for Farming Macadamia</u>

Planting: Selected varieties of excellent nursery grown grafted seedlings should be used in any replanting or new planting. The selection of the macadamia varieties should be done based on adaptability of the variety to the soil and climate conditions of the area and to general productivity. The tree holes should be large enough to accommodate root growth and are to be filled with a cinder/soil/macadamia husk mix to provide adequate media around the roots. Water should be available immediately to the root system.

Tree Spacing: In new plantings tree spacing should be adequate to allow sunlight to penetrate to the ground and for adequate air circulation within the tree branches. A spacing of 30 feet by 30 feet between trees and rows is recommended.

Fertilization: An N-P-K fertilizer should be applied four times per year for older trees and six times per year for young trees. The application should be made during periods when there is reliable rainfall to dissolve the material into the soil. Micronutrients are added to the fertilizer mix once per year. Leaf tissue samples should be taken once a year for analysis to determine the specific nutrient formulas of the fertilizer needed by the trees for optimum growth and production.

Weed Control: The area within the tree rows (under the tree canopy) should be kept free of weeds and grass. This is done primarily to facilitate harvesting. Roundup is the herbicide recommended for this area. Application rates should be the minimum necessary to control weeds and grass. The standard application rate is 1/2% Roundup mixed with an additive (Excel 90) and water applied at approximately 60 gallons per acre. With regular application at low rates, the use of an herbicide can be kept to a minimum. Irregular maintenance allows the weed growth to get out of control and requires the application of Roundup at higher rates. The applicator must wear approved safety equipment and be completely conversant with the safe handling procedures of using Roundup. EPS's Worker Protection Standard must be followed in the application of all pesticides.

A thick grass ground cover should be encouraged to grow between the tree rows. This grass cover should be kept mowed to a height of 18 inches or less. Grass provides erosion control for the soil, protecting the soil from heavy rainfall or flooding by water flowing from areas mauka of the orchard. It both absorbs and slows down the rainwater if there is sheet flow. A ground cover also decreases water evaporation and adds organic matter to the soil as the mowed cuttings decay. As the orchard matures, a shade tolerant grass or other vegetative ground cover should be planted as the tree canopy filters out much of the sunlight.

The perimeter of the orchard should be kept free of weeds to reduce the impact of the perimeter area as a haven for insect and rats. Where possible it should be mowed to minimize the use of chemicals.

Water: In new plantings either irrigation or hand watering with a tanker should be done if rainfall is not adequate (one inch per week). Older orchards would benefit from irrigation both in better tree health and increased productivity. An irrigation system is recommended to achieve optimum nut production.

Pruning: Sucker pruning of trunk suckers prevents a diversion of tree nutrients to these non-productive branches on the tree. These suckers normally grow from the trunk below the graft and are therefore not genetically true to the grafted variety.

Following harvesting the tree is pruned to remove low branches that interfere with orchard cultivation and to remove any branches that have the potential to compete with the central trunk. Material removed through pruning is either removed from the orchard or chipped on site to add organic matter to the orchard floor.

Best Management Practices for Managing Open Space/Buffer Areas

The open space and buffer areas are defined as the coastal land in the Conservation District, approximately 39 acres, and lands immediately below the by-pass road, approximately 42 acres. The lands below the by-pass road would include highway and road edge, drainage areas, and buffer areas around the irrigation lake. The coastal lands will remain in their natural state, so the application of Best Management Practices to this area will generally be minimal.

Planting: Plants that are adapted to the areas should be planted. It is important that plants that are drought tolerant be selected. Where it is feasible and desirable, native plants should be selected for planting.

Weed Control: Noxious weeds should be removed where it is practical and a maintenance program established to control these weeds. Both chemical control with herbicides, such as Roundup and Amine 4, and mechanical control using weed-wacking (mechanical weed-eater) and mowing will be required. In some cases heavy equipment and/or chain saws may be required to remove exotics like Christmas berry. Tree and branch material removed should be chipped and used as mulch on the new plants. Planting competitive trees, bushes and grasses will minimize the time and work required in the control of noxious weeds.

In areas where selective removal of trees and brush is required, it is recommended that individual trees and brush be cut with a chain saw, the stump painted immediately with undiluted Roundup, and the material chipped in place to provide organic matter for the remaining vegetation.

Fertilization: Until plants become established a fertilizer program is recommended. This program will encourage faster root and foliage development.

Water: Initial watering is required if there is no rainfall. Plants should receive an inch per week of either rain or irrigation until they are established. The time required will vary with the plant species, but will generally be from three to six months.

Pest Control: Insect pests should not be a problem if plant selection is done based on climate and soil conditions in the area. However, pigs and goats will destroy the plants if these animals are not controlled. Trapping or hunting will be necessary. Rats will eat seeds generated by the plants as they mature and prevent the natural propagation of desired plants. Rats can be controlled with regular baiting.

Alternative Farming Practices That Would Reduce or Eliminate the Use of Agrichemicals

Alternative Farming Practices for Farming Macadamia

Weed Control: A shade tolerant grass or other shade tolerant ground covers can be planted in the tree rows under the tree canopy. This grass or ground cover should be mowed close to the ground to allow for nut harvesting. Once the nut drop begins, harvesting and mowing intervals would need to be timed to minimize nut damage that would be caused by mowers.

Some nutrient loss would occur due to the grass, but most of this would be regained in the decayed organic matter from the grass cuttings. Decreasing tree density and/or more aggressive pruning would be required to provide sunlight to the ground cover. The orchard perimeter must be constructed so that it can be mowed. This would eliminate any herbicide use.

Alternatives include plastic weed mats that are placed under the tree canopy. These weed mats allow water and nutrients to move through them, but prevent weed growth. The installation of weed mats is costly and not presently used in any commercial application on the island.

Mulching with macadamia husk and/or other mulch is an excellent practice, but will not control weeds for a sustained period of time unless mulch is reapplied at regular intervals. Mulching poses a problem for harvesting as the nuts are difficult to pick from the dense material.

Pest Control: Rats can be trapped thus avoiding the use of baits. This approach is considerably more costly than the conventional method of using rat bait.

There are no insecticides recommended for macadamia.

Alternative Farming Practices for Managing Open Space/Buffer Areas

Weed Control: The use of plant material and ground covers in the areas to be intensely maintained is a preferred method of controlling weed species by crowding them out. Hand weeding and mowing will be required as an alternate means of control. Weed mats can also be used in selected areas to control weeds while the plant material is expanding. Mulching with wood chips and/or composted materials, such as macadamia husk and green waste, is an effective method of decreasing weed growth. Mulching also adds organic matter to the soil, and helps decrease evaporation.

Pest Control: Rats can be trapped. Organic type pesticides, such as soaps and oils, are available to control insect pests on plants when necessary. Generally these soaps and oils will need to be applied more often than commercial pesticides.

Integration of the AMP with the Water Quality Monitoring and Mitigation Program for the Keopuka Project

The Agricultural Management Plan will be developed on an annual basis and the agricultural chemicals to be used in the macadamia orchards and the open space/buffer areas listed. The estimated time of application, if it is feasible, will be included. This list and timetable will be submitted for review by the water quality monitoring personnel for comment. If there are any chemical residual problems anticipated, a mitigation program will be done prior to chemical application. The water quality monitoring will test for the chemicals used on these areas.

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Information on agrichemicals obtained from product labels and Material Safety Data Sheets.

APPENDIX B

Water Resources Report

EVALUATION OF
WATER RESOURCES
FOR
THE LANDS OF KEOPUKA

South Kona, Hawaii

FOR:

PACIFIC STAR, LLC

PREPARED BY:

WAIMEA WATER SERVICES INC.
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April, 2000

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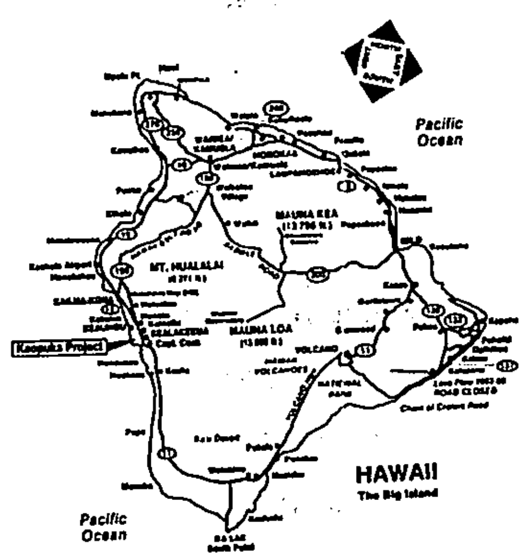
EVALUATION OF WATER RESOURCES LANDS OF KEOPUKA

1.0 INTRODUCTION

The 660-acre Keopuka project is located in the District of South Kona on the island of Hawaii (Exhibit A1 and A2). The maximum build out is expected to consist of 125 lots residential units and 100 lodge units and an 18-hole golf course with a clubhouse. The existing 30 acres macadamia nut orchard will remain in operation.

The lot sizes will range in size from 1 to 5+ acres. The majority of the lands consist of rough a'a and pahoehoe basaltic lava covered with native and introduced shrubs and scattered trees. Below an elevation of about 600', vegetation is nearly absent. Other than the golf course and its amenities (makai of the Mamalahoa Highway Bypass), the majority of the land will contain single home lots (A-5a). Agriculture will be minimal due to rough lava. Open space will remain along the shore.

LOCATION PLAN – ISLAND
EXHIBIT A1



PROJECT PLAN
EXHIBIT A2

1.1 RECOMMENDATIONS: (Summary)

1. An exploration irrigation well should be drilled at about elevation 900 feet just makai of the Mamalahoa Bypass entry. The water will be used for irrigation water for the golf course and agricultural areas.

2. A second irrigation well as noted in Exhibit G, Section 3.1, Irrigation Water, will be needed.

3. Reach an agreement with the Hawaii County Department of Water Supply to properly locate potable water sources and determine necessary system improvements. The potable source(s) should be located off site and be built in concert with the DWS system.

4. Use wastewater treatment plant effluent (R1) for blending with golf course irrigation water.

5. Establish a ground water monitoring program with near-shore monitor wells.

1.2 SITE DESCRIPTION

The proposed 660-acre project site is located south of Kealakekua and makai of Mamalahoa Highway (see Exhibit A2) in the ahupuaa of Keopuka between Onouli and Kaawaaloa. The lands are steeply sloping from mauka (elevation 1390') to makai (elevation 0').

1.3 WATER DEMAND

The estimated water demand for the project is outlined in Table 1 based upon the expected development units. The estimated water demand for this project is based on **the County standards of 400 gpd (gallons per day) average per housing unit.** The other unit numbers used are based on previous uses from similar facilities and activities.

For the purposes of this report, the figures in Table 1 will be used as the reference amounts for the estimated water demands. For definition purposes, (gpd) is gallons per day, (gpad) is gallons per acre daily, and (mg/l) is milligrams per liter.

The Hawaii County Department of Water requires a 16- hour day maximum demand of **600 gpd per water unit for well and system design purposes.** The owner plans on using many water conservation practices at the project such as reduced landscaping areas and indigenous plants.

ESTIMATED AVERAGE DAILY WATER DEMANDS AT BUILDOUT- TABLE 1

	UNITS (average)	TOTAL
POTABLE WATER		
125 HOUSING UNITS	400 GPD*	50,000 GPD
1 GOLF CLUB HOUSE	20,000 GPD	20,000 GPD
1 GOLF MAINT. BLDG.	2,000 GPD	2,000 GPD
1 SEWAGE TREAT. BLDG.	5,000 GPD	5,000 GPD
100 LODGE UNITS	400 GPD*	40,000 GPD
SUB-TOTAL		117,000 GPD
IRRIGATION WATER		
150 ACRES GOLF COURSE	6,000 GPAD**	900,000 GPD
20 ACRES COMMON LANDSCAPE	4,000 GPAD	80,000 GPD
75 ACRES AGRICULTURAL	2,000 GPAD***	150,000 GPD
SUB-TOTAL		1,130,000 GPD
TOTAL WATER DEMAND (DAILY)		1,247,000 GPD
TOTAL IRRIGATION WATER DEMAND		1,130,000 GPD

gpm - gallons per minute
gpd - gallons per day
gpad - gallons per acre daily
*County Design Standard
** - 30% higher during grow-in
*** - assuming drip irrigation

TABLE 1

The maximum daily demand for potable water, which is based on the average daily demand times 1.5, dictates the needed installed pumping capacity for potable wells. An amount of about 600 gpd for one housing unit is the maximum day amount used (400 gpd ave. daily use times 1.5).

MAXIMUM DAY POTABLE DEMAND – TABLE 2

POTABLE WATER	TOTAL AVE.*	MULTIPLIER	TOTAL
125 HOUSING UNITS	50,000 GPD	1.5	75,000 GPD
1 GOLF CLUB HOUSE	20,000 GPD	1.5	30,000 GPD
1 GOLF MAINT. BLDG.	2,000 GPD	1.5	3,000 GPD
1 SEWAGE TREAT. BLDG.	5,000 GPD	1.5	7,500 GPD
100 LODGE UNITS	40,000 GPD	1.5	60,000 GPD
SUB-TOTAL	117,000 GPD		175,500 GPD

* Totals from Table 1.

TABLE 2

There may be a need to increase the projected demand above the DWS standards. There are indications that the high end homes, when occupied, have a higher daily consumption than set forth in the DWS design criteria.

1.4 GEOLOGY AND HYDROLOGY (by Stephen P. Bowles, Island Resources Ltd.)

Water supply along the Kona coast is derived from two sources: direct rainfall catchment and by well tapping the groundwater lens. At the higher elevations above 1500', the rainfall is normally adequate to furnish a limited catchment supply. The only reliable water supply is from groundwater. There are no perennial streams in the project area.

The recharge percolates downward into the high level aquifer(s) mauka of the project, into the basal lens at sea level and thence to the sea (see Exhibit C2). Fresh groundwater floats on the underlying salt water in a ratio of about 1 to 40, i.e., for every one foot of fresh water head above sea level; there is approximately 40 feet of fresh water below sea level. The equation is modified by tidal and recharge fluctuations, which produce a thick brackish or transition zone between the fresh water and salt water (see Exhibit D). The head or water level of the lens slopes upward away from the shore (inland) at rates normally from 1 to 2 feet per mile. Near the shore, the lens is brackish, due to oscillations of the tide and seasonal variations in recharge rate of flow.

Recent (since 1990) discoveries of high level groundwater have been made mauka of Mamalahoa Highway. Water levels have been verified in several wells scattered from Kalaoa in north Kona to Kealakekua Bay in South Kona. Water levels in excess of elevation 350' have been verified by

pumping at wells at Keei mauka and above Higashihara Park at Honalo (Exhibit C3). At the observation well mauka of the Kona Hospital, a water level of 490 feet was reported. A production well (3155-02) is now under construction at that site and the water level has been confirmed at elevation 494 feet (10/92).

The production well at Halekii (3155-02) is presently in service in the DWS system. The discovery and confirmation of high-level groundwater at Kealakekua has markedly changed the interpretation of the water resources in the district.

Based on the estimated recharge, the seaward flow of groundwater should be approximately 11 mgd per mile of shoreline. This value was used originally to estimate the possible existence of fresh water in the basal lens. Hypothetically, the subject property (Hokuli'a) should have a groundwater flow of 23 mgd (2.25 miles of shoreline).

Discoveries made recently by the exploration well (Hokuli'a #3056-01) indicate that this groundwater flow value is greatly exaggerated. Based on general estimates from the exploration well water level of 3.8 feet and on preliminary water quality data showing total chlorides of about 340 mg/l, it must now be assumed that the groundwater flow through the property to the sea most probably does not exceed 4 to 6 mgd. The estimated groundwater flow appears to be more than adequate to support the irrigation water needs of the project.

Drilling of the exploration well has confirmed the existence of a major hydrogeologic boundary between the Hokukano exploration well (3056-01) at elevation 810 feet and the D.W.S. production well (3155-01) at elevation 1,780 feet near the Kona Hospital. Based on the water quality and water level data, it appears that the majority of the groundwater recharge is diverted away from the subject property. The high water level differential between the two wells in a distance of 1.5 miles indicates a geologic structure(s) of relatively low permeability.

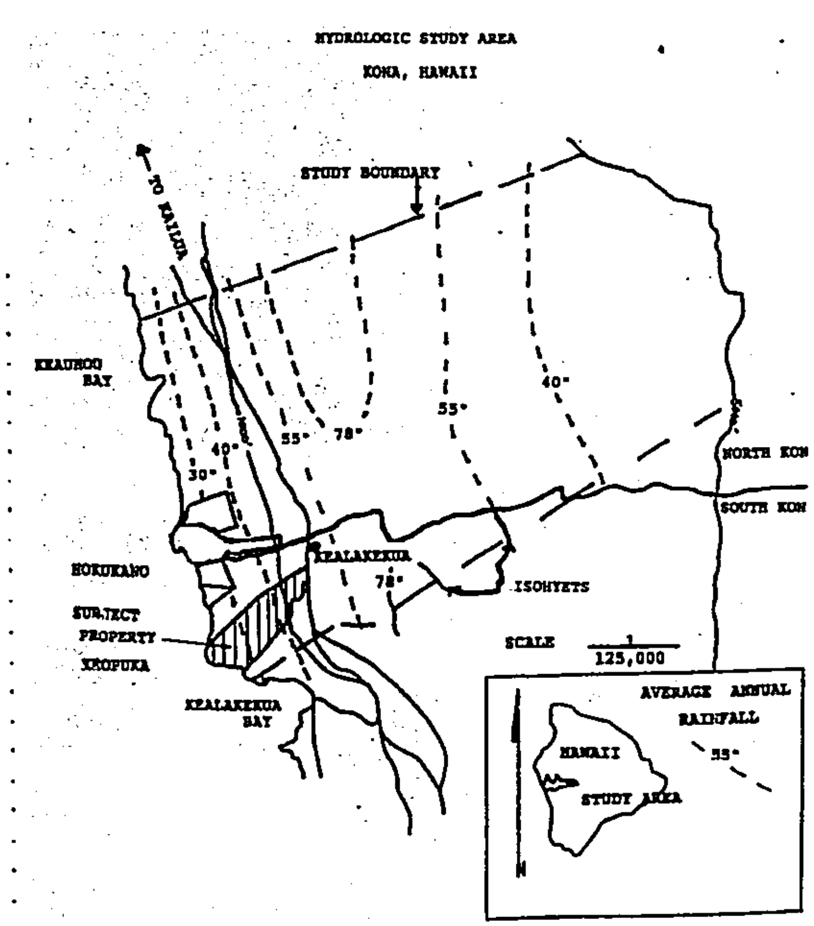
The existence of this geologic boundary has been clearly defined between Halekii (3155-01) and the irrigation well (3056-01) at Hokulia.

Recent offshore bottom surveys along the Kona coast (J.G. Moore, et al, 1989) have indicated that massive submarine landslides are in evidence along the Kona coast. Continuing studies of the landslides imply that on shore faulting is associated with the slides labeled Alika 1, and Alika 2 (in Exhibit C4). With the completion of the Hokukano well and the DWS Kealakekua well in 1992, it now appears that not only does on shore faulting exist, more than likely these faults in some way impede or divert the groundwater flow. Such a boundary is likely to be abrupt. Rarely are fault systems in Hawaii found to be boundaries in themselves. Most probably such faulting has caused either a major vertical displacement or tilting which results in subsequent lava flows having a steeper dip.

It seems probable that the hydrogeologic boundary is caused by steeply dipping younger lavas cascading over and veneering a fault scarp. There is no other evidence such as dikes, sills or other intrusives, even implied, which might cause a structural boundary. While the presentation above seems logical and certain, there is no conclusive evidence to support this hypothesis other than the fact that an abrupt hydrogeologic boundary occurs between the two wells.

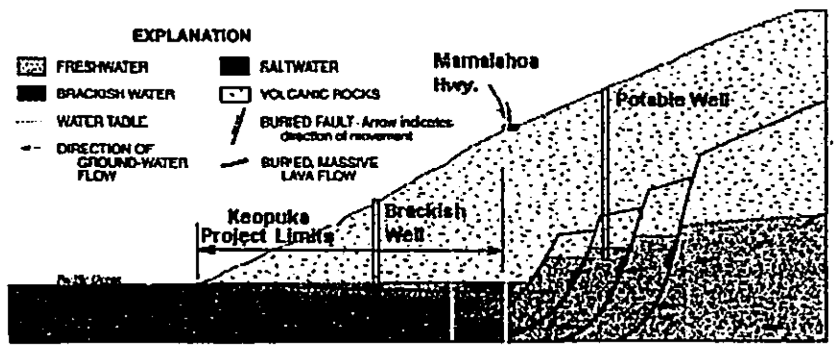
The existence of a fault boundary at Kealakekua Bay Uka was further validated with the drilling of DWS well 2753-03, just above Mamalahoa Highway in Keei (Exhibit C3). The well was drilled from an elevation of 1,347 feet and struck water at elevation + 381feet. The water level of the Keei well 2753-01, located makai of the highway stands at elevation + 2.8 feet. It is reasonable to expect that there will be similar geologic structures located at or just above the Keopuka mauka boundary at elevation 1400'.

RAINFALL WITH PROJECT SHOWN
EXHIBIT C1



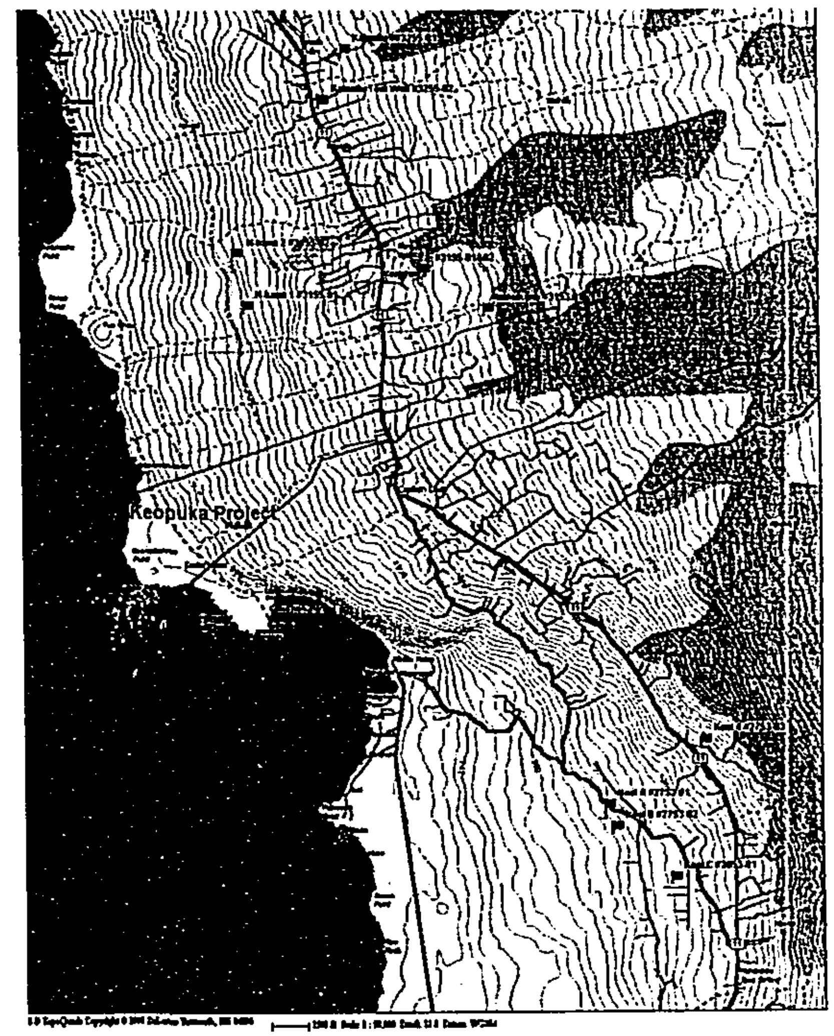
RAIN FALL IN PROJECT AREA (From S. Bowles study; August 14, 1990)

CROSS SECTION
EXHIBIT C2

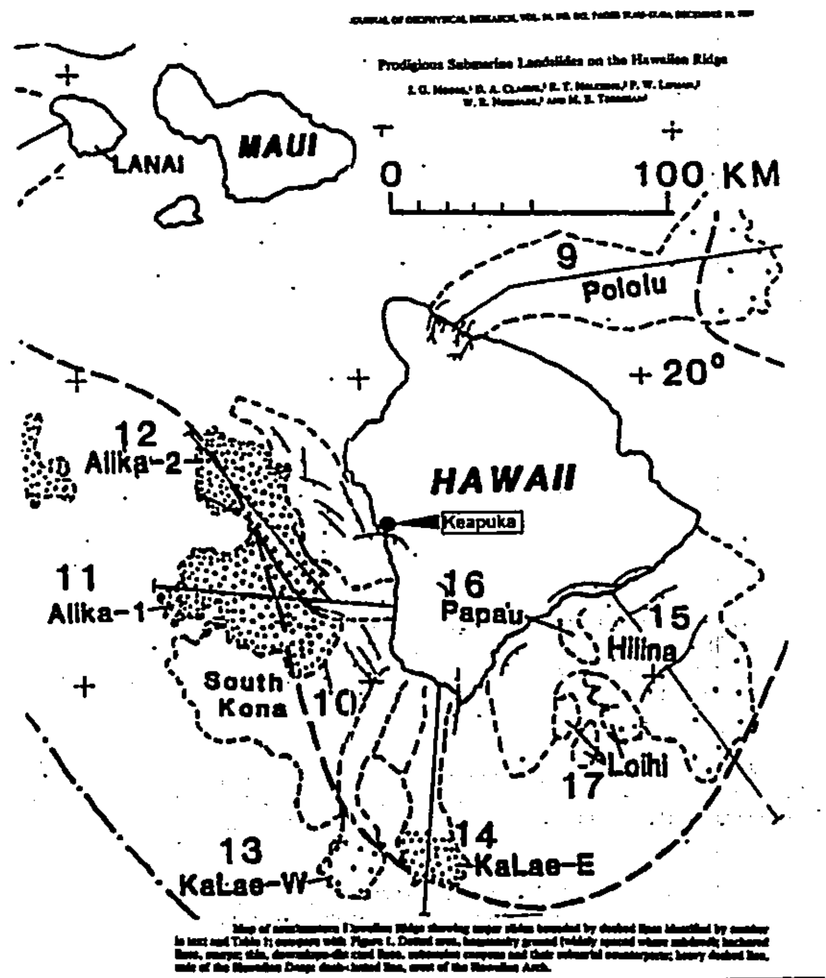


Schematic Cross Section (Modified from USGS Report 99-4073)

WATER WELLS IN AREA
EXHIBIT C3



SUBMARINE LAND SLIDES
EXHIBIT C4

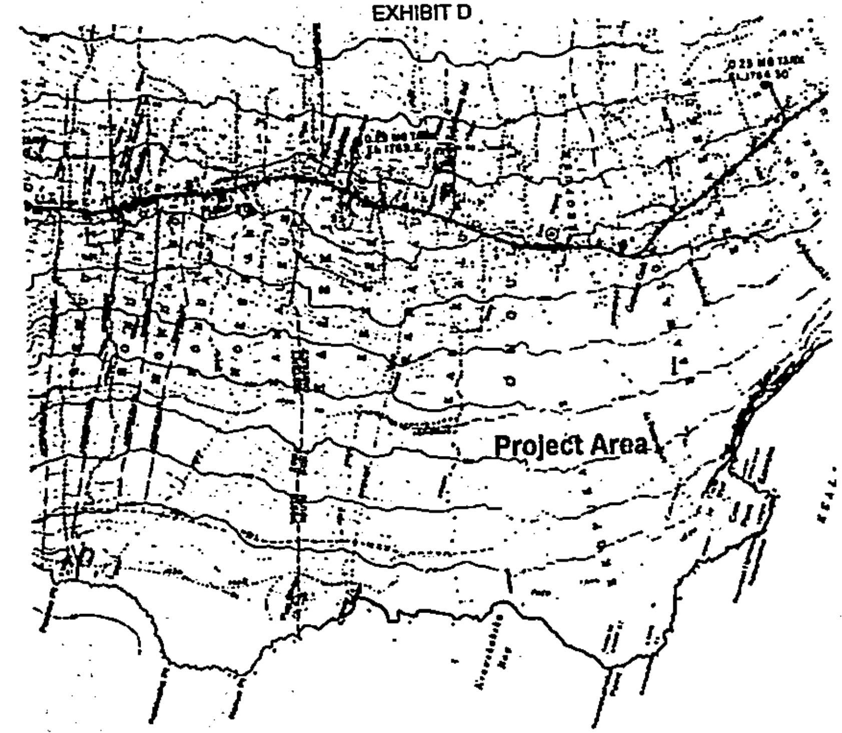


2.0 POTABLE WATER

2.1 REGIONAL WATER SYSTEM DESCRIPTION
COUNTY OF HAWAII

The County of Hawaii has a water system above the properties along Mamalahoa Highway and are identified as System 78 & 80 on the attached County map (Exhibit D). The pressure feed for this system is identified at the tank sites of 1763' elevation.

COUNTY WATER SYSTEM PLAN
EXHIBIT D



2.2 POTABLE WATER; WELL(S) OFF SITE

EVALUATION FOR SOURCES: In the review process for defining water sources the following criteria are used for setting parameters:

1. Resources
2. Land use and ownership as related to demands in the area, pollution potential and quality and quantity potential.
3. Infrastructure including power, road access, and water system access.
4. Design and regulation standards for water systems.

Based on Water resource studies by Island Resources Ltd., off site potable water wells in south Kona may be located between the elevations of 1500' to 1800 feet. New potable well sites will need to be located as to properly conform to the County water system (Exhibit D).

Exhibit (F) indicates locations of drilled, planned or permitted wells as recorded with the State Water Commission on Water Resource Management, the County or known development plans. This exhibit includes existing potable wells, existing non-potable wells, existing test or observation wells and those wells with permits applied for, or under construction.

WATER WELL MAP LOCATION
EXHIBIT F

Based on previous agreements by other developers with the Department of Water Supply, sources to be developed with the County of Hawaii as stand alone wells which are to be turned over to the County for operation and which use DWS transmission lines to transmit the water to the project site, 60% of the water will be dedicated for the County's use and 40% will be allocated to the project. Any additional well provided to the County would require only 10% of the wells production. This type of source development must be considered as part of this project. The water developed from the potable well source(s) to meet the demands noted in Table 1 will need to include the above ratio divisions.

Each new well site will require a well, pump, piping, power connection, controls, fencing, access, and, depending on location, storage tanks. Development costs must include these components.

DEMAND: Using the maximum daily demand per unit of 600 gallons per day for pump design purposes the demand balance for Keopuka is as follows:

Keopuka demand (Table 2)	175,500 gpd
DWS share @ 60%	263,250 gpd
Capacity required	**438,750 gpd**

PUMP CAPACITY: The required installed pump capacity using a 16 hour pumping day, assuming that the source is built with the allocation above, will be:

Keopuka	183 gpm
DWS	274 gpm
Total	**457 gpm**

2.3 TRANSMISSION LINES AND STORAGE

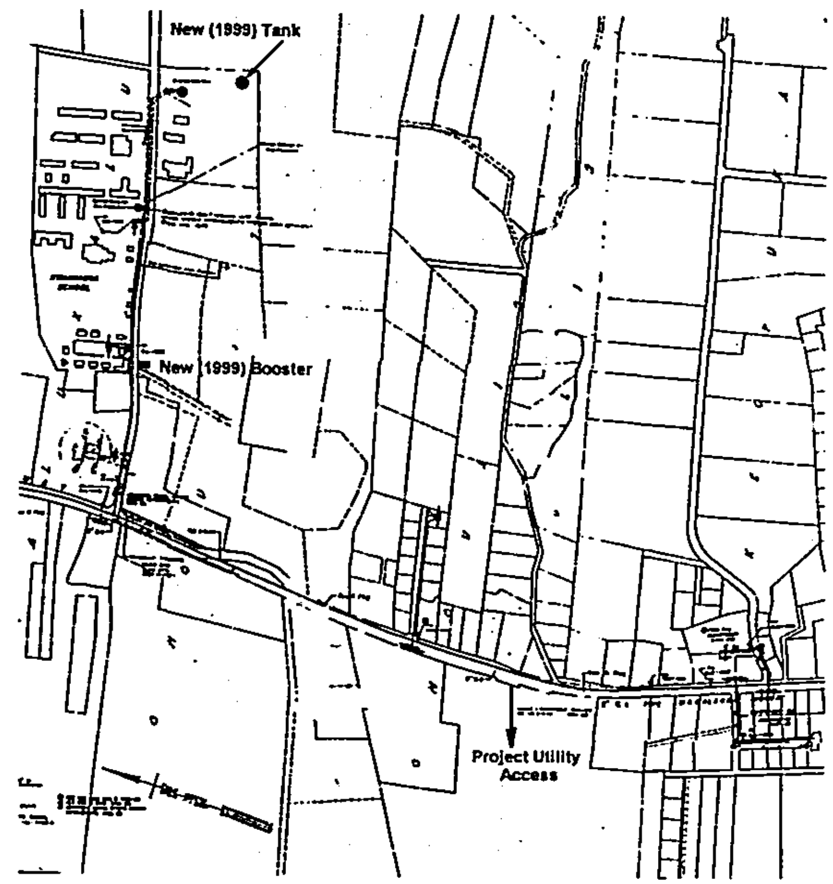
Improvements to the existing or planned transmission system may be required to support the project. The developer will likely be required to participate in the water system improvements along with other developers. In addition to potential well source costs, investment in the transmission system from the source to the project may be required.

Potable water well(s) may be located in the areas previously mentioned and the DOW may not have existing transmission capability to deliver the water from potential sources to the project. The timing of proposed water demands will be important in determining appropriate transmission improvements and investment. Adequate maximum day and peak hour storage may be required, both on site and off site, depending on the distribution system designs.

Fire flow for the project will also need to be included in the water system design. The needed storage to supply the required flow will be a factor in tank sizing and related land and construction costs. The land and tanks must be located above and within the project

on lands with the proper elevations. The actual siting of tanks within the project will be based on hydraulic service zones in order to meet the County standards and those of insurance underwriters.

TRANSMISSION LINE
EXHIBIT G



2.4 CONCLUSION:

Based on new county wells north and south of the project site, which have tapped the high level aquifer, there are adequate water resources in the region to meet the water requirements of Keopuka.

An additional water source to satisfy the remaining maximum day demand of 175,500 gallons per day potable water will need to be developed with the cooperation of the County Department of Water. A new well site most probably will be located above elevation 1400'.

The proposed pumpage rate would be 500 gpm or greater. Additional standby capacity may be required by the DWS along with appropriate system improvements.

3.0 IRRIGATION WATER

3.1 IRRIGATION WATER; WELLS ON SITE

On site golf course irrigation wells will be expected to produce water with chlorides ranging from 250 to 1,000 mg/l. The exploration well identified in section 2.3 further identified the water quality expected on the property. Water quality will also be effected by the elevation of well sites. The water quality from the exploration well pilot hole located at 800' elevation produced about 340 mg/l chloride water.

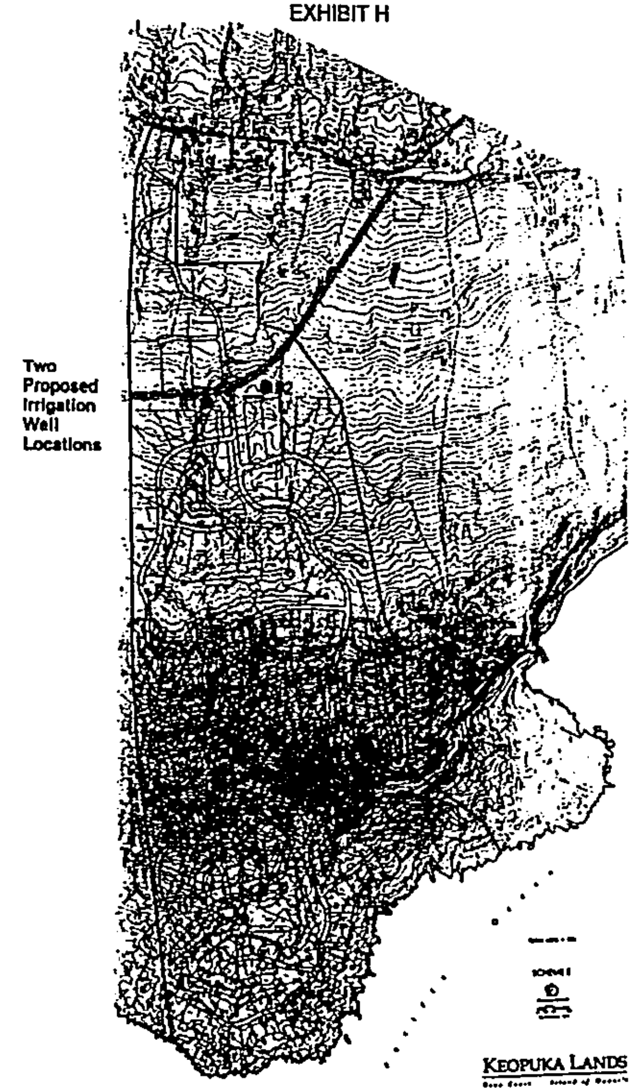
An additional well will be located as a result of the findings at the exploration well. This well location is noted in Exhibit I.

Table 3 expresses the chemical breakdown of two wells that may have similar characteristics to irrigation wells developed on the project property. Further water quality testing will be provided when the well is pump tested.

Plant types used on the project may be effected by the water quality used for irrigation. High salinity water cannot be used directly on bermuda grass. There are certain types of turf grass, which may be acceptable and are more salt tolerant. More exotic plantings will require fresher water. Water demands for plants requiring chlorides of 250 mg/l or less (fresh water) should be developed. Where feasible, landscaping with native or salt tolerant plants should be used.

With the information from the exploration well, quality data can further be defined. The developer may want to plant test plots of turf and other plant types on the property to determine the best use of grasses, plants and soil blends. A reduction in irrigation requirements might be achieved through the use of appropriate soils and soil additives.

IRRIGATION WELL LOCATION
EXHIBIT H



TYPICAL BRACKISH BASAL LENS WATER QUALITY- TABLE 3

ITEM	UNIT	HUALALAI WELL #3758-01 *	WAILEA WELL #9 **	HOKUKANO #3056-01***
Silicate	mg/l	68	30	
Calcium	mg/l	16	18	
Magnesium	mg/l	28	44.3	
Sodium	mg/l	261	790	
Potassium	mg/l		34.3	
Bicarbonate	mg/l	58		
Carbonate	mg/l	0		
Sulfate	mg/l	79	100	
Chloride	mg/l	480	850	340
Fluoride	mg/l	0.1		
Nitrate	mg/l	1.3	2.1	
TDS	mg/l	943	1790	650
Conductivity			2950	1270
pH		7.8	8.1	

* Chemical Quality of Ground Water in Hawaii, Report R48, USGS
** Brewer Analytical Laboratories, 11-17-89, Wailea Resort Company, Ltd.
*** Pilot hole test only, field tests

TABLE 3

Lake storage and transmission lines to the golf course from irrigation wells will need to identified and planned for. Efficient use of gravity irrigation could significantly reduce energy consumption and operating costs. Fire flow might also be incorporated into the storage and line sizing using irrigation water.

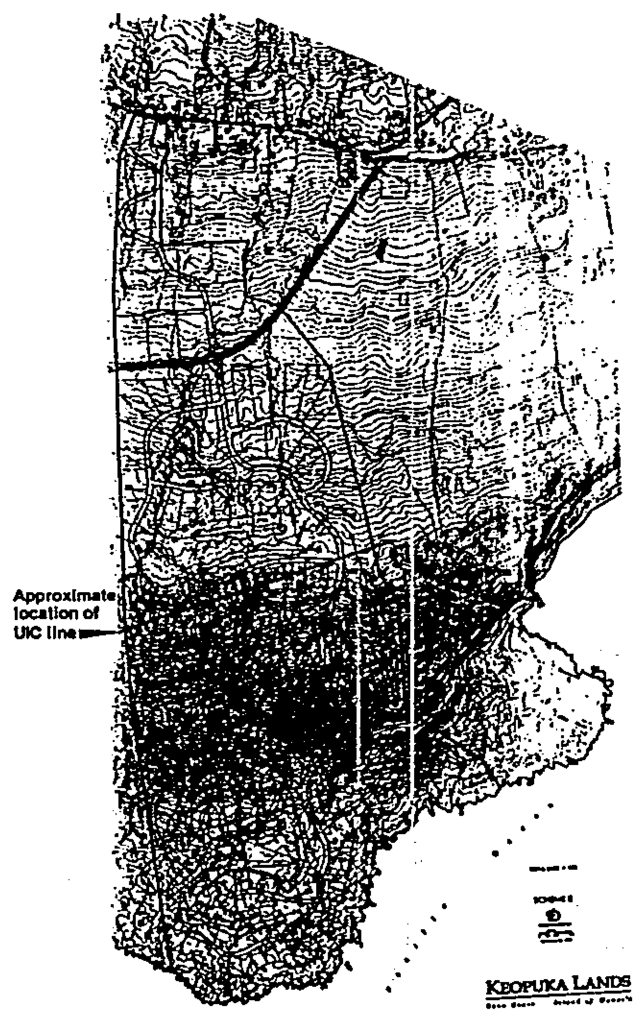
3.2 WWTP EFFLUENT

Waste Water Treatment Plant (WWTP) effluent may be a small but valuable source of irrigation water for this property. As indicated on Exhibit I, the lodge, clubhouse and driving range are in close proximity of one another and makai of the UIC (Underground Injection Control) line. This would indicate that waste water discharge does not require special permits. Regardless, the waste water from the clubhouse and lodge should be treated to an R1 grade (tertiary) and used to irrigate the general area including the driving range. Effluent is usually of sufficiently low salinity to be used for irrigation. The cost to bring water to the site will have been incurred in the drinking water supply making the use of effluent water as an irrigation resource economically viable.

WWTP (R1) effluent can also be used for irrigation of exotic plants. This water can be used directly or to blend with brackish water sources for irrigation.

Consideration should be given to the use of single lot aerobic treatment plants (R2). The discharge could either be disposed of onsite or collected for tertiary (R1) treatment processing and used for irrigation.

UIC LINE MAP
EXHIBIT I



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2. ________; 1992; EVALUATION OF WATER RESOURCES FOR HOKUKANO PROJECT; Waimea Water Services, Inc.; manuscript report for Oceanside 1250 Partners.

3. ________; 1998; DWS DISTRIBUTION PLATS; Maps of Department of Water Supply, County of Hawaii.

4. Oki, D.S.; 1999; GEOHYDROLOGY AND NUMERICAL SIMULATION OF THE GROUND-WATER FLOW SYSTEM OF KONA, ISLAND OF HAWAII; USGS Water Resources Report 99-4073.

5. Wolfe and Morris; 1996; GEOLOGIC MAP OF THE ISLAND OF HAWAII; USGS Map 1-2524-A.

APPENDIX C

Nearshore Marine Communities and Coastal Water Quality Report

STATUS OF NEARSHORE MARINE COMMUNITIES AND COASTAL WATER QUALITY FRONTING THE KEOPUKA LANDS PARCEL, SOUTH KONA, HAWAII

PRECONSTRUCTION BASELINE REPORT

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EAC Report No. 2000-09
Draft - April 2000

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EXECUTIVE SUMMARY

This study was undertaken to establish baseline conditions for the marine communities and water quality characteristics along a 1.6 km section of coastline fronting the proposed development of Keopuka Lands, South Kona District, Hawaii. This proposed development will take 660 acres extending from the coast to the Belt Highway at an elevation of about 1,400 feet and putting them into a 18-hole golf course and 125 agricultural lots along with a 100-unit member's hale, open space recreational area, and related infrastructure. Included in the development are approximately 39 acres (16 ha) open space element along the coastline. Identified environmental concerns include the potential impact of changes in (1) runoff and sedimentation during construction and (2) water quality due to the subsequent operation of the facilities on the adjacent marine communities and waters fronting the project site. Because of these environmental concerns, a marine life and water quality monitoring and mitigation plan has been developed. If accepted by the regulatory agencies, this plan should insure the environmental integrity of these resources. The current report provides the quantitative baseline against which the results of future monitoring will be compared. The approach is to focus monitoring on ground and nearshore marine water quality because most human generated pollutants that may compromise water quality and impact aquatic biota are from sources on land. If changes are noted in water chemistry, studies then focus on the aquatic biota to determine if impact is or has occurred. If impact has occurred, a mitigation plan is put into action. Through the annual cycle, routine monitoring will assess the status of both water quality and marine communities in the ocean fronting the project site.

This study has established baseline conditions in the waters fronting the project site (from just north of Keawekaheka Point on the north to the shoreline heiau near Cook's Point on the south) from shore to the 20 m (60-foot) isobath. In total more than 26.8 ha (66 acres) of nearshore waters were encompassed in this study; four zones or biotopes were identified in this area. These zones are: the biotope of sand which lies principally seaward of the project's study area, the biotope of *Porites compressa* at depths from 10 to 30 m, the biotope of *Porites lobata* found at depths between 6 to 15 m, and the biotope of boulders usually in water from 4 to 10 m of depth directly adjacent to the shoreline. Six permanently marked stations were established to sample benthic (primarily coral) and fish communities in these zones. Qualitative observations on the benthic and fish communities were carried out in December 1991. Hurricane Iniki impacted the marine communities along this coast in September 1992. In April 2000, a quantitative survey was completed and provides the baseline data on the status of marine communities prior to any construction on the project site.

In general the marine communities resident to the waters fronting the Keopuka project site are diverse and the fish communities do not show the declines in abundance to the degree often seen elsewhere along this coast in recent years. No unusual marine species or communities were noted in the study area. A major parameter in structuring Hawaiian coral and benthic communities is wave impact. Coral community development is greatest where exposure to occasional high energy (i.e., storm generated surf) is least. Much of the storm generated surf impinges on the West Hawaii coast from a NNW to WNW direction as occurred during Hurricane Iniki. Thus stations that sample communities exposed to these directions usually show poorer coral community development. Similarly, fish community development is greatest where shelter and food resources are best developed. The development of shelter is frequently correlated with the growth of coral, hence where coral development is poor, fish community development may mirror this. The results from some of the stations in this study reflect this. No endangered species were encountered in the study area, however humpback whales have been seen well-offshore of the site during previous (winter) field visits. Despite the fact that only one green sea turtle (a threatened species) was seen in the study area in the April 2000 survey, it is expected that turtles must, at a minimum, pass through the waters fronting the project site.

In the study area 28 sites were established to quantitatively assess water quality characteristics. All of these sites sampled marine waters. Nine of these sites were sampled in December 1991 and all were sampled in April 2000; both of these sample efforts were during dry or low rainfall periods. Rainfall is monitored daily on the adjacent project (at Hokuli'a) and if a high rainfall event occurs (i.e., 1.25 inches in 24 hours or greater) prior to the commencement of construction, sampling of all water quality sites will be undertaken which will provide water quality information under "wet" conditions.

Water quality in the nearshore marine environment is influenced by groundwater effluxing along the shoreline which results in gradients of concentration for certain dissolved nutrients. Because some nutrient species occur in relatively high concentration in groundwater and are near-absent in oceanic waters, a concentration gradient is established. Among the constituents showing these concentration gradients are nitrate nitrogen and silica. On the other hand, high biological activity in the shallow waters fronting the project site is probably the mechanism creating relatively high concentrations of ammonia nitrogen (which is a product of animal metabolism) encountered here. The diffuse groundwater percolation to the sea is most evident along the shoreline near the north and south boundaries of the project site and it results in geometric means for some parameters not meeting State Department of Health standards. Despite not meeting state standards for some parameters and sample sites, the waters fronting the Keopuka project site are typical of well-flushed, undeveloped West Hawaii coastal settings.

An analysis of sediment samples from the nearshore waters fronting the project as well as from a control site in Kealakekua Bay using a series of pesticide screens did not note the presence of any of the materials for which these test were done.

Over the last thirty years a number of West Hawaii coastal areas have been developed. Most of these developments include golf courses, resorts, residential and commercial areas as well as related infrastructure. Concern over impacts of these developments has resulted in several long-term monitoring programs being developed and implemented to insure the protection of water quality and aquatic resources. Perhaps the program with the longest continuous monitoring effort is at Waikoloa where golf course and resort development commenced in the late-1970's. A quarterly water quality monitoring program was implemented in the mid-1980's and has continued since that time. Twenty permanent stations in this program sample a broad crossection of water; from wells inland of the coastal development, through anchialine pools, wells and Hawaiian fishponds all adjacent to the development and out into the ocean fronting the Waikoloa project site. The program also collects samples from two undeveloped locations on the Kona coast to serve as control sites. Samples in this program focus on measuring water quality parameters identified by the Department of Health.

The results of the Waikoloa program show gradients of inorganic nutrients that have naturally greater concentrations inland and decrease due to dilution and uptake as groundwater moves to the shore; once in the ocean these concentrations fall to low oceanic levels with 100 m of the shoreline. Imposed on this are apparent anthropogenic inputs related to golf course, resort and residential development. These inputs are within the range of concentrations that are found at other locations on the West Hawaii coast that have no surrounding development. Measurement of these anthropogenic inputs through time showed them to have increased and then declined, probably in response to an increasingly careful golf course management regime. Quantitative studies on the aquatic species in anchialine pools at Waikoloa shows little change in abundance of these organisms which supports the contention that changes in water quality have had no lasting impact on the anchialine species in the system.

Results from ten years of monitoring the marine communities and water quality fronting the golf course and resort development at Hulopoe Bay, Lana'i have not detected any change in the water quality or abundance of marine species that can be attributed to the development. Changes observed have been related to natural events such as Hurricane Iniki in 1992 or to fluctuations in ammonia nitrogen due to the presence or absence of schools of fish. Thus, quantitative studies examining these and many other coastal developments in Hawaii have not detected the problems anticipated by regulatory agencies or the public. This is probably due to careful planning, construction and maintenance policies imposed by regulatory agencies on developments resulting in much less impact to aquatic systems today than may have occurred in the past. Imposition of the environmentally sensitive policies by regulatory agencies as well as implementation of a comprehensive monitoring program should serve to protect the aquatic resources and the quality of ground and nearshore waters when the proposed development at Keopuka occurs.

INTRODUCTION

The Keopuka Lands project site encompasses approximately 660 acres extending from the coastline to an elevation of about 1,400 feet fronting the Mamalahoa Highway (Hawaii Belt Road) in South Kona. The development is situated north of Kealakekua Bay and fronts about 1.6 km of coastline. The project proposes to develop an agricultural lot subdivision (125 lots), an 18-hole golf course with a 100-unit member's hale, open space recreational area and related infrastructure. Included in the development will be open space elements along the coastline. Other than approximately 30 acres in macadamia nuts at the mauka end of the project site, the site is undeveloped. Previously, Hawaiian agriculture was probably important in the area.

Annual average rainfall on the project site is about 35 inches in the more mauka portions of the site with the summer months receiving the majority of the rainfall which is an unique characteristic of the Kona coast. The general slope of the property ranges from relatively flat and rolling pahoehoe fields adjacent to the coast to relatively steep terrain in the more mauka (inland) portion of the project site.

The coastal area encompassing approximately a 400-foot setback that follows the shoreline is planned as a natural open-space recreational element. The development plan includes preservation of historic features, along with the existing trail system which will provide access for the public for shoreline use.

The golf course has been planned in areas of relatively mild slopes in order to integrate with existing land forms and minimize the need for extensive grading. The golf course and related facilities will be sited to protect significant historical and cultural sites and will integrate existing vegetation into the layout. Turf areas within the fairways would be reduced from typical golf course areas to lessen the amount of irrigation required, while still providing for a pleasant golf experience. Irrigation water will be collected from holes subject to potential runoff by a subsurface drainage system that recycles the collected water to irrigation ponds for reuse on the course. The onsite drainage system will consist of golf course retention/infiltration basins and drywells to dispose of runoff generated from roads. Siltation basins will be constructed, as required, to control runoff water quality, and may be incorporated into the golf course. Runoff generated by rainfall on the golf course may be retained and used to supplement the treated effluent and brackish water used to irrigate the golf course.

The project is envisioned to be developed over a period of time that will be phased to meet market demand. The first phase will include the golf course, related roadways, and facilities and are planned for development in 2001-2002. Agricultural lots and the Clubhouse would be developed soon thereafter, or, as market demand dictates. Thus the agricultural lot development may be phased over some period of time to meet the market demand.

A. Purpose

The proposed development of the Keopuka parcel could potentially impact the quality of coastal groundwater as well as the marine receiving waters adjacent to the project site. Ultimately with declines in water quality, marine communities resident to the receiving waters could also be negatively affected. Because of the potential for impact, regulatory agencies often require appropriate monitoring of water quality and marine communities resident to the receiving waters for development projects occurring in coastal settings. Because of the proximity of the Kealakekua Bay and its' designation as a State Marine Life Conservation District (MLCD) as well as the fact that this development will occur in a coastal setting, the concern for impact with development of Keopuka is heightened.

Regulatory agencies usually require that a comprehensive ground- and near shore marine water quality monitoring plan be developed along with a best management practices plan for the golf and agricultural components to insure that degradation of the ground- and nearshore marine waters will not occur and will remain in a pristine state. Since the quality of the water has a major influence on aquatic communities that reside in it, a comprehensive monitoring program should not only consider water quality but also the status of the resident aquatic communities. A water quality and nearshore marine community monitoring program has been developed to insure that degradation to the important aquatic communities and the waters in which they reside will not occur when the development of the Keopuka lands is undertaken.

B. Approach

With any coastal development the potential exists for negative impacts to occur on resident aquatic biota. Potential environmental degradation processes may be minimized if the proper informaion is assembled early on in any coastal development scheme. Environmental data can serve to identify areas that may be susceptible to anthropogenic impacts, or conversely, particularly resistant to such impacts. An objective of any environmental baseline assessment is to establish quantitative information to accurately depict the community structure of the extant aquatic communities as well as describe the physio-chemical environment. Aquatic community structure can be defined by the abundance, diversity and local distribution of all macrofauna and flora. The information so collected will serve to identify living aquatic resources that may be of significant commercial, cultural, recreational or scientific importance as well as those resources which may represent rare or unique ecological features that could be especially susceptible to human-induced impacts. The quantitative description of the physio-chemical environment provides the baseline upon which the subsequent monitoring can be compared; significant deviation from the baseline may serve as an "early warning" of impact to the aquatic communities.

Many anthropogenic impacts to aquatic communities emanating from coastal development are mediated by water. Activities on land creating potential pollutant problems are carried to the groundwater and/or nearshore marine environment via water. Water is the common transport mechanism and this water may come from irrigation or from rainfall and runoff. Thus, a first means of detecting a potentially harmful impact to aquatic biota may be through changes in the quality of ground and/or receiving waters.

Marine environmental surveys and monitoring programs are usually performed to evaluate the feasibility of and ecosystem response to specific proposed activities. Appropriate survey methodologies reflect the nature of the proposed action(s). An acute potential impact (such as channel dredging that may be undertaken on other projects) demands a survey designed to determine the route of least harm and the projected rate and degree of ecosystem recovery. Impacts that are more chronic or progressive require different strategies for measurement. Management of chronic stress to a marine ecosystem demands identification of system perturbations which exceed the boundaries of natural fluctuations prior to proceeding with the project. Thus, a thorough understanding of normal ecosystem variability is required in order to separate the impact signal due to development from natural background variability.

The potential impacts confronting the marine ecosystem fronting the proposed development at Keopuka are most probably those associated with chronic progressive stresses. There have probably been few, if any, direct impacts to the majority of the project site in modern times. However, the area has suffered indirect impacts such as the introduction of non-native vegetation (such as kiawe) and grazing feral animals (cattle, etc.) which may have led to accelerated erosion and resultant sedimentation in the sea during periods of high rainfall and these have probably been ongoing for many years at this project site. However, it should be recognized that surface runoff to the ocean would be an extremely rare event due to the highly porous nature of the landscape dominated by geologically young lavas. This is particularly true adjacent to the shoreline where an extensive porous pahoehoe lava field is present.

The major source of changes to water quality due to development in the nearshore marine environment fronting the project site is via the groundwater. Thus, the strategy being used in this monitoring effort is to sample the known points where groundwater (1) occurs in open exposures or wells prior to entering the sea and (2) sampling in the marine environment where groundwater does enter the sea. A second part to the sampling strategy employed is to sample water quality during a period of relatively low rainfall (a "dry" period) and again following a period of local heavy rainfall ("wet" period sampling defined below at 1.25 inches of rainfall in a 24-hour period as measured at a rain gage abut 250 m north of the north boundary of the project site) if this is at all possible prior to construction. Presumably, more materials are carried to the sea during heavy rainfall events than during dry periods. This sampling strategy obtains information on water quality at two extremes of the envelope of variability. Presently, there are no known depressions in the coastal lava field that intersect the ground watertable so the sampling of groundwater prior to its entry into the ocean will have to wait until proposed coastal monitoring wells are drilled later in the study (see below).

In 1991 a preliminary survey of the quality of the waters fronting the Keopuka parcel was completed and focused on water quality of the area. Marine community development was also noted but quantitative studies were not completed due to a hiatus in the project. Almost ten years has elapsed since these preliminary observations were made. In September 1992 Hurricane Iniki struck the Hawaiian Islands and marine communities in parts of the West Hawaii coast were severely impacted (Dollar and Tribble 1993, Brock 1996). Some of these impacts are still evident today in the marine communities. As time has passed, marine resources in the waters fronting the adjacent Hokuli'a project (to the north) and those offshore of the Keopuka parcel have received increasing use by the fishing public. Impacts to the coastal resources have occurred from these natural and anthropogenic disturbances.

This document presents the results of the preliminary baseline with the water quality data being collected during a low rainfall or "dry" period. Also included is a status of the marine communities of the waters fronting the Keopuka Lands project site.

METHODS

A. Water Chemistry Sampling

All water quality sampling for the Keopuka project has followed sampling protocols as given by the West Hawaii Coastal Monitoring Protocols (1992). Water quality parameters that have been evaluated include those as stipulated by the Department of Health for Class AA open coastal waters as given in Title 11, Chapter 54, Amended Administrative Rules for Water Quality Standards (1992). These parameters include the specific criteria of ammonia nitrogen, nitrate+nitrite nitrogen, total nitrogen, total phosphorus, chlorophyll-*a*, and nephelometric turbidity. Also collected were samples for the non-specific criteria including dissolved oxygen, temperature, pH and salinity as well as silica and orthophosphorus, the former because of its importance as a conservative tracer of groundwater and the latter due to its biological importance. Orthophosphorus is the biologically reactive form of phosphorus and it is an important constituent of dry fertilizers and thus was measured. Silica occurs in relatively high concentration in groundwater and treated sewage effluent and is in low concentration in oceanic waters. Silica is not particularly biologically reactive in inshore marine ecosystems and thus serves as a conservative tracer for groundwater. It is important in any analysis of land-derived sources of nutrients using mixing models which are appropriately employed where sufficient volumes of groundwater enter the sea such as occurs at Keopuka. In addition, the Hawaii State Department of Health has proposed a new water quality standards based on the work we have completed for the West Hawaii coast (see Dollar, Brock and Smith 1995). These proposed standards which are undergoing review, utilize the mixing model approach and require information about dissolved silica concentrations in all samples.

Water samples for nutrient analyses were taken in 125 ml acid-washed polyethylene bottles. These samples were filtered through glass fiber filters and immediately placed on ice and subsequently frozen until analysis (except for silica which was refrigerated). Analyses for ammonia nitrogen, nitrate+nitrite nitrogen and orthophosphorus were carried out using a Technicon AutoAnalyzer and standard techniques; inorganic and total (after oxidation) nutrient analyses were determined using manual spectrophotometric techniques on a fiber optic colorimeter. The analytical procedures followed those given in Standard Methods (1985) with modifications according to Strickland and Parsons (1972).

Turbidity samples were collected as unfiltered water and stored on ice in 125 ml polyethylene bottles until measurements were made. Turbidity was measured on a Monitek Laboratory Nephalometer following the procedures as described in Standard Methods (1985). The instrument was calibrated as specified by the Environmental Protection Agency with standard formazin solutions prior to and after sample measurements. Prior to measurement, samples were throughly mixed to disperse particulate materials and measured in duplicate when all air bubbles disappeared.

Chlorophyll-*a* samples were collected by filtering known volumes of seawater through glass microfiber filters; filters were frozen until laboratory analyses were carried out. Laboratory procedures followed Standard Methods (1985) and pigments were extracted and determined fluorometrically. Salinity samples were collected in 125 ml polyethylene bottles in the field, filled completely and capped tightly until measurement with an AGE salinometer in the laboratory. In the field oxygen was measured using a YSI Model 58 meter, temperature with a laboratory thermometer and pH was determined using a Hanna millivolt meter. Sample processing was done by an EPA/DOH approved laboratory.

In the marine waters fronting the Keopuka project site, sources for the measured parameters in this study will come from (1) marine waters adjacent to the project site, (2) from groundwater entering the ocean in the intertidal/shallow subtidal along the project site, (3) from runoff emanating from the project site following exceptionally heavy rainfall, and (4) for some parameters (i.e., ammonia nitrogen) there may be *in situ* generation by biological activity. Separation of the sources of these materials is made by sampling at sites ranging from the shore in a seaward (makai) direction both at the surface as well as at depth. In general, inputs form land will create concentration gradients because inorganic nutrients occur in low concentrations in offshore oceanic waters. Thus, a number of samples taken in an onshore to offshore series sampling both surface and "at depth" waters will serve to identify inputs coming from land (i.e., sample through any existing gradients).

Establishing these onshore-offshore water sampling "transects" at locations with high groundwater input provide the most useful data. This is because future inputs from land will most likely be carried by the groundwater and first appear at the shoreline at these points. In addition, water quality sampling transects were established near the north and southern boundaries of the project site which allows identification of materials being carried into the study area from elsewhere. To address the question of materials being generated *in situ*, the boundary samples can be compared to samples taken in transects established offshore of the central part of the project site.

Low salinity groundwater often has relatively high inorganic nutrient concentrations relative to seawater. Being lighter, low salinity groundwater will overlie denser, warmer seawater. Mixing by wind and waves will serve to break down this stratification with time. Thus the highest nutrient waters are often at the surface in a lower-salinity layer which is best developed close to shore. Because of this, samples were collected from just under the surface in the low salinity water layer (if existing) and were also be taken below the surface sample at depth (usually about 1 m above the bottom) from sample sites where depths exceed 1 m.

Baseline water quality sampling were carried out at four onshore-offshore "transects" to meet the objectives as given above. Each transect was comprised of seven water quality samples; one sample collected on the surface at the shoreline, a second approximately 20 m offshore at the surface and a third just below the second about 1 m above the bottom (depths ranging from 5 to 12 m), a fourth sample collected about 50 m offshore at the surface and a fifth sample just below the fourth at about 1 m above the bottom. The sixth sample was collected at the surface approximately 100 m from shore and the seventh sample collected beneath the sixth sample at depth about 1 m above the bottom. One transect was established close to the northern boundary of the project site, a second near the southern boundary and the remaining two offshore of the central part of the project site. In addition, the several samples were taken in replicate for purposes of the quality assurance/quality control program as required by the Department of Health. The locations of the water quality sample sites are given in Figure 1.

This water quality sampling strategy concentrates the collection of samples in waters close to shore where inputs from land would be most evident and follows that as outlined in the West Hawaii Monitoring Protocols (1992). Such a sampling scheme, which allows the scaling of water chemistry parameters to salinity or other conservative tracers (such as silica) is applicable to a hydrographic mixing model that has been established as an effective method of determining changes in chemical make-up of groundwater discharge (Dollar, Brock and Smith 1995). In addition, the method allows identification of chemical sources on land that are contributing to material input to the marine environment.

From the data collected, dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) were calculated for each sample taken by simple subtraction from the total nitrogen and total phosphorus results. High DON concentrations are indicative of sewage input and thus can be useful for identifying sources of high nitrate, ammonia or total nitrogen, especially where both dry fertilizers and dilute treated sewage effluent (used for irrigation) are both used on the project site. When sufficient data are accumulated, they will be analyzed using non-parametric statistics which avoids some of the assumptions of normality and homogeneity of variances.

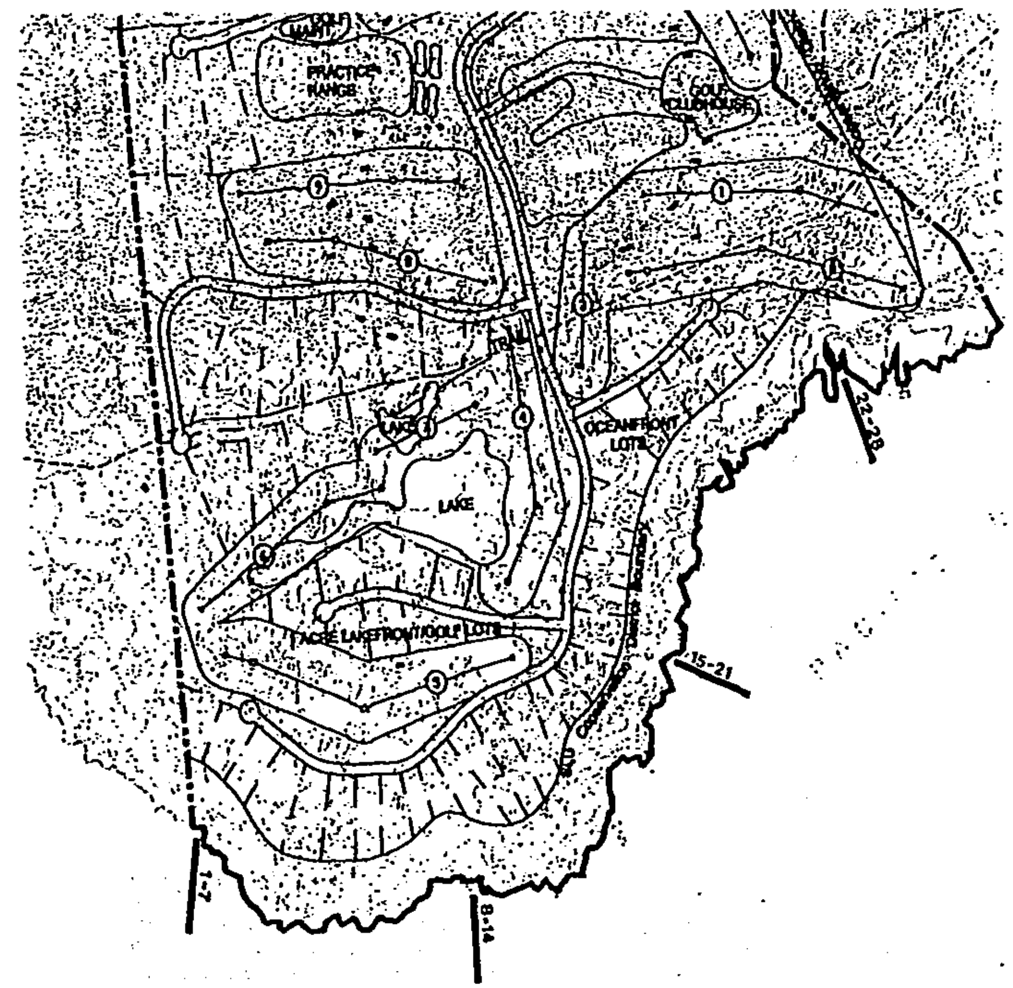

FIGURE 1. Map of the makai or seaward portion of the Keopuka project site showing the approximate locations of the 28 water quality sample sites. Samples with an "S" are collected within 20 cm of the surface and samples with a "B" are collected at depth about 1 m from the bottom. Seven samples were collected each along one of four "transects" each commencing at the shoreline and extending seaward 100 m. Shoreline samples from the four transects include numbers 1-S, 8-S, 15-S and 22-S; samples collected 20 m offshore include 2-S, 3-B, 9-S, 10-B, 16-S, 17-B, 23-S, 24-B; samples from 50 m offshore include 4-S, 5-B, 11-S, 12-B, 18-S, 19-B, 25-S, 26-B and samples from 100 m offshore including 6-S, 7-B, 13-S, 140-B, 20-S, 21-B, 27-S, and 28-B. Map courtesy of PBR HAWAII. Inc.

B. Pesticide Sampling

Pesticides (i.e., insecticides and herbicides) and heavy metals (e.g., mercury and arsenic) are a concern of regulatory agencies and the public particularly for coastal developments where the potential for movement of these materials from the site of application to the adjacent ocean and marine biota is high. Presumably, no pesticide or heavy metal use has occurred in the past the Keopuka project site, however a predevelopment baseline of several commonly used pesticides and heavy metals in sediments taken from the near shore area was be carried out. These data will serve as a baseline against which later required pesticide sampling can be compared. Naturally occurring arsenic and mercury in areas of recent volcanism may be quite variable and often relatively high. Arsenic is a common active ingredient of many herbicides used today (such as MSMA). Having some baseline information on the pre-development concentration of this element as well as others will assist in understanding relatively high concentrations that may be encountered later in the study.

Pesticide analyses were carried out on three sediment samples collected from the near shore waters fronting the project site with one of these samples being collected in Kealakekua Bay near the Cook Monument to serve as a control. Sediments were collected from similar depths as close to shore as is feasible.

Sediment samples were analyzed for elemental arsenic as well as for three pesticide screens. These screens search for classes of pesticides but do not identify individual products. Screens performed include the EPA Method 8080 for chlorinated pesticides such as oryzalin (Surflan) and oxadiazon (Ronstar 2G). EPA Method 8140 was used for organophosphate pesticides such as chlorpyrifos (Dursban) and EPA Method 8150B for Phenoixy acid herbicides such as dicamba, MCPA and MCPP (Trimec Southern). Because it is an important product to both golf course and grounds maintenance, the samples were also examined for the herbicide Roundup. Sediment samples were collected in acetone rinsed, teflon lined jars. Once collected, samples were chilled and immediately air-shipped to California where the analyses were carried out by an EPA-approved laboratory.

C. Proposed Coastal Monitoring Wells

To most effectively address the objective of determining if any impact will emanate from the project site either during the construction process or later with the subsequent maintenance of the completed project, the monitoring protocol calls for the development of a series of coastal monitoring wells. The plan calls for two to three coastal monitoring wells be developed along with one well in the more inland or mauka portion of the project site. The strategy here is to utilize any well developed along the inland or mauka portion of the development (usually used as a source of low salinity irrigation water) and compare water quality data from this site to data from shallow wells developed for monitoring purposes along the makai or seaward edge of the

project site. In general, groundwater flows from the inland areas through the lava strata down slope to the sea. The inland irrigation well(s) would serve as a sampling point for groundwater as it enters the project site. The shallow makai wells would sample the groundwater as it leaves the project site but prior to its entry into the ocean. Comparison of water chemistry data taken in the mauka well(s) to that collected in the makai wells will readily show any inputs coming from the activities on the project site. Further comparison of the makai well data to the data collected in the ocean will demonstrate the fate of these materials as they enter the ocean. (Often, materials identified in coastal wells never appear in the ocean due to dilution and uptake). These data will also value if a constituent is found to be elevated at the shoreline of the site once human activities have commenced; without the mauka and makai wells, the supposition will be that the elevated materials are coming from the project site where they may otherwise be already in the groundwater prior to its entry under the Keopuka project site. Parameters to be monitored are the same as those for marine waters with the exception of chlorophyll-*a* which is a measure of phytoplankton biomass and well samples have not been exposed to sunlight and thus would not have any chlorophyll-*a* present.

As noted above, the Department of Health has proposed new guidelines for water quality standards for the West Hawaii coast. These guidelines are based on local ecological conditions and utilize regression techniques to determine what local water quality standards should be for waters with salinities less than 32 ppt. These guidelines require groundwater samples drawn from inland wells that serve as the undisturbed controls as well as sampling in coastal marine locations. If these proposed guidelines are accepted, the proposed monitoring plan will adhere to the new ecologically-based standards as well as undertake sampling for the parameter, total suspended solids which is not now being sampled. Development of monitoring wells on the project site will bring the project into conformance with the proposed guidelines if they are enacted. If and when these wells are developed, water quality sampling will commence and will become a routine part of the monitoring program.

D. Marine Community Sampling

The objectives of the marine biological monitoring program are to: (1) determine the status of marine communities in the waters fronting the project site, and once the "during construction" phase is initiated, (2) to quantitatively ascertain any changes that occur to these communities over the life of the program and (3) if change occurs, determine the causal mechanism(s) and/or source(s) for these changes and if activities on the project site are responsible, suggest mitigation measures to alleviate the problems. In all probability, if activities on the Keopuka project site are responsible for change occurring in the marine communities, the mechanism responsible will be changes in water quality. Thus detection of these changes in the water quality studies are the first signal of potential impact to marine communities.

The methods used in carrying out this study follow those prescribed in the West Hawaii Coastal Monitoring Protocol (1992). These methods are briefly described below.

The first step in any quantitative delineation of marine communities is to define the major zones or biotopes present in the study area. This is accomplished by towing (or swimming) a diver through the study area from shore to the outer boundary (here the 20 m isobath). Biotopes are quantitatively defined partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each defined biotope, a number of permanently marked stations are established and quantitative studies conducted at each including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance is made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments are carried out suing SCUBA. Permanent stations are usually marked by use of steel pins, nylon cable ties , and small subsurface floats tied to the substratum which allows for repeated sampling of the same location.

The location of stations were subjectively chosen as being representative of a given biotope and in some cases coincided with water quality sampling points. Subtidally stations were marked using nylon cable ties and small fishing floats secured to the seafloor and extending up about 1.2 m to assist in the subsequent relocation of the site. Biotopes approximately paralleled the shoreline so stations sampling the different biotopes were established along imaginary mauka-makai (onshore-offshore) lines. The location of the innermost or shallowest station and the most offshore or deep station were noted using prominent landmarks to assist in the later relocation of these areas.

Immediately following site selection, a visual fish census was undertaken to estimate the abundance of fishes. These censuses were conducted over a 25 x 4 m corridor and all fishes within this area to the water's surface were counted. Data collected included species, numbers of individuals and an estimate of each fish's length; the length data were later converted to standing crop estimates using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25 m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., cross coral mounds, sand flats, and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25 m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels (family Muraenidae) and nocturnal species, e.g., squirrelfishes (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus, family Scorpaendiae; the flatfishes, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2 cm in some dimension (without disturbing the substratum) were censused in a 4 x 25 m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms and holothurians. Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that re beyond the scope of this survey (e.g., see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals, sponges and macrothalloid algae were quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50 cm). These data have been converted to percentages. Quadrat sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, 20 and 25 m).

If macrothalloid algae were encountered in the 1 x 1 m quadrats or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of fieldwork, notes are taken on the number, size and location of any threatened or endangered species (such as spinner porpoises, humpback whales or green sea turtles) seen within or near the study area. Additionally, casual observations were made on recreational use patterns as observed within the study area while carrying out other field studies. Further information on threatened or endangered species and use patterns were obtained by questioning users familiar with area. This analysis of marine communities prior to the commencement of construction will serve as the baseline whose data will be quantitatively compared to data collected during the period of project construction. Statistical analyses will focus on nonparametric methods which will avoid some of the assumptions regarding normality of the data. Statistical analyses will focus on changes at a given location through time as well as changes that may occur across locations at any time.

These methods will provide quantitative information on the status of the marine communities in the waters fronting the project site as well as point out any change that may occur. Once activities on the project site have commenced, any statistically significant negative change encountered in the marine communities (usually seen as a decrease in abundance of a species, etc.) will be examined in light of the water quality data to determine source(s) of these changes. If the source is from the Keopuka project site, the developer, contractor, and appropriate regulatory agency personnel will be immediately contacted and mitigative measures will be suggested to reverse the problem(s)

RESULTS AND DISCUSSION

A. Status of Water Quality

Water quality parameters as specified by the State Department of Health (DOH) Water Quality Standards were collected and measured at the surface (about 20 cm below the water surface) and/or at depth (about 1 m above the bottom) at 28 locations fronting the project site. All water quality samples are marine. The station locations are given in Figure 1.

The water quality results are presented in Tables 1 (April 2000) and 2 (December 1991) by sampling date. There are two trends apparent in these data: (1) the concentrations of some dissolved nutrients (particularly nitrate nitrogen and silicate) decrease with distance from shore and (2) salinity shows a weak increase with distance from shore. Although the gradients are weak, they are related to the diffuse input of groundwater along the shoreline. Both silica and nitrate+nitrite nitrogen usually exist in high concentration in groundwater owing to metabolism of organic material and mineral dissolution; these ions are in low concentration in open ocean waters and hence they (along with salinity) may serve as tracers for freshwater (here low salinity groundwater) input into oceanic settings.

Although apparent at several sites, the greatest groundwater input along the shoreline of the project site was located in a small bay along the northern boundary of the Keopuka project site (stations 1-7) as well as at the south end of the project site just offshore of the shoreline heiau (stations 22-28). The surface samples (numbers 1-S, 2-S, 22-S and 23-S) show some elevation of silica adjacent to the shoreline and related to the groundwater input.

The preconstruction water quality sampling program has been scheduled to occur during the low rainfall or dry season as well as during the wet season. For the South Kona District, the period of greatest rainfall occurs during the months of June through October. Because rainfall is driven by orographic processes, most of it falls in the uplands or mauka area well away from the coast. The preconstruction baseline has included, at a minimum, field sampling during two dry and should include one wet period. Ideally, one dry and one wet period sampling should occur per year prior to the commencement of construction. If the commencement of the construction phase is more than one year away, preconstruction baseline water quality data will continued to be collected during once per year during the wet and dry seasons. This continued effort will provide a more statistically-rigorous baseline.

There have been two water quality sampling events that comprise this baseline study thus far; these surveys were carried out on 12 December 1991 and 21 April 2000 and were carried out during periods of relatively little rainfall. Ideally, conducting water quality sampling following a significant rainfall event (1.25-inch or greater in a 24-hour period) would provide information following a "wet" period and that extreme of the envelope of variability. Rainfall is measured automatically on the adjacent project site at Hokuli'a at a weather station established for that purpose. It is proposed that rainfall data from that station be used as the trigger for "wet" period water quality sampling at Keopuka (see proposed "during construction" monitoring and mitigation plan).

TABLE 2 Table of water quality parameters (in ug/l unless otherwise noted) as measured at 9 of 28 sites from nearshore waters fronting Keopuka,South Kona District on 12 December 1991 representing a low rainfall or "dry" period. Surface samples are denoted with an "S" and deep bottom samples with a "B". At the foot of the table are given the geometric means; underlined values exceed state water quality standards for "dry" coastlines.

STATION	Nitrate N	Ammonia N	Total N	Ortho-P	Total P	Silica	DOP	DON	Salinity (o/oo)	Turbidity ntu	Chl-a ug/l	Temp	Oxygen % Sat.	pH
8-S	6.02	3.36	97.02	2.17	9.61	310.52	11.16	96.18	34.592	0.08	0.106	25.5	102	8.19
9-S	0.56	7.14	81.20	1.86	8.68	59.64	10.85	98	34.760	0.08	0.086	25.5	101	8.21
10-B	0.42	1.96	97.02	1.86	8.37	161.56	12.71	102.2	34.769	0.08	0.080	25.4	101	8.23
11-S	0.14	2.80	87.50	1.24	7.44	45.08	7.44	99.96	34.760	0.07	0.090	25.8	100	8.24
12-B	0.56	1.40	87.50	3.72	7.75	41.16	11.47	109.06	34.781	0.08	0.122	25.4	100	8.26
13-S	1.96	4.06	101.78	2.48	8.69	189.56	9.92	102.62	34.764	0.07	0.138	25.5	101	8.26
22-S	45.78	1.96	143.22	6.20	11.78	1163.68	8.37	116.06	33.609	0.07	0.070	25.5	103	8.28
23-S	6.86	2.38	85.96	3.10	8.68	183.96	11.16	110.04	34.583	0.07	0.070	25.7	102	8.28
25-S	1.40	2.66	87.50	2.48	8.37	65.80	9.92	128.52	34.718	0.08	0.102	25.6	101	8.27
	1.66	2.76	95.19	2.52	8.74	134.93	10.21	106.54	34.591	0.08	0.094	25.6	101	8.25

TABLE 1 Table of water quality parameters (in ug/l unless otherwise noted) as measured at 28 sites from nearshore waters fronting Keopuka,South Kona District on 21 April 2000 representing a low rainfall or "dry" period. Surface samples are denoted with an "S" and deep bottom samples with a "B". At the foot of the table are given the geometric means; underlined values exceed state water quality standards for "dry" coastlines.

STATION	Nitrate N	Ammonia N	Total N	Ortho-P	Total P	Silica	DOP	DON	Salinity (o/oo)	Turbidity ntu	Chl-a ug/l	Temp	Oxygen % Sat.	pH
1-S	27.86	3.64	125.58	8.68	16.43	688.60	7.75	94.08	33.966	0.16	0.108	26.2	102	8.21
2-S	8.26	2.80	111.72	6.20	13.95	202.72	7.75	100.66	34.526	0.09	0.117	25.8	101	8.20
3-B	4.48	1.82	115.06	7.75	14.26	114.24	6.51	108.78	34.623	0.09	0.114	25.8	101	8.20
4-S	1.26	1.96	121.52	6.51	13.33	57.68	6.82	118.30	34.686	0.10	0.111	25.8	102	8.20
5-B	1.68	4.06	169.96	7.44	17.05	57.12	9.61	164.22	34.696	0.28	0.115	25.9	102	8.18
6-S	0.14	1.54	111.44	5.89	13.33	43.68	7.44	109.76	34.697	0.11	0.097	26.2	101	8.18
7-B	1.12	3.08	123.06	5.58	15.50	47.88	9.92	118.86	34.707	0.09	0.126	25.9	100	8.20
8-S	4.34	1.68	112.14	5.58	14.57	145.32	8.99	106.12	34.564	0.08	0.127	26.1	103	8.21
9-S	0.42	3.64	159.46	4.96	15.50	46.76	10.54	155.40	34.709	0.11	0.119	25.6	102	8.13
10-B	0.14	1.54	109.20	4.96	14.57	45.64	9.61	107.52	34.705	0.09	0.113	25.6	101	8.14
11-S	0.00	1.96	98.28	4.34	13.64	46.20	9.30	96.32	34.701	0.08	0.112	25.6	101	8.21
12-B	0.28	6.02	126.10	5.27	15.50	46.70	10.23	121.80	34.711	0.13	0.300	25.8	100	8.20
13-S	0.28	2.24	145.60	4.65	13.64	42.28	8.99	143.08	34.706	0.10	0.104	25.5	100	8.21
14-B	0.70	13.02	153.16	5.58	15.50	44.80	9.92	139.44	34.712	0.11	0.105	25.6	103	8.20
15-S	2.38	1.54	97.72	4.96	13.95	69.16	8.99	93.80	34.679	0.07	0.089	25.2	102	8.19
16-S	1.40	2.24	118.30	6.51	13.64	58.24	7.13	114.66	34.696	0.07	0.097	25.2	102	8.15
17-B	1.12	1.40	125.86	6.20	14.57	58.80	8.37	123.34	34.698	0.07	0.091	25.0	103	8.17
18-S	0.42	2.38	116.06	4.96	13.95	62.16	8.99	113.26	34.693	0.09	0.095	24.5	101	8.47
19-B	0.56	0.84	97.58	4.65	15.81	56.00	11.16	96.18	34.700	0.12	0.092	24.5	100	8.14
20-S	0.70	1.82	100.52	4.96	15.81	59.36	10.85	98.00	34.699	0.08	0.101	24.5	101	8.02
21-B	0.28	0.98	103.46	4.65	17.36	49.84	12.71	102.20	34.707	0.10	0.100	24.6	102	8.22
22-S	25.34	2.80	128.10	8.99	16.43	557.20	7.44	99.96	34.103	0.12	0.099	24.5	102	8.20
22-S REP	26.74	2.94	136.92	9.30	16.12	577.36	6.82	107.24	34.074	0.09	0.103	24.5	102	8.20
23-S	24.06	2.10	135.24	7.75	19.22	511.00	11.47	109.06	34.155	0.10	0.090	24.8	100	8.07
24-B	3.64	1.68	107.94	5.27	15.19	89.04	9.92	102.62	34.668	0.07	0.094	24.5	101	8.13
25-S	7.56	2.10	125.72	7.75	16.12	198.24	8.37	116.06	34.534	0.09	0.120	25.8	102	7.95
26-B	3.08	1.26	114.38	6.51	17.67	118.72	11.16	110.04	34.649	0.10	0.091	24.6	103	8.16
27-S	3.64	3.22	135.38	7.13	17.05	112.84	9.92	128.52	34.647	0.12	0.106	24.7	101	8.15
28-B	0.28	1.54	114.94	6.20	15.19	54.32	8.99	113.12	34.718	0.15	0.117	24.5	101	8.16
	1.62	2.24	120.91	6.04	15.27	91.32	9.03	113.04	34.590	0.10	0.110	25.3	101	8.17

The Hawaii State Department of Health (DOH) has developed standards for coastal waters as given in Hawaii Administrative Rules Chapter 11-54. The coastal waters fronting the Keopuka project site are given the highest rating (Class AA) and thus have the most stringent standards. Standards for a particular class of marine coastal waters vary depending upon the amount of freshwater input from land (i.e., groundwater, stream or surface runoff). "Dry" coastlines are those having less than 3 million gallons of freshwater input per shoreline mile per day while "wet" coastlines have more than 3 million gallons per shoreline mile per day. Freshwater input along the Keopuka coastline is primarily via the groundwater. Since we do not know how much groundwater is entering the ocean fronting the project site, the more conservative "dry" standards are used below.

The DOH water quality standards are usually compared to (1) the geometric means of samples collected at a single location over time or (2) the geometric means calculated for all sample locations during a single sampling event. The geometric means calculated from all sample sites during a single sampling event for each parameter are given at the bottom of each data set in Tables 1 and 2. Table 3 presents the DOH standards for open coastal waters. By date, parameters out of compliance with state standards vary. In December 1991 only ammonia nitrogen did not meet the standards and in the April 2000 survey total nitrogen was out of compliance with state standards. These data suggest that there is variability in measured concentrations of the parameters at the sample sites through time. Since there has been limited sampling at the 28 sample sites, comparisons of individual sample locations through time cannot be made at this point in time.

The limited data suggest that many of the parameters vary between individual sites and some do not meet state water quality standards despite the lack of development on this coastline. These data suggest that many of the standards are too stringent and do not reflect the natural ecological conditions existing in the marine waters fronting the project site. In summary, the data as given in Tables 1 and 2 are typical of those collected from other Kona coast marine sites.

It is interesting to note that State standards for open coastal waters are frequently exceeded irrespective of the presence of nearby coastal development. Brock and Kam (1989) found that under dry conditions nitrate+nitrite nitrogen concentrations are equal to "dry" criteria for waters fronting Lahaina, Maui (a developed area) and that chlorophyll-*a* exceeded the "wet" criteria; following a heavy rain (858 mm or 3.38 inches over a 24-hour period) nitrate+nitrite nitrogen, turbidity and chlorophyll-*a* all exceeded state standards (Brock 1990a). At Mahukona, Hawaii an area with little surrounding development, both chlorophyll-*a* and ammonia nitrogen exceeded DOH "dry" standards (Marine Research Consultants 1989, Brock 1990b).

TABLE 3. Specific criteria specified by the Department of Health water quality standards for open coastal waters as amended in 1992. Standards are given in ug/l.

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than 10% of the time	Not to exceed the given value
Total Nitrogen (ug/l)	150.00* 110.00**	250.00* 180.00**	350.00* 250.00**
Ammonia Nitrogen (ug/l)	3.50* 2.50**	8.50* 5.00**	15.00* 9.00**
Nitrate+Nitrite Nitrogen (ug/l)	5.00* 3.50**	14.00* 10.00**	25.00* 20.00**
Total Phosphorus (ug/l)	20.00* 16.00**	40.00* 30.00**	60.00* 45.00**
Chlorophyll-*a* (ug/l)	0.30* 0.15**	0.90* 0.50**	1.75* 1.00**
Turbidity (NTU)	0.50* 0.20**	1.25* 0.50**	2.00* 1.00**

* "Wet" criteria apply when the open coastal waters receive more than three million gallons per day of fresh water discharge per shoreline mile.
** "Dry" criteria apply when the open coastal waters receive less than three million gallons per day of fresh water discharge per shoreline mile.
Applicable to both "wet" and "dry" conditions:
Salinity - Shall not vary more than 10 percent from natural or seasonal changes considering hydrologic input and oceanographic factors.
N.T.U. = Nephalometric Turbidity Units
Orthophosphate was eliminated from he list of requirements in the revised 1988 document but because of its biological importance, it was measured in this study. The old "wet" criteria was 7.00 ug/l and "dry" standard was 5.00 ug/l.

A weekly ocean water quality monitoring program has been in place at the Natural Energy Laboratory of Hawaii Authority (NELHA) at Keahole Point, Hawaii since 1982. The waters offshore of Keahole Point are considered to be pristine; the presence of high quality deep ocean water adjacent to shore was an important factor in locating the NELHA facility there. The long-term mean for ammonia nitrogen at Keahole Point is 5.04 ug/l which exceeds the dry standard but the long-term mean for nitrate nitrogen (2.80 ug/l) does not exceed the dry standard. The lack of compliance seen in water quality on both developed and undeveloped coastlines suggests that revision of the standards should be considered. The Department of Health is examining the possible implementation of ecologically-based standards which would base standards on the local natural conditions prior to any development rather than the absolute standards that are presently in use today. The author has and is continuing to assist the Department in the development of ecologically-based water quality standards.

Despite the concentrations of some parameters not meeting state standards in some samples, most of the water quality data are typical of a well-flushed, open coastal Hawaiian marine ecosystem. The high geometric mean for ammonia nitrogen is probably related to high community metabolism which is characteristic of many coral reef settings where the marine communities are well-developed such as is the case offshore of the Keopuka project site.

1. Pesticide/Metals Analyses

Sediments from three sites were sampled for some of the materials commonly used on today's golf courses. Because costs of pesticide analyses are high, efforts were focused (1) on a small number of sites and since many pollutents will adsorb to sedimentary particles, sampling was confined to sediments where the probability of finding these materials is greater. All three samples were carbonate sand with some basalt fraction. Samples were taken as close as possible to land with the expectation that if a pesticide is to be encountered, the probability is greater closer to land. A control sample was taken from the northeast corner of Kealakekua Bay at a depth of 3 m. This sample site is east of the Cook Monument and the sand at this location was predominately fine carbonate material. The second sample was collected just offshore of the heiau situated along the shoreline near the southern boundary for the Keopuka project site about 20 m offshore at a depth of 5 m and the third sample was taken about 20 m offshore of the pahoehoe bench at Keawekaheka Point at a depth of 3.5 m. The sediments in all of the samples appeared to be primarily carbonate sand with a small amount of basaltic materials.

TABLE 4. Results of the pesticide analyses from three sediment samples collected at a Kealakekua Bay control site, offshore of Keawekaheka Point and offshore of the shoreline heiau at the south end of Keopuka project site. Analyses were made for elemental arsenic used extensively in herbicides, the screens for organochlorine and organophosphate pesticides, phenioxy acid herbicides and Roundup. Samples were collected on 21 April 2000. ND indicates concentrations were below the detection limits as given in the body of the table.

Sample Location	Arsenic (mg/l)	Organochlorine Pesticides (mg/l)	Organophosphate Pesticides (mg/l)	Phenioxy Acid Herbicides (mg/l)	Roundup (ppm)
Kealakekua Bay Control	ND<2.0	ND<0.05	ND<0.2	Dicamba ND<0.18 MCPA ND<167 MCPP ND<129	ND<0.05
Keawekaheka Point	ND<2.0	ND<0.05	ND<0.2	Dicamba ND<0.18 MCPA ND<167 MCPP ND<129	ND<0.05
Offshore South Heiau	ND<2.0	ND<0.05	ND<0.2	Dicamba ND<0.18 MCPA ND<167 MCPP ND<129	ND<0.05

The results of the pesticide analyses are given in Table 4. Where sample results are below the limit of detection (given in the table as "ND"), these limits are given in the table. All materials were below the limits of detection in these sediment samples. However, marine carbonate/basaltic sands from other undeveloped sites along the West Hawaii coast often show a low concentration elemental arsenic. The detection of this element at low concentrations is not at all surprising because arsenic is a common, naturally-occurring constituent of volcanic soils.

Arsenic was detected in the sediment sample collected just offshore of Puu Ohau about 1.4 km to the north of Keopuka in an undeveloped area (Brock 1999). In many natural environments, arsenic is a common component and this is the case on volcanic islands. We have detected arsenic in the past in sediment samples collected in anchialine pools from both developed and undeveloped areas along the Kona coast (Brock 1998). Despite its detection, arsenic may naturally occur at relatively high concentrations. Kabata-Pendais and Pendais (1984) note that naturally occurring arsenic in sandy soils is in the range of 1 to 30 mg/kg, in soils over volcanic rocks it ranges from 2.1 to 11 mg/kg with a mean of 5.9 mg/kg, in soils overlying limestone arsenic will range from 1.5 to 21 mg/kg with a mean of 7.8 mg/kg and in basalts such as occurs in Kona, the range is from 0.6 to 2.0 mg/kg. Thus the presence of some arsenic is expected in many samples collected from completely undisturbed West Hawaii sites; its absence in the present samples is somewhat surprising.

B. Marine Communities Offshore of Keopuka

Marine communities offshore of Keopuka were qualitatively surveyed in 1991. Funding constraints halted this environmental work on the project soon thereafter. In September 1992 Hurricane Iniki caused considerable damage along the western shores of the Hawaiian Islands. On the West Hawaii coast, Hurricane Iniki damaged marine communities as documented by Brock (1992a, 1992b, 1996) and Dollar and Tribble (1993). Besides storm events such as Hurricane Iniki, changes have undoubtedly occurred in the nearshore marine communities over the intervening eight years due to greater human use of the resources as well as due to natural fluctuations in abundance of marine species. For these reasons as well as the need for a strong quantitative description of the marine communities for the baseline led to the survey carried out on 21 April 2000.

Sample stations were permanently marked with a combination of nylon cable ties and subsurface floats in the ecological zones or biotopes as described below. The qualitative reconnaissance made to define major zones or biotopes fronting the Keopuka project site extended from the shoreline to approximately the 20 m isobath up to ~300 m from shore. In total, approximately 268,000 m^2 (or 0.27 km^2) were examined in this analysis and four major biotopes were defined. In general, the submarine topography offshore of the Keopuka project site is steep such that in some areas within 100 m of the shoreline, water depths may be in excess of 100 m. The ecological zones or biotopes being partly determined by wave exposure (hence

water depth) are laterally compressed and are oriented approximately parallel to shore. The physical extent of the biotopes is given in Figure 2. It should be noted that the boundaries of each are not sharp but rather grade from one to another; these are ecotones or zones of transition. Biotopes were defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural components present in the benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes were named for distinctive features of each as shown in Figure 2.

The biotope of sand is very poorly developed in the study area. Offshore areas to the north and south of the Keopuka project site have extensive sand habitat primarily in waters below 30 m in depth. Offshore of Keopuka, the biotope of sand is best developed at the north end of the project site (north of Keawekaheka Point) below 30 m of depth which is outside of the boundaries of this study. Because of the lack of appropriate shelter and solid substratum, benthic and fish communities are poorly developed in this biotope. This and the fact that the majority of the sand biotope was outside of the boundaries of this study, this biotope was not sampled.

Shoreward of the biotope of sand is the biotope of *Porites compressa*. The biotope of *Porites compressa* occurs roughly as a "band" paralleling the shoreline and usually commences at a depth of about 10 to 12 m and may extend to depths in excess of 25 m, again outside of the scope of this survey. The dominant feature of this biotope is the coral, *Porites compressa*. Two stations (numbers 3 and 6) were established to sample this biotope. Inshore of the biotope of *Porites compressa* is the biotope of *Porites lobata* which is the dominant coral in this biotope. The biotope of *Porites lobata* is found at depths from about 4 to 10 m in the study area. Again, two stations (numbers 2 and 5) sampled the communities found in this zone. Inshore of the biotope of *Porites lobata* is the biotope of boulders. The biotope of boulders is usually found just seaward of the shoreline on the Keopuka coastline. It occurs as a narrow band of large basalt boulders situated at the base of a underwater cliff which forms the near-vertical pahoehoe shoreline at Keopuka. The biotope of boulders is dominated by basalt boulders affording considerable cover for fishes in water from 3 to about 7 m in depth. Station numbers 1 and 3 sampled this biotope.

FIGURE 2. Map showing the approximate boundaries of four biotopes identified in this study (lettered) and six permanently marked biological sampling stations (numbers 1-6). The biotopes are: A = the biotope of sand, B = the biotope of *Porites compressa*, C = the biotope of *Porites lobata* and D = the biotope of boulders. Note that the biotope of sand was not quantitatively surveyed in this study because it lies primarily at depths greater than 20 m (the outer limits of the study area).

In some small areas is another zone or biotope; this is the shallow high energy bench biotope. The shallow high energy bench biotope occurs as a seaward extension of the more horizontal portions of the pahoehoe lava flow where it enters the sea. North of Keopuka, the shallow high energy bench biotope is better developed; offshore of Keopuka this biotope is poorly represented and thus was not quantitatively sampled in this survey.

By way of summary, there are three well-defined biotopes present in the nearshore waters fronting the Keopuka project site. These biotopes are (from shallowest to deepest): the biotope of boulders, the biotope of *Porites lobata* and the biotope of *Porites compressa*. Seaward (and outside of the scope of the present survey) is the biotope of sand usually encountered below about 30 m in depth. Six permanently marked stations have been established to sample the three biotopes. The results of the survey are presented below along with qualitative observations made in the biotope of sand.

1. The Biotope of Sand

The biotope of sand lies principally seaward of the survey area below depths of 30 m. As the name implies, the substratum in the biotope of sand is dominated by coral sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves especially in shallow water. Thus many species in the sand biotope are cryptic and difficult to see; among those are many molluscs and crustaceans such as the Kona crab (*Ranina ranina*). Hence, without considerable time spent searching in the biotope of sand, many species in this habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant.

Benthic communities on sand substrates usually have their greatest development at depths below which wave impact occurs (below ~30 m). Because of constraints with bottom time at these depths, only a short qualitative survey was done. Species commonly seen in the deeper regions of the biotope of sand include a number of molluscs: the helmet shell (*Cassis cornuta*), augers (*Terebra crenulata, T. maculata* and *T. inconstans*), the leopard cone (*Conus leopardus*), oak cone (*Conus quercinus*), and flea cone (*Conus pulicarius*). Echinoderms are present also including the sea hare (*Brissus* sp.), starfish (*Mithrodia bradleyi*), and brown sea cucumber (*Bohadschia vitiensis*). The commercially important kona crab (*Ranina ranina*) is also seen along with the opelu or mackeral scad (*Decapterus macarellus*), nebeta (*Xyrichthys pavo*), grey snapper or uku (*Aprion virescens*), pfluger's goatfish or weke nono (*Mulloidichthys pflugeri*) and the white goatfish or weke (*Mulloides flavolineatus*). Other fish species occasionally seen include the goby-like fish (*Parapercis schauslandi*), sting ray or hihimanu (*Dasyatis hawaiiensis*), and goby (*Gnatholepis anjerensis*). Undoubtedly with greater searching, many more species would be encountered in this biotope.

2. The Biotope of *Porites compressa*

The characteristic feature of the biotope of *Porites compressa* is the usual dominance of the finger coral, *Porites compressa*. This biotope is usually confined to areas deeper than about 10 to 12 m where the impact of waves has attenuated. This biotope is a common feature of the submarine slopes that commence in about 10 m and terminate in about 30 m of water along much of the West Hawaii coast. Hurricane Iniki in September 1992 had a large impact in this biotope offshore of Keopuka resulting in much of the coral being broken down into small pieces. Due to its rather delicate branching nature, *Porites compressa* is intolerant of wave action and is easily broken. Offshore of Keopuka most of the *Porites compressa*was severely impacted by the storm and coverage by this species has not returned. However, this coral community is slowly recovering as evidenced by the numerous recruits and small colonies established throughout this biotope.

Where present, the coral *Porites compressa* provides considerable small-scale cover for small fishes and invertebrates. Thus a number of fishes and invertebrates are commonly seen in this biotope; among these are damselfishes, butterfly fishes, angelfishes, cardinalfishes, squirrelfishes, moray eels and small wrasses. Besides these fishes, many cryptic invertebrates are also found in this biotope. Among these are the sponges *Plakortis simplex* and *Terpios zeteki*, the soft coral *Anthelia edmondsoni*, cone shells (*Conus imperialis*, *C. miles* and *C. distans*), the phyllidiid (*Phyllidia varicosa*), banded shrimp (*Stenopsus hispidus*), marbled shrimp (*Saron marmoratus*), hermit crabs (*Dardanus* spp.), starfish (*Linckia multiflora*), sea cucumbers or loli (*Holothuria pardalis*, *H. edulis* and *H. atra*) and sea urchins (*Eucidaris metalaria*, *Chondrocidaris gigantea* and *Heterocentrotus mammillatus*).

The submarine slopes provide large scale vertical relief attracting wandering predators such as the mu or emperor (*Monotaxis grandoculis*), uku or grey snapper (*Aprion virescens*) and jacks or papio (several species of the family Carangidae).

Two stations were established to sample the biotope of *Porites compressa*, one of these (station 3 was located offshore of the shoreline heiau at the south boundary of the project site and the second (station 6) offshore of Keawekaheka Point. Station 3 sampled the biotope of *Porites compressa* about 45 m from the shoreline at a depth between 13 and 14 m. The transect was established roughly parallel to shore along the top of a steep slope dropping into more than 30 m of water. The substratum at this station is comprised primarily of emergent smooth basalt boulders and dead broken pieces of *Porites compressa* which was probably created when Hurricane Iniki struck this coast in 1992. The results of the quantitative survey carried out at this station in April 2000 are given in Table 5. Two algal species (*Halimeda opuntia* and *Asparagopsis taxiformis*) had a mean coverage of 0.4% and six coral species had a mean coverage of 6.4%. Three corals, e.g., *Porites compressa*, *P. lobata* and *Pocillopora meandrina* contributed the most to the coverage. The invertebrate census noted five species including the red miter shell (*Mitra papalis*), the christmas tree worm (*Spirobranchus gigantea*) and two sea

urchin species - the green urchin (*Echinometra mathaei*), black urchin (*Tripneustes gratilla*) as well as the coral eating starfish, *Acanthaster planci*. The fish census noted 349 individuals amongst 29 species. The most abundant species include the damselfish (*Chromis vanderbilti*), smalltail wrasse (*Pseudojuloides cerasinus*), brown surgeonfish or ma'i'i'i (*Acanthurus nigrofuscus*), bluelined surgeonfish or maiko (*Acanthurus nigroris*) and the yellow tang or lau'ipala (*Zebrasoma flavescens*). The standing crop of fish at station 3 was estimated to be 109 g/m^2. Species contributing most heavily to this biomass include the palenose parrotfish or uhu (*Scarus psittacus* - 7% of the total), a single large redlip parrotfish or palukaluka (*Scarus rubroviolaceus*) and the orangebar surgeonfish or na'ena'e (*Acanthurus olivaceus*).

Station 6 sampled the biotope of *Porites compressa* about 85 m from the shoreline in water from 15 to 17 m deep. This station was established again along the top edge of a very steep rubble slope dropping away to depths in excess of 30 m. As with the previous station, the substratum is a mix of dead *Porites compressa* rubble with some emergent smooth basalt. The results of the quantitative survey carried out at Station 6 are given in Table 6. The quadrat survey noted four macroalgal species (*Porolithon onkodes*, *Asparagopsis taxiformis*, *Turbinaria ornata* and *Botryocladia skottsbergii*) having a mean coverage of 1.4%, the soft coral, *Anthelia edmondsoni* with a mean coverage of 0.03% and six coral species (*Porites lobata*, *P. compressa*, *Pocillopora meandrina*, *P. eydouxi*, *Montipora verrucosa* and *Pavona varians*) having a mean coverage of 16.1%. The macroinvertebrate census noted six species: the rock oyster (*Spondylus tenebrosus*), nudibranch (*Phyllida varicosa*), cone shell (*Conus miles*), christmas tree worm (*Spirobranchus gigantea*), black sea urchin (*Tripenustes gratilla*) and the black sea cucumber (*Holothuria atra*). There were 32 species of fish and 274 individuals censused at this station. The most abundant species were the damselfishes (*Chromis vanderbilti*, *C. agilis*), smalltail wrasse (*Pseudojuloides cerasinus*), ma'i'i'i (*Acanthurus nigrofuscus*), and the goldring surgeonfish or kole (*Ctenochaetus strigosus*). The standing crop of fishes was estimated to be 109 g/m^2 and the species contributing the most include the bulletnose parrotfish or uhu (*Scarus sordidus* - 16%), a single palukaluka (*Scarus rubroviolaceus* - 13%) and the orangespine unicornfish or umaumalei (*Naso lituratus*) comprising 14% of the total estimated weight at this station.

TABLE 5. Summary of the benthic survey conducted at station 3 approximately 55 m offshore and just north of the shoreline heiau near the south boundary of the Keopuka project site South Kona District, Hawaii in the biotope of *Porites compressa* on 21 April 2000. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 13 to 14 m; mean coral coverage is 6.4% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 0m	5m	10m	15m	20m	25m
Algae						
Halimeda opuntia				0.1		
Asparagopsis taxiformis						2.0
Corals						
Porites lobata	12.0	2.5		0.2	0.1	2.2
Porites compressa	6.0		0.9	1.0		0.4
Pocillopora meandrina	0.8	0.1	3.0	5.5	0.3	3.0
Montipora verrucosa			0.1	0.1	0.1	
Cyphastrea ocellina			0.1			
Fungia scutaria						0.1
Sand			6.0	4.0	1.0	
Rubble	44.2	97.4	89.9	89.1	98.5	52.3
Hard Substratum	37.0					40.0

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	4.0
Porites compressa	2.0
Sand	4.0
Rubble	86.0
Hard Substratum	6.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Mitra papalis	1
Phylum Annelida	
Spirobranchus giganteа	3
Phylum Echinodermata	
Echinometra mathaei	6
Tripneustes gratilla	3
Acanthaster planci	1

D. Fish Census (4 x 25m)
29 Species
349 Individuals
Estimated Biomass = 109 g/m^2

TABLE 6. Summary of the benthic survey conducted at station 6 approximately 85 m offshore of Keawekaheka Point, Keopuka, South Kona District, Hawaii in the biotope of *Porites compressa* on 21 April 2000. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranged from 15 to 17 m; mean coral coverage is 16.1% (quadrat method).

A. Quadrat Survey

Species	Quadrat Number 0m	5m	10m	15m	20m	25m
Algae						
Porolithon onkodes	4.0					
Asparagopsis taxiformis					2.0	1.7
Turbinaria ornata						0.1
Botryocladia skottsbergii					0.6	
Soft Corals						
Anthelia edmondsoni			0.2			
Corals						
Porites lobata	2.0	1.2	0.3	0.4	2.5	1.0
Porites compressa	21.0		1.0			
Pocillopora meandrina	2.0	8.5	9.0	2.5	15.0	27.0
Pocillopora eydouxi						1.0
Montipora verrucosa					0.3	0.3
Pavona varians	1.3					
Sand		3.0	5.0	10.0		
Rubble		77.3	24.5	47.1	39.6	12.0
Hard Substratum	69.7	10.0	60.0	40.0	40.0	57.0

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	2.0
Porites compressa	4.0
Pocillopora meandrina	4.0
Sand	2.0
Rubble	66.0
Hard Substratum	22.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	1
Phyllidia varicosa	1
Conus miles	1
Phylum Annelida	
Spirobranchus gigantea	4
Phylum Echinodermata	
Tripneustes gratilla	11
Holothuria atra	1

D. Fish Census (4 x 25m)
32 Species
274 Individuals
Estimated Biomass = 108 g/m^2

3. The Biotope of *Porites lobata*

The biotope of *Porites lobata* is situated shoreward of the biotope of *Porites compressa* in waters from 4 to 10 m in depth. In the survey area, the biotope of *Porites lobata* appears as a near-continuous feature. The characteristic feature of this biotope is the presence of the coral, *Porites lobata*; colonies of this species are known to attain diameters in excess of four meters and at this size, may be greater than 200 years of age. In this study several colonies were seen near Keawekaheka Point that had basal diameters of up to 1.5 m. Further north offshore of the Hokuli'a project site, individual colonies of this same coral species were seen with basal diameters in excess of 3.5 m. The differences in size are probably related to the degree of exposure to occasional high energy surf with the Keopuka area receiving more impact.

Often associated with the large *P. lobata* colonies is a characteristic assemblage of fishes and invertebrates that diurnally shelter beneath the coral. Among these are some species of commercial interest including the squirrelfish or menpachi (*Myripristes amaenus*), red goatfish or weke'ula (*Mulloides vanicolensis*), spiny lobsters or 'ula (*Panulirus penicillatus*), the slipper lobster or ula'papa (*Paribaccus antarcticus*) and the tiger cowry or leho (*Cypraea tigris*).

Two stations (station numbers 2 and 5) were established to sample the biotope of *Porites lobata*. Station 2 was established about 30 m offshore of the shoreline heiau close to the south boundary of the project site in water from 6.4 to 8.2 m in depth. The results of the quantitative survey carried out at this station are given in Table 7. The quadrat survey noted one algal species, limu kohu (*Asparagopsis taxiformis*) with a mean coverage of 2% and six coral species (*Porites lobata, P. compressa, Pocillopora meandrina, Montipora verrucosa, M. patula* and *Pavona varians*) having a mean coverage of 27.9%. The dominant coral species is *Porites lobata* in this zone. The macroinvertebrate census noted six species including the rock oyster (*Spondylus tenebrosus*), christmas tree worm (*Spirobranchus gigantea*), and four sea urchin species: *Tripneustes gratilla, Echinometra mathaei, Echinostrephus aciculatum* and *Echinothrix calamaris*. The fish census at this station noted 31 species and 346 individuals. The most abundant species were the damselfish (*Chromis vanderbilti*), ma'i'i'i (*Acanthurus nigrofuscus*) and the na'ena'e (*Acanthurus olivaceus*). The standing crop was estimated to be 238 g/m² and the most important species by weight include the uhu (*Scarus sordidus* - 6%), the umaumalei (*Naso lituratus* - 22%) and the na'ena'e (*Acanthurus olivaceus*) comprising 51% of the total weight present at this station.

TABLE 7. Summary of the benthic survey conducted at station 2 approximately 30 m offshore and just north of the shoreline heiau near the south boundary of the Keopuka project site South Kona District, Hawaii in the biotope of *Porites lobata* on 21 April 2000. Results of the 6 m² quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 6.4 to 8.2 m; mean coral coverage is 27.9% (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Asparagopsis taxiformis	0.3	0.1	3.7	8.0		
Corals						
Porites lobata	7.0	2.1	23.0	24.0	65.0	9.0
Porites compressa				3.0	0.7	0.4
Pocillopora meandrina	17.0	7.5	3.2	1.7		2.3
Montipora verrucosa	0.2					
Montipora patula	1.5					
Pavona varians					4.0	
Hard Substratum	74.0	90.3	70.1	63.3	30.3	88.3

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	16.0
Porites compressa	2.0
Pocillopora meandrina	2.0
Montipora patula	4.0
Hard Substratum	76.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	1
Phylum Annelida	
Spirobranchus gigantea	19
Phylum Echinodermata	
Tripneustes gratilla	2
Echinometra mathaei	33
Echinostrephus aciculatum	1
Echinothrix calamaris	1

D. Fish Census (4 x 25m)

31 Species
346 Individuals
Estimated Biomass = 238 g/m²

Station 5 was established about 45 m offshore of Keawekaheka Point in water about 8 m in depth. The substratum at this station is a mix of basalt boulders, relatively flat pahoehoe and the coral, *Porites lobata*. The results of the quantitative of station 5 are summarized in Table 8. The quadrat survey noted one coralline algal species (*Porolithon onkodes*) with a mean coverage of 0.8%, the soft coral, *Palythoa tuberculosa* having a mean coverage of 0.1% and six coral species. These corals are *Porites lobata, P. compressa, Pocillopora meandrina, Montipora verucosa, M. patula* and *Leptastrea purpurea* collectively having a mean coverage of 23.3%. Seven macroinvertebrate species were noted in the census area; these are the rock oyster (*Spondylus tenebrosus*), christmas tree worm (*Spirobranchus giganteа*), sea urchins (*Echinostrephus aciculatum, Heterocentrotus mammillatus, Echinometra mathaei*), sea cucumber (*Holothuria atra*) and starfish (*Linckia multiflora*). The fish census noted 27 species and 274 individuals; the most common species were the damselfish (*Chromis agilis*), ma'i'i'i (*Acanthurus nigrofuscus*), kole (*Ctenochaetus strigosus*) and the lau'ipala (*Zebrasoma flavescens*). The standing crop of fishes was estimated to be 212 g/m 2 and the species making the largest contribution to this biomass included the sleek unicornfish or kala holo (*Naso hexacanthus* - 31%), na'ena'e (*Acanthurus olivaceus* - 22%), umaumalei (*Naso lituratus* - 8%) and a single broomtail filefish or loulu (*Alutera scripta*) making up 6% of the total standing crop at this station.

4. The Biotope of Boulders

The biotope of boulders occurs in shallow water close to the shoreline along the West Hawaii coast. Typically, basalt boulders dominate the substratum in this biotope. These boulders are usually situated in a narrow band that approximately parallels the shoreline just seaward and at the base of the near vertical pahoehoe bench that constitutes the shoreline at Keopuka. The water depths typically range from about 4 to 7 m in this biotope. The width of the biotope of boulders is usually about 10 to 40 m and this zone is a near-continuous feature along the project site coast. The physical extent of the biotope of boulders is shown in Figure 2.

TABLE 8. Summary of the benthic survey conducted at station 5 approximately 45 m offshore of Keawekaheka Point, Keopuka, South Kona District, Hawaii in the biotope of *Porites lobata* on 21 April 2000. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth was 8 m; mean coral coverage is 23.3% (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Porolithon onkodes	1.0	1.5			2.0	
Soft Corals						
Palythoa tuberculosa		0.6				
Corals						
Porites lobata	5.0	4.0		11.0	3.5	14.0
Porites compressa			2.2			
Pocillopora meandrina	26.0	13.0	9.0	14.0	14.0	16.0
Montipora verrucosa		2.0		2.7		1.5
Montipora patula				1.0		
Leptastrea purpurea				1.0		
Sand	2.0					
Hard Substratum	66.0	78.9	88.8	70.3	80.5	68.5

B. 50-Point Analysis

Species	Percent of the Total
Algae	
Asparagopsis taxiformis	2.0
Corals	
Porites lobata	4.0
Pocillopora meandrina	16.0
Hard Substratum	88.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	2
Phylum Annelida	
Spirobranchus giganteа	49
Phylum Echinodermata	
Echinostrephus aciculatum	1
Heterocentrotus mammillatus	3
Linckia multiflora	1
Echinometra mathaei	29
Holothuria atra	1

D. Fish Census (4 x 25m)

27 Species
274 Individuals
Estimated Biomass = 212 g/m²

Because this biotope is found in shallow water, it is subjected to occasional impact of storm surf which retards the development of most corals. Other than some encrusting coralline and microalgal algae species, as well as a small amount of two coral species (*Pocillopora meandrina* and *Porites lobata*), there is little obvious sessile biota in this biotope. However, the presence of many large basalt boulders (diameters from 1 to 3 m) provide considerable cover for a diversity of fish species. Two stations (numbers 1 and 4) sampled the biota in this biotope.

Station 1 was established approximately 10 m offshore of a small point just north of the heiau adjacent to the south boundary of the Keopuka project site. The substratum at this station is a mix of relatively smooth pahoehoe with large basalt boulders scattered across it. These boulders range from about 1 to 3.5 m in diameter and are spaced from contact between each to more than 3 m apart. The shoreline just shoreward of this station is a pahoehoe flow that drops abruptly into the ocean forming a near-vertical cliff. Surf on the day of sampling (21 April 2000) did not permit careful examination of the area inshore of the station.

The results of the quantitative survey carried out at station 1 are summarized in Table 9. The quadrat survey noted two macroalgal species (*Asparagopsis taxiformis* and *Turbinaria ornata*) with a mean coverage of 0.2% and four coral species (*Porites lobata, Pocillopora meandrina, Montipora verrucosa* and *Pavona varians*) having a mean estimated coverage of 16.3%. The macroinvertebrate census noted seven species including the rock oyster (*Spondylus tenebrosus*), cone shells (*Conus marmoratus* and *C. miles*), christmas tree worm (*Spirobranchus gigantea*), brown hermit crab (*Aniculus strigatus*) and sea urchins (*Echinometra mathaei* and *Heterocentrotus mammillatus*). The fish census noted 220 individual fish among 27 species. The most common species were the damselfish (*Chromis vanderbilti*), ma'i'i'i (*Acanthurus nigrofuscus*), na'ena'e (*Acanthurus olivaceus*) and the lau'ipala (*Zebrasoma flavescens*). The standing crop of fish was estimated to be 154 g/m² and three species comprised the majority of the biomass. These species were the na'ena'e (*Acanthurus olivaceus* - 61% of the total), the ma'i'i'i (*Acanthurus nigrofuscus* - 7%) and the lau'ipala (*Zebrasoma flavescens*) making up 4% of the biomass at this station.

TABLE 9. Summary of the benthic survey conducted at station 1 approximately 10 m offshore and just north of the shoreline heiau near the south boundary of the Keopuka project site South Kona District, Hawaii in the biotope of boulders on 21 April 2000. Results of the 6 m² quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 4.6 to 5.5 m; mean coral coverage is 16.3% (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Asparagopsis taxiformis					0.8	
Turbinaria ornata					0.2	
Corals						
Porites lobata	7.0	4.7	1.0	3.8	21.0	27.0
Pocillopora meandrina	7.7	8.3	2.0	3.7	1.7	2.0
Montipora verrucosa	3.5	2.8	0.1	0.4		
Pavona varians						1.0
Sand	1.5	3.0	6.0	3.0		
Hard Substratum	80.3	81.2	90.9	89.1	76.3	70.0

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	8.0
Pocillopora meandrina	8.0
Montipora patula	2.0
Sand	6.0
Hard Substratum	76.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	4
Conus marmoratus	1
Conus miles	1
Phylum Annelida	
Spirobranchus gigantea	41
Phylum Arthropoda	
Aniculus strigatus	1
Phylum Echinodermata	
Echinometra mathaei	122
Heterocentrotus mammillatus	1

D. Fish Census (4 x 25m)

27 Species
220 Individuals
Estimated Biomass = 154 g/m²

TABLE 10. Summary of the benthic survey conducted at station 4 approximately 30 m offshore of Keawekaheka Point, Keopuka, South Kona District, Hawaii in the biotope of boulders on 21 April 2000. Results of the 6 m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 3.7 to 5 m; mean coral coverage is 20.6% (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Porolithon onkodes					2.0	2.0
Soft Corals						
Anthelia edmondsoni	1.0	2.0	0.6			
Corals						
Porites lobata	8.0	2.8	7.0	3.0		3.5
Pocillopora meandrina	7.0	16.0	13.0	12.0	23.0	14.0
Montipora verrucosa	4.0		2.0	1.0		
Sand			2.0	3.0		
Hard Substratum	80.0	79.2	75.4	81.0	75.0	80.5

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	6.0
Pocillopora meandrina	12.0
Sand	2.0
Hard Substratum	80.0

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Drupa morum	1
Spondylus tenebrosus	3
Conus miliaris	1
Latirus nodus	1
Phylum Annelida	
Loimia medusa	1
Spirobranchus giganteа	9
Phylum Arthropoda	
Panulirus penicillatus	3
Phylum Echinodermata	
Echinometra mathaei	1
Heterocentrotus mammillatus	1

D. Fish Census (4 x 25m)

39 Species
429 Individuals
Estimated Biomass = 443 g/m^2

Station 4 sampled the biotope of boulders about 30 m offshore of Keawekaheka Point in water from 3.7 to 5 m in depth. Shoreward of the station a emergent pahoehoe bench drops abruptly into the sea to a depth of 3 to 4 m. The substratum is primarily smooth pahoehoe sloping gently seaward with large basalt boulders scattered across it. These boulders are from about 1 to 4 m in diameter and are spaced from being in contact with one another to about 4 m apart. The large number of boulders creates considerable local shelter for fishes. Table 10 presents a summary of the quantitative survey carried out at station 4. The quadrat survey noted the coralline algal species, *Porolithon onkodes*, having a mean coverage of 0.7%, the soft coral (*Anthelia edmondsoni*) with a mean coverage of 0.6% and three coral species (*Porites lobata*, *Pocillopora meandrina* and *Montipora verrucosa*) having an estimated mean coverage of 20.6%. Nine macroinvertebrate species were encountered in the 4 x 25 m transect area; these species were the drupe (*Drupa morum*), rock oyster (*Spondylus tenebrosus*), cone shell (*Conus miliaris*) spindle shell (*Latirus nodus*), two polychaete species (*Spriobranchus gigantea* and *Loimia medusa*), three spiny lobsters or 'ula (*Panulirus penicillatus*) and two sea urchin species (*Echinometra mathaei* and *Heterocentrotus mammillatus*). Thirty-nine species of fishes (429 individuals) were censused at station 4. The most abundant species were the brick soldierfish or menpachi (*Myripristes amaenus*), yellowfin goatfish or weke'ula (*Mulloides vanicolensis*), sergeant major or mamo (*Abudefduf abdominalis*), damselfish (*Chromis vanderbilti*), whitebar surgeonfish or maiko'iko (*Acanthurus leucoparleus*), ma'i'i'i (*Acanthurus nigrofuscus*), kole (*Ctenochaetus strigosus*), and the black surgeonfish (*Ctenochaetus hawaiiensis*). The standing crop of fishes was estimated to be 443 g/m^2 and the species contributing most heavily to this biomass included the umaumalei (*Naso lituratus* 11%), the black surgeonfish (*Ctenochaetus hawaiiensis* - 12%) and the weke'ula (*Mulloides vanicolensis*) making up 24% of the standing crop at this station.

Table 11 summarizes the quantitative biological data collected at the six permanently marked stations in April 2000. These same data are presented as means by each of the three biotopes or zones recognized and sampled in this study in Table 12. The Keopuka data are similar to data collected using the same techniques offshore of the Hokuli'a project site directly adjacent and to the north of the Keopuka project. In general, fish communities are well-developed offshore of Keopuka; coral communities are likewise well-developed but the impact of Hurricane Iniki in September 1992 has had a lasting impact in the *Porites compressa* community as evidenced by the relatively low coverage by this species in the deeper *P. compressa* biotope.

TABLE 11. Summary of the quantitative measurements made on biological parameters by station (numbers 1 - 6) in the 21 April 2000 survey.

Parameter	Station Number 1	2	3	4	5	6	Mean
No. Algal Spp.	2	1	2	1	1	4	2
% Algal Cover	0.2	2.0	0.4	0.7	0.8	1.4	0.9
No. Coral Spp.	4	6	6	3	6	6	5
% Coral Cover	16.3	27.9	6.4	20.6	23.3	16.1	18.4
No. Invert Spp.	7	6	5	9	7	6	7
No. Invert Ind.	171	57	14	21	86	19	61
No. Fish Spp.	27	31	29	39	27	32	31
No. Fish Ind.	220	346	349	429	274	274	315
Biomass (g/m²)	154	238	109	443	212	108	211

TABLE 12. Summary of the means of the quantitative measurements made on parameters in each of the three major biotopes or ecological zones identified in this study. These biotopes are the biotope of boulders (stations 1 and 4), the biotope of *Porites lobata* (stations 2 and 5), and the biotope of *Porites compressa* (stations 3 and 6).

Parameter	Biotopes Boulders	*P. lobata*	*P. compressa*
No. Algal Spp.	2	1	3
% Algal Cover	0.5	1.4	0.9
No. Coral Spp.	4	6	6
% Coral Cover	18.5	25.6	11.3
No. Invert Spp.	8	7	6
No. Invert Ind.	96	72	17
No. Fish Spp.	33	29	31
No. Fish Ind.	325	310	312
Biomass (g/m²)	299	225	109

5. Fishery Resources

During the course of the fieldwork from 1991 to present many commercially important marine species have been encountered in the waters fronting the Keopuka site as well as offshore of the adjacent Hokuli'a parcel. This coastline has historically been important from the standpoint of fishery resources. In the prehistoric and early historic periods, the Hokukano-Keopuka coastline was important for fishery resources which were traded for agricultural products from the mauka hinterland (Handy, *et al.* 1978). In modern times the relatively abundant fishery resources has not only attracted fishermen but also commercial dive tour operations to the area.

A summary of some of the important edible species seen during the survey work is given below. As noted above, the shelter afforded by the basalt boulders in the biotope of boulders allows for a greater diversity of fishes in this zone than encountered in many other habitats. The proximity of this potentially productive biotope to the shoreline assists today's fishermen in their quest for fish as it must have in times past. Qualitative observations made in the biotope of boulders fronting the Keopuka project site noted a number of species of commercial and recreational interest. In the emergent intertidal the urchin or hauke'uke kaupali (*Colobocentrotus atratus*) and limpets or opihi makaiauli (*Cellana exarata*) and opihi alinalina (*Cellana sandwicensis*) are seen. Subtidally in the biotope of boulders are a number of fishes of commercial and recreational interest including the brown moray eel or puhi paka (*Gymnothorax flavimarginatus*), mullet or 'anae (*Mugil cephalus*), flagtails or aholehole (*Kuhlia sandvicensis*), baitfishes or nehu (*Stolephorus purpureus*), trumpetfish or nunu (*Aulostomus chinensis*), squirrelfishes or ala'ihi (*Adioryx lacteoguttatus, A. xanththerythrum*), soldierfish or menpachi (*Myripristes amaneus*), hawkfishes such as the po'opa'a (*Cirrhites pinnulatus*), the hilu piliko'a (*Paracirrhites forsteri*), the emperor or mu (*Monotaxis grandoculis*), the chub or nenue (*Kyphosus bigibbus*), several jack or papio species (family Carangidae - such as the omilu *Caranx melampygus*, paopao *Gnathodon speciosus*), yellowfin goatfish or weke'ula (*Mulloides vanicolensis*), the white goatfish or weke (*Mulloides flavolineatus*), the sidespot goatfish or malu (*Parupeneus pleurostigma*), the blue goatfish or moano kea (*Parupeneus cyclostomus*), the doublebar goatfish or munu (*Parupeneus bifasciatus*), the manybar goatfish or moano (*Parupeneus multifasciatus*), blue spot grouper or roi (*Cephalopholis argus*), bluelined snapper or ta'ape (*Lutjanus kasmira*), mamo (*Abudefduf abdominalis*), bigeye or aweoweo (*Priacanthus cruentatus*), snapper or wahanui (*Alphareus furcatus*), grey snapper or uku (*Aprion virescens*), yellowstripe wrasse or hilu (*Coris flavovittata*), tableboss or a'awa (*Bodianus bilunulatus*), ornate wrasse or 'ohua (*Halichoeres ornatissimus*), ringtail wrasse or po'ou (*Cheilinus rhodochrous*),, belted wrasse or 'omaka (*Stethojulis balteata*), yellowtail coris or 'akilolo (*Coris gaimard*), saddleback wrasse or hinalea lauwili (*Thalassoma duperrey*), christmas wrasse or awela (*Thalassoma fuscum*), bird wrasse or 'akilolo (*Gomphosus varius*), bulletnose parrotfish (*Scarus sordidus*), spectacled parrotfish or uhu'ahu'ula (*Scarus perspicillatus*), redlip parrotfish or palukaluka (*Scarus rubroviolaceus*), whitespot surgeonfish or 'api (*Acanthurus guttatus*), convict tang or manini (*Acanthurus triostegus*), maiko'iko (*Acanthurus leucoparieus*), na'ena'e (*Acanthurus olivaceus*), eye-stripe parrotfish or palani (*Acanthurus dussumieri*), achilles tang or paku'iku'i (*Acanthurus achilles*), ma'i'i'i (*Acanthurus nigrofuscus*), maiko (*Acanthurus nigroris*), ringtail surgeonfish or pualo (*Acanthurus blochii*), kole (*Ctenochaetus strigosus*), black surgeonfish (*Ctenochaetus hawaiiensis*), lau'ipala (*Zebrasoma flavescens*), sailfin tang or mane'one'o (*Zebrasoma veliferum*), umaumalei (*Naso lituratus*), bluespine unicornfish or kala (*Naso unicornis*), lei triggerfish or humuhumu lei (*Sufflamen bursa*), black triggerfish or humuhumu 'ele'ele (*Melichthys niger*), and pinktail triggerfish or humuhumu hi'ukole (*Melichthys vidua*). Several important invertebrates were also seen in this biotope including the seven-eleven crab or alakuma (*Carpilius maculatus*), the swimming crab (*Charybdis hawaiensis*), spiny lobsters or 'ula (*Panulirus penicillatus*), slipper lobsters or 'ula'papa (*Paribaccus antarcticus*), the drupe shell or makaloa (*Drupa morum*), the humpback cowry or leho ahi (*Cypraea mauritiana*) and the octopus or he'e (*Octopus cyanea*). Often at the base of the pahoehoe cliff that forms the shoreline is seen the subtidal limpet or opihi ko'ele (*Cellana talcosa*).

It should be noted that macroalgae or limu are not a common element along the Keopuka coastline. In the intertidal zone were seen limu 'aki'aki (*Ahnfeltia concinna*) and *Grateloupia phuquoensis*. Subtidally few algae were noted as given in Tables 4 through 9 and only one of these is commonly consumed by people. This species is limu kohu (*Asparagopsis taxiformis*) which is seasonally abundant in some areas during the spring as offshore of Keopuka.

Many of the same species above as well as other wandering predators and schooling species are commonly encountered along the steep drop off in the biotope of *Porites compressa*. Some of the species seen include the mackeral scad or opelu (*Decapterus macarellus*), the sleek unicornfish or kala holo (*Naso hexacanthus*), spotted unicornfish or kala lolo (*Naso brevirostris*), the milkfish or awa (*Chanos chanos*) and more jacks or papios including the amberjack or kahala (*Seriola dumerili*), leatherback or la'i (*Scomberoides laysan*), rainbow runner or kamanu (*Elagatis bipinnulata*), white ulua (*Caranx ignobilis*), papio (*Carangoides ferdau*), and the threadfin ulua or ulua kihikihi (*Alectis ciliaris*).

The shoreline at Keopuka is well-known in recreational fishing circles for yielding many large ulua (family Carangidae). This area has been fished by shore fishermen for many years using the "slide-bait" technique. A recent article in the "Hawaii Fishing News" (May 2000, page 12) by Capt. Rick Gaffney notes that there are more than 32,000 recreational ulua fishermen in Hawaii who generate as much as $30 million annually in pursuit of their quarry. Each year a small number of these fishermen are fortunate enough to land an ulua weighing 100 pounds or more putting these anglers in the coveted "100 Plus Club". A number of fish weighing 100 pounds or more are annually taken at the Keopuka site thus it is an important area to these individuals.

6. Fish Community Structure

Fish community structure may be defined as the abundance and diversity of fishes present in a given location. Thus community structure is determined by the numbers, sizes, and weights of each species of fishes present in the assemblage. In general the fish communities present offshore of the Keopuka project site are well-developed with many families represented. A summary of the standing crop of fishes by family for all stations is given in Table 13 and the complete results of the censuses undertaken at the six stations are given in Appendix A.

Studies conducted on coral reefs in Hawaii and elsewhere have estimated fish standing crops to range from 20 to 200g per square meter (Brock 1954, Brock *et al.* 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, much of the variation in standing crop appears to be related to the variation in the local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (5 to 20 g/m^2). Goldman and Talbot (1975) noted that the upper limit to fish biomass on coral reefs is about 200 g/m^2. Ongoing studies (Brock and Norris 1989) suggest that with the manipulation (increasing) of habitat space or food resources (Brock 1987), local fish standing crops may approach 2000 g/m^2. Thus under certain circumstances, coral reefs may be able to support much larger standing crops of fishes than previously realized.

Summaries of the standing crop of fishes by family for all stations are presented in Table 13. The biomass estimates were high (i.e., greater than 200 g/m^2) at stations 2, 4 and 5. The most important contributors to these high standing crops were the surgeonfishes (family Acanthuridae) with an overall mean of 63% and parrotfishes (family Scaridae) having an overall mean of 12%. These relatively high standing crops are not too unusual on well-developed Hawaiian nearshore communities that have received little disturbance. As noted above, the abundance of cover and shelter at these stations plays a role in the presence of well-developed fish communities. - Although not quantitatively sampled in this study, the lack of fishes over sand as mentioned above is not unusual where standing crop estimates in Hawaiian sand habitats range from 0 to about 20 g/m^2 (Brock 1954, Brock *et al.* 1979).

TABLE 13. Summary of the estimated standing crop of fishes given as a percentage and calculated from estimated individual fish lengths observed in the field for families of fishes that collectively contributed 97% or more to the total standing crop at the six permanent stations sampled on 21 April 2000.

Family	Station Number 1	2	3	4	5	6
Acanthuridae	87.1	81.3	59.1	41.3	73.7	36.0
Balistidae	0.6	1.6	2.3	0.8	6.6	3.4
Carangidae	2.9					
Chaetodontidae	1.2	0.9	1.2	0.5	1.3	1.8
Cirrhitidae	0.4	0.2	0.3	0.8	0.2	0.4
Holocentridae				4.3		
Kyphosidae	2.0	0.8		1.3	2.0	
Labridae	3.0	2.7	7.5	2.1	2.4	16.4
Lutjanidae	1.3			0.8		1.4
Monacanthidae	0.5			0.3	6.0	
Mullidae	0.4	3.3	4.0	39.3	0.5	1.6
Ostracioniidae	0.1		0.2			
Pomacanthidae			0.2			0.2
Pomacentridae	0.2	0.3	0.8	2.7	0.6	0.5
Scaridae		6.2	23.9	4.4	6.5	30.4
Serranidae		1.0		1.4		4.4
Tetraodontidae		1.6				
Zanclidae	0.3		0.5		0.2	2.5
% Total	100	99.9	100	100	100	100

Occasionally high standing crops of fishes are due to the chance encounter with roving predators or schooling species. For example at station 1 a single omilu (*Caranx melampygus*) which often forages as a single predator comprised 3% of the total estimated biomass at that station. At station 4 a school of yellowfin goatfish or weke'ula (*Mulloides vanicolensis*) made up 23% of the total present and at station 5 a school of sleek unicornfish or kala holo (*Naso hexacanthus*) passed through the transect area during censusing resulting increasing the biomass at that station by 31%.

7. Invertebrate Community Structure

Excluding the corals, the invertebrate censuses did not yield any unusual results; species common to the habitats examined in this study are the same as one would commonly encounter elsewhere in the Hawaiian Islands in similar habitats. As noted above, the census techniques used here for macroinvertebrates assesses only those species that are large (greater than 2 cm in some dimension), diurnally exposed, and are motile. The method is probably accurate for some of the echinoderm species but little else. Thus the macroinvertebrate census data are of limited value for describing the benthic community. Sessile and/or colonial forms are assessed by use of the quadrat technique.

Physical disturbance from occasional storm surf is one of the most important parameters in determining the structure of Hawaiian coral communities (Dollar 1982). Numerous studies have shown that occasional storm generated surf may keep coral reefs in a non-equilibrium or sub-climax state (Grigg and Maragos 1974, Connell 1978, Woodley *et al.* 1981, Grigg 1983). Indeed, the large expanses of near-featureless lava or limestone substratum present around much of the Hawaiian Islands at depths less than 30 m attest to the force and frequency of these events (Brock and Norris 1989). These same wave forces also impinge and impact fish communities (Walsh 1983).

Quantitative biological surveys carried out in the waters fronting the Hokuli'a project site directly north of Keopuka both before and after Hurricane Iniki demonstrate the impact of that storm on coral community development (see Brock 1999). The results of the biological survey offshore of Keopuka suggest that portions of the site, like many other Hawaiian marine communities receives considerable, albeit occasional, wave impact and these communities were impacted by Hurricane Iniki with damage still apparent in certain areas. In general, the open substratum present in much of the biotope of *Porites compressa* fronting the project site is probably the result of wave action retarding the development of the coral communities. The small size of many of the coral colonies suggests that wave forces occur with sufficient frequency such that only small colonies are present and that making it evident that wave impact is important in structuring these benthic communities. The impact of wave forces is attenuated with increasing depth such that, in general, benthic community development is greater with increasing depth at the project site. However, large the energy associated with large waves (such as Hurricane Iniki) usually first impinges on deeper areas. Apparently, much of the wave energy

from this 1992 event impinged and heavily impacted the *Porites compressa* communities at depths between 10 and 25 m offshore of Keopuka and these communities have been slow in recovering.

Biological surveys usually show that benthic and fish community development is greatest in deeper areas (here the biotopes of *Porites compressa* and *Porites lobata*) and least in the biotope of sand. Marine communities with the greatest biological development are those receiving less disturbance in the form of wave impact (as in deeper water) as well as those found on hard and stable substratum. Both of these factors are requisite for the success of corals. The stable hard substratum and coral development creates shelter habitat for fish and other invertebrates.

8. Threatened and Endangered Species

During the course of the fieldwork considerable effort was made to determine if any green sea turtles (*Chelonia mydas*) were present in the waters fronting the Keopuka project site. Green sea turtles are a threatened species having been given that status in 1977-78. No turtles were seen during the course of the early qualitative surveys in 1991. In the April 2000 survey one juvenile turtle (straight line carapace length estimated at 50 cm) was seen offshore of Keawekaheka Point near biological station 6.

Green turtles are a common element in the nearshore waters along much of the West Hawaii coast albeit most individuals seen are juveniles (i.e., having straight line carapace lengths >75 cm). Green turtles typically rest on the bottom or under shelter and will forage on algae under the cover of darkness frequently on the intertidal bench habitat (Balazs 1980). Over much of the project site many areas were seen that could serve as appropriate resting habitat (i.e., caves, ledges, etc.) but very little algal forage was apparent anywhere in the project site. Additionally, very little algae were seen intertidally (such as *Pterocladia capillacea*) and this may be related to the high densities of herbivorous sea urchins (*Colobocentrotus atratus, Echinometra oblongata* and *E. mathaei*) which probably serve to effectively graze most of the algae down. As noted above, macroalgae was not commonly seen subtidally and this is also probably related to the abundance of sea urchins (*Heterocentrotus mammillatus, Echinothrix diadema, E. calamaris, Echinometra mathaei, Tripneustes gratilla*) and herbivorous surgeonfishes and parrotfishes.

A well-known pod of spinner porpoises (*Stenella longirostris*) is resident to Kealakekua Bay (probably a resting area) just south of the southern boundary of the Keopuka project site. No spinner porpoises were seen during the course of the fieldwork in the waters fronting the project site. Like the green sea turtle, spinner porpoises are protected.

It should be noted that the endangered humpback whale (*Megaptera novaeangliae*) is known to frequent island waters in their annual migrations to Hawaiian wintering grounds. They normally arrive in island waters about December and depart by April. In general their distribution in Hawaii appears to be limited to the 180 m (100 fathom) isobath and in shallower waters (Nitta and Naughton 1989). During past fieldwork in the Keopuka - Hokuli'a areas humpback whales have been seen and "heard" underwater during the winter months. In no cases have whales been seen within 1 to 1.5 km of the shoreline. No humpbacks were seen during the April 2000 field effort.

9. Recreational/Commercial Use

During the course of the fieldwork for both the Keopuka project as well as the Hokuli'a project we have noted considerable recreational use of the waters fronting the project site. SCUBA and snorkel dive tours utilize the waters north and south of Keopuka and many fishing vessels pass troll through this area. During our fieldwork we often noted from 2 to 9 dive tour boats offshore of Hokuli'a usually through the morning and mid-afternoon hours with a hiatus at noon. Dive tour vessels pass by Keopuka on their way to Kealakekua Bay and Cook's Monument. As noted above, the primary recreational use of the Keopuka shoreline and marine resources is by shoreline fishermen targeting primarily ulua. The waters offshore of Hokuli'a - Keopuka and Kealakekua Bay areas are important to the fishing charter industry -- Puu Ohau (Hokuli'a) is locally known as "Red Hill" and is an area where many Pacific blue marlin (*Makaira nigricans*) are caught.

C. Potential Impacts to Marine Communities with the Proposed Development

The diversity of the nearshore communities at Keopuka and environs have persisted under the present natural conditions of probably rare storm water runoff and groundwater input. - Despite probable rare surface water input and occasional wave events, the nearshore communities have persisted.

Sedimentation has been implicated as a major environmental problem for coral reefs. Sedimentation can occur naturally with storm water runoff and also with coastal construction when soils are exposed and rainfall occurs. Increases in turbidity may decrease light levels resulting in a lowering of primary productivity. Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading. Many benthic species including corals are capable of removing sediment settling on them but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual becomes buried. However the impact of sedimentation on Hawaiian reefs may be overstated. Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2000 tons of kaolin clay. These authors found that after two weeks there was no damage to the reef corals and associated communities except where the organisms were actually buried by the clay deposits for a period of more than two weeks.

The "during construction" phase of this development increases the potential for runoff to occur. Runoff occurs with high rainfall without appropriate mitigation to hold exposed soils in place. If prudent construction practices are followed (i.e., not uncovering too much soil at any one time, building temporary catchment and settling basins, etc.) and construction is not hampered by high rainfall events, little or no sediment should reach the sea. Following project completion, the soil should be covered and/or planted and catchment basins developed such that the generation of sediment from the project site reaching the sea will be less than occurs today.

The chemical environment may, to a large degree, dictate the structural and functional characteristics of aquatic communities thus alteration in this environment may serve to change marine communities. If changes in physio-chemical inputs are not too great, a potential for chronic, low-level disturbance can result in adjacent aquatic communities. In the development and operation of a coastal community in a relatively low rainfall setting such as at Keopuka, chronic disturbance may possibly come from the irrigation and upkeep of golf courses. In many dry coastal Hawaiian resorts, golf courses are irrigated by a combination of brackish groundwater and treated sewage effluent. In addition, dry fertilizers, pesticides and herbicides are applied to these courses. The nutrient subsidy from fertilizers and sewage as well as the pesticides and herbicides placed on these golf courses could migrate downward to the groundwater table and move laterally in the low salinity watertable towards the shoreline.

The potential for such impact may be addressed through an examination of water quality data collected on the West Hawaii coast at Waikoloa approximately 70 km to the north of Keopuka. A relatively long-term and routine water quality and aquatic community monitoring program has been in place at Waikoloa and is carried out by the University of Hawaii. A characteristic feature of West Hawaii is its diffuse groundwater discharge at the shoreline due to the island's geologically young lavas (Cox *et al.* 1969). The high porosity of these young lavas will not support water contained above sealevel near the shoreline, resulting in a system where groundwater moves rapidly through the lava towards the sea and seawater readily intrudes (Cox *et al.* 1969). In this porous setting are depressions or pools that extend down into the watertable; these ponds are termed anchialine pools.

The characteristics of the groundwater entering the ocean at Waikoloa have been described by Maciolek and Brock (1974), Bienfang (1977), Ziemann (1984, 1985), U.S. Army Corps of Engineers (1985), Brock and Norris (1987, 1988a) and Brock *et al.* (1988). Since April 1986 a regular program of water quality sampling and monitoring of benthic communities has been undertaken; the program monitors tide state, salinity, nutrient, pesticide and herbicide levels in anchialine pools, the nearshore marine environment and at other West Hawaii locations with no surrounding development.

Summarizing the data presented by Brock and Norris (1987, 1988a) and Brock *et al.* (1988) at Waikoloa, the concentration of inorganic nutrients is high in inland (mauka) pools and decreases in a seaward direction. Inland of the pools is golf course development; mauka of the golf course and planted grounds are a series of wells dug for irrigation purposes. Nutrient concentrations are low in the wells. Brock and Norris (1988a) concluded that the source of high nutrient levels observed in the pools was from the Waikoloa golf course which is heavily fertilized with sewage enriched irrigation water and commercial fertilizers. It was suggested that leaching of these materials through the thin topsoil to the groundwater beneath was occurring. Brock and Norris (1988a) found no statistically significant changes in water quality from the 1986-1988 period during the operation of the resort but significant changes had occurred in comparing the period prior to resort development (1977) to the 1986-88 period. The observed increases were for nitrate + nitrite nitrogen and orthophosphate. Despite these changes, these authors note that the 1986-88 mean concentrations of nitrate + nitrite nitrogen, ammonia nitrogen, orthophosphate, silicate, total organic carbon in the waters from the developed Waikoloa setting fall well within the range of values measured in anchialine and shoreline areas along the West Hawaii coast with no surrounding development. Furthermore the concentration gradient in nutrients at Waikoloa shows minimal elevation at the shoreline and 100 m seaward of the shore is not detectable (Brock and Norris 1988a). Other than arsenic, pesticides and herbicides applied at Waikoloa are not detectable; arsenic concentrations were the same in groundwater from either developed or control areas (with no surrounding development) suggesting that low levels of arsenic contamination are natural in Kona coast groundwater (Brock and Norris 1988a).

At Waikoloa mean nitrate+nitrite nitrogen concentrations reported by Brock and Norris (1988a) range from a high in mauka pools of 1,260 ug/l to 37.8 ug/l at the shoreline. In other locations naturally occurring nitrate nitrogen levels are greater; Johannes (1980) reported groundwater nitrate levels between 1,610 to 5,320 ug/l from Perth, Australia and Marsh (1977) noted nitrate nitrogen concentrations in Agana, Guam groundwater of 2,478 ug/l. The highest known concentration of nitrate+nitrite nitrogen consistently found along the West Hawaii coast is 2,800 ug/l in the Kukio land division, an area that, until recently, has had no surrounding or upland development (Brock unpublished data). Thus, high nitrate values are a naturally occurring phenomena in groundwater entering the sea on Hawaiian coastlines.

Periodic sampling of the aquatic biota of the anchialine pools at Waikoloa since 1972 (Maciolek and Brock 1974) to present have yielded no obvious change in ponds where exotic fish (i.e., non-native species such as topminnows and tilapia) have not been introduced. Brock and Norris (1988a) point out that the aquatic biota is unaffected by the nutrient loading. Possible mechanisms to the apparent insensitivity of the aquatic biota to the excess nutrients may be the characteristic short water residence time of ponds and the usual presence of large numbers of the herbivorous shrimp (opae'ula). Through their grazing, these crustaceans appear to keep many macrothalloid algal or limu species and possibly phytoplankton from otherwise dominating the system. Also, the insensitivity of the biota to high nutrient levels may be a reflection of their living in a habitat that naturally has a highly variable nutrient chemistry thus they are preadapted to such a system.

With the extremely low inorganic nutrient concentrations that typify marine waters, benthic algae rapidly strip out the nutrients found in any incoming groundwater at Waikoloa (Brock and Norris 1988a). Macrothalloid algal species are rare at Waikoloa probably due to the high grazing pressure exerted by herbivorous fishes and sea urchins in the shallow subtidal areas (Brock and Norris 1988b) as is the case in the waters fronting the Keopuka project site. The marine baseline survey of the waters fronting Waikoloa carried out in August 1988 found no unique or unusual marine communities but rather the marine fish and benthos of Waikoloa are very similar to those encountered elsewhere in other West Hawaii reef sites; there was no evidence of man-induced disturbance in these communities (Brock and Norris 1988b) suggesting that what little nutrient input has occurred has had no discernible impact.

The long-term studies at Waikoloa suggest that coastal development (in particular, golf courses) may increase the concentration of inorganic nutrients in the underlying groundwater but that these changes are (1) not chemically detectable outside of 100 m of shore, and (2) do not manifest any discernible change in the aquatic communities whether these communities are in brackish or marine waters. The Waikoloa development is situated on a very porous substrate of pahoehoe and a'a lava located just a few meters above mean sealevel and having only a thin (about 30 cm) layer of soil for planting. Due to the greater elevation, age and soil (greater thickness) in the Keopuka golf course, the opportunity for leaching of materials to the watertable at Keopuka is probably less than that at Waikoloa. Furthermore, if leaching of materials does occur, a greater period of time would pass prior to detection.

The data suggest that the development at Keopuka project site may, over a long period of time, increase the concentration of inorganic nutrients in the underlying watertable but that the increases will be less than seen in some natural systems in Hawaii. Furthermore, the Waikoloa data suggests that there should be no discernible impact due to changes on the nearshore marine communities fronting the project site due to changes in nutrient chemistry. The proposed water quality and marine life monitoring program should insure that no impact occurs to either the ground or nearshore waters or to the marine biota resident to those waters.

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Appendix A. Results of the 4 x 25m visual fish censuses carried out at 6 stations offshore of Keopuka on 21 April 2000. The estimated standing crop of fish is given at the foot of the table for each station.

SPECIES	1	2	3	4	5	6
HOLOCENTRIDAE						
Myripristis amaenus				31		
SERRANIDAE						
Cephalopholis argus		1		1		1
CARANGIDAE						
Caranx melampygus	1					
LUTJANIDAE						
Lutjanus kasmira				1		
Aphareus furcatus	1			1		1
MULLIDAE						
Mulloides flavolineatus				23		
Mulloides vanicolensis				38		
Parupeneus multifasciatus	1	3	3	2	1	4
Parupeneus bifasciatus		1	1	1		
KYPHOSIDAE						
Kyphosus bigibbus	1	1		2	1	
CHAETODONTIDAE						
Forcipiger flavissimus					3	1
Chaetodon lunula		1	1			
Chaetodon ornatissimus	2	2	1	2	2	2
Chaetodon quadrimaculatus	2	2		2	2	2
Chaetodon multicinctus		2	4	4	4	
POMACANTHIDAE						
Centropyge potteri			4			4
POMACENTRIDAE						
Abudefduf abdominalis				32		
Plectroglyphidodon johnstoni	1	1	1			
Plectroglyphidodon imparipe	1	1				
Chromis vanderbilti	88	175	217	52		33
Chromis hanui			6		4	7
Chromis agilis		4	6		88	105
Stegastes fasciolatus		1		9		

Appendix A. Continued

SPECIES	1	2	3	4	5	6
CIRRHITIDAE						
Paracirrhites arcatus	3	6	4	12	4	5
Paracirrhites forsteri	1			1		
Cirrhitus pinnulatus				1		
LABRIDAE						
Labroides phthirophagus		1	1	1	1	1
Bodianus bilunulatus						1
Cheilinus rhodochrous			1			1
Thalassoma duperrey	9	10	1	12	13	19
Gomphosus varius		3		2	3	1
Coris venusta	1					
Coris gaimard			1			
Pseudojuloides cerasinus			30			15
Stethojulis balteata	1			1		
Macropharyngodon geoffroy	1					
Halichoeres ornatissimus		6		1		
SCARIDAE						
Scarus sordidus		4		1	1	3
Scarus psittacus			1	2	2	1
Scarus rubroviolaceus			1			1
BLENNIIDAE						
Plagiotremus ewaensis		1	1			
ACANTHURIDAE						
Acanthurus leucopareius	5			37		
Acanthurus nigrofuscus	44	35	23	44	19	19
Acanthurus nigroris	11	14	12		13	
Acanthurus olivaceus	27	27	8	3	8	2
Acanthurus dussumieri						1
Acanthurus guttatus				2		
Acanthurus blochii	1	1				
Ctenochaetus strigosus		10	2	41	43	15
Ctenochaetus hawaiiensis				38	3	2
Zebrasoma flavescens	12	18	12	17	25	13
Naso lituratus	3	10	1	8	6	4
Naso hexacanthus			1		17	1
ZANCLIDAE						
Zanclus cornutus	1		1		1	5

Appendix A. Continued

SPECIES	1	2	3	4	5	6
BALISTIDAE						
Rhinecanthus rectangulus				1		
Melichthys niger		1		1	7	
Melichthys vidua						1
Sufflamen bursa	1	2	3	1	3	2
Xanthicthy mento		1				
ALUTERIDAE						
Alutera scripta					1	
MONACANTHIDAE						
Pervagor melanocephalus				1		
Cantherhines sandwichiensis	1			1	1	
OSTRACIIDAE						
Ostracion meleagris	1					
Ostracion whitleyi			1			
TETRAODONTIDAE						
Arothron meleagris		1				
Canthigaster jactator	1			1		1
Number of Individuals	220	346	349	429	274	274
Number of Species	27	31	29	39	27	32
Biomass (g/m2)	154	238	109	443	212	108

APPENDIX D

Draft Comprehensive Neashore and Coastal Water Quality Monitoring Report

DRAFT COMPREHENSIVE NEARSHORE AND COASTAL WATER QUALITY MONITORING PROGRAM IN SUPPORT OF THE DEVELOPMENT OF KEOPUKA LANDS

SOUTH KONA, HAWAII

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INTRODUCTION

The Keopuka Lands project site encompasses approximately 660 acres extending from the coastline to an elevation of about 1,400 feet fronting the Mamalahoa Highway (Hawaii Belt Road) in South Kona. The development is situated north of Kealakekua Bay and fronts about 1.4 km of coastline. The project proposes to develop an agricultural lot subdivision (125 lots), an 18-hole golf course with a 100-unit member's hale, open space recreational area and related infrastructure. Included in the development will be open space elements along the coastline. Other than approximately 30 acres in macadamia nuts at the mauka end of the project site, the site is undeveloped. Previously, Hawaiian agriculture was probably important in the area.

Annual average rainfall on the project site is about 35 inches in the more mauka portions of the site with the summer months receiving the majority of the rainfall which is an unique characteristic of the Kona coast. The general slope of the property ranges from relatively flat and rolling pahochoe fields adjacent to the coast to relatively steep terrain in the more mauka (inland) portion of the project site.

The coastal area encompassing approximately a 400-foot setback that follows the shoreline is planned as a natural open-space recreational element. The development plan includes preservation of historic features, along with the existing trail system which will provide access for the public for shoreline use.

The golf course has been planned in areas of relatively mild slopes in order to integrate with existing land forms and minimize the need for extensive grading. The golf course and related facilities will be sited to protect significant historical and cultural sites and will integrate existing vegetation into the layout. Turf areas within the fairways would be reduced from typical golf course areas to lessen the amount of irrigation required, while still providing for a pleasant golf experience. Irrigation water will be collected from holes subject to potential runoff by a subsurface drainage system that recycles the collected water to irrigation ponds for reuse on the course. The onsite drainage system will consist of golf course retention/infiltration basins and drywells to dispose of runoff generated from roads. Siltation basins will be constructed, as required, to control runoff water quality, and may be incorporated into the golf course. Runoff generated by rainfall on the golf course may be retained and used to supplement the treated effluent and brackish water used to irrigate the golf course.

The project is envisioned to be developed over a period of time that will be phased to meet market demand. The first phase will include the golf course, related roadways, and

facilities and are planned for development in 2001-2002. Agricultural lots and the Clubhouse would be developed soon thereafter, or, as market demand dictates. Thus the agricultural lot development may be phased over some period of time to meet the market demand.

Purpose

The proposed development of the Keopuka parcel could potentially impact the quality of coastal groundwater as well as the marine receiving waters adjacent to the project site. Ultimately with declines in water quality, marine communities resident to the receiving waters could also be negatively affected. Because of the potential for impact, regulatory agencies often require appropriate monitoring of water quality and marine communities resident to the receiving waters for development projects occurring in coastal settings. Because of the proximity of the Kealakekua Bay and its' designation as a State Marine Life Conservation District (MLCD) as well as the fact that this development will occur in a coastal setting, the concern for impact with development of Keopuka is heightened.

Regulatory agencies usually require that a comprehensive ground- and near shore marine water quality monitoring plan be developed along with a best management practices plan for the golf and agricultural components to insure that degradation of the ground- and nearshore marine waters will not occur and will remain in a pristine state. Since the quality of the water has a major influence on aquatic communities that reside in it, a comprehensive monitoring program should not only consider water quality but also the status of the resident aquatic communities. This proposed water quality and nearshore marine community monitoring program has been developed to insure that degradation to the important aquatic communities and the waters in which they reside will not occur when the development of the Keopuka lands is undertaken.

PART 1: PRECONSTRUCTION BASELINE MONITORING PROGRAM

A. Approach

With any coastal development the potential exists for negative impacts to occur on resident aquatic biota. Potential environmental degradation processes may be minimized if the proper information is assembled early on in any coastal development scheme. Environmental data can serve to identify areas that may be susceptible to anthropogenic impacts, or conversely, particularly resistant to such impacts. An objective of any environmental baseline assessment is to establish quantitative information to accurately depict the community structure of the extant aquatic communities as well as describe the physio-chemical environment. Aquatic community structure can be defined by the abundance, diversity and local distribution of all macrofauna and flora. The information so collected will serve to identify living aquatic resources that may be of significant commercial, cultural, recreational or scientific importance as well as those resources which may represent rare or unique ecological features that could be especially susceptible to human-induced impacts. The quantitative description of the physio-chemical environment provides the baseline upon which the subsequent monitoring can be compared; significant deviation from the baseline may serve as an "early warning" of impact to the aquatic communities.

Many anthropogenic impacts to aquatic communities emanating from coastal development are mediated by water. Activities on land creating potential pollutant problems are carried to the groundwater and/or nearshore marine environment via water. Water is the common transport mechanism and this water may come from irrigation or from rainfall and runoff. Thus, a first means of detecting a potentially harmful impact to aquatic biota may be through changes in the quality of ground and/or receiving waters.

Marine environmental surveys and monitoring programs are usually performed to evaluate the feasibility of and ecosystem response to specific proposed activities. Appropriate survey methodologies reflect the nature of the proposed action(s). An acute potential impact (such as channel dredging that may be undertaken on other projects) demands a survey designed to determine the route of least harm and the projected rate and degree of ecosystem recovery. Impacts that are more chronic or progressive require different strategies for measurement. Management of chronic stress to a marine ecosystem demands identification of system perturbations which exceed the boundaries of natural fluctuations prior to proceeding with the project. Thus, a thorough understanding of normal ecosystem variability is required in order to separate the impact signal due to development from natural background variability.

The potential impacts confronting the marine ecosystem fronting the proposed development at Keopuka are most probably those associated with chronic progressive stresses. Impacts due to human activities (e.g., accelerated erosion and resultant sedimentation) have probably been ongoing for many years at this project site due to the use of the lands for grazing coupled with occasional periods of high rainfall although it should be recognized that surface runoff to the ocean would be an extremely rare event due to the highly porous nature of the landscape dominated by geologically young lavas. This is particularly true adjacent to the shoreline where an extensive porous pahoehoe lava field

is present.

The major source of changes to water quality due to development in the nearshore marine environment fronting the project site is via the groundwater. Thus, the strategy to be used in the baseline work is to sample the known points where groundwater (1) occurs in open exposures or wells prior to entering the sea and (2) sampling in the marine environment where groundwater does enter the sea. A second part to the sampling strategy employed is to sample water quality during a period of relatively low rainfall (a "dry" period) and again following a period of local heavy rainfall ("wet" period sampling defined below at 1.25 inches of rainfall in a 24-hour period as measured at a rain gage abut 250 m north of the north boundary of the project site) if this is at all possible prior to construction. Presumably, more materials are carried to the sea during heavy rainfall events than during dry periods. This sampling strategy obtains information on water quality at two extremes of the envelope of variability. Presently, there are no known depressions in the coastal lava field that intersect the ground watertable so the sampling of groundwater prior to its entry into the ocean will have to wait until proposed coastal monitoring wells are drilled later in the study (see below).

In 1990-91 a preliminary survey of the quality of the waters fronting the Keopuka parcel was completed and focused on water quality of the area. Marine community development was also noted but quantitative studies were not completed due to a hiatus in the project. Almost ten years has elapsed since these preliminary observations were made. In September 1992 Hurricane Iniki struck the Hawaiian Islands and marine communities in parts of the West Hawaii coast were severely impacted (Dollar and Tribble 1993, Brock 1996). Some of these impacts are still evident today. As time has passed, marine resources in the waters fronting the adjacent Hokuli'a project (to the north) and those offshore of the Keopuka parcel have received increasing use by the fishing public. Impacts to the coastal resources have occurred from these natural and anthropogenic disturbances. Every effort will be made to incorporate the original data with data collected in the present effort. However, it must be recognized that some of the information will not be directly comparable, especially with the biological information, i.e., finding old permanently marked stations for marine surveys may be impossible for markers have probably been lost.

The objective of the preconstruction and during-construction monitoring programs are to determine if any quantifiable change is occurring that is related to the development at Keopuka. Change in marine communities and water quality can be from natural sources as well as from anthropogenic activities. Thus it is imperative that any monitoring program is able to separate change due to natural phenomena from those due to human activities. The only way to confidently detect these changes and to identify source(s) or causal mechanism(s) for the changes is to use a rigorous quantitative approach in gathering and analyzing the data.

B. Baseline Survey Methodology

1. Water Quality

A preliminary (low rainfall period) baseline survey will be undertaken in April 2000. This survey will focus on sampling water quality and nearshore marine communities fronting the project site. Sampling protocols to be used will follow those as given by the West Hawaii Coastal Monitoring Protocols (1992). Water quality parameters to be evaluated include those as stipulated by the Department of Health for Class AA open coastal waters as given in Title 11, Chapter 54, Amended Administrative Rules for Water Quality Standards (1992). These parameters include the specific criteria of ammonia nitrogen, nitrate+nitrite nitrogen, total nitrogen, total phosphorus, chlorophyll-*a*, and nephelometric turbidity. Also collected will be samples for the non-specific criteria including dissolved oxygen, temperature, pH and salinity as well as silica and orthophosphorus, the former because of its importance as a conservative tracer of groundwater and the latter due to its biological importance. Orthophosphorus is the biologically reactive form of phosphorus and it is an important constituent of dry fertilizers and thus should be measured. Silica occurs in relatively high concentration in groundwater and treated sewage effluent and is in low concentration in oceanic waters. Silica is not particularly biologically reactive in inshore marine ecosystems and thus serves as a conservative tracer for groundwater. It is important in any analysis of land-derived sources of nutrients using mixing models which are appropriately employed where sufficient volumes of groundwater enter the sea such as occurs at Keopuka.

The preliminary sampling design dictates that approximately 35 locations will be sampled for these water quality parameters. All of these sites are in the marine environment fronting the project site with stations being located from the shoreline to a point about 0.2 km seaward due to the steep submarine topography fronting the project site (50 fathoms. within 200-300 m from shore)

Ultimately with the during-construction monitoring, the objectives of the water quality monitoring program are (1) to quantify the concentration of measured parameters in the marine environment fronting the project site and (2) to quantify any input of these parameters from the project site. To meet these objectives requires delineation of inputs

from the project site separating these from inputs coming in from other areas. In the marine waters fronting the Keopuka project site, sources for the measured parameters in this study will come from (1) marine waters adjacent to the project site, (2) from groundwater entering the ocean in the intertidal/shallow subtidal along the project site, (3) from runoff emanating from the project site following exceptionally heavy rainfall, and (4) for some parameters (i.e., ammonia nitrogen) there may be *in situ* generation by biological activity. Separation of the sources of these materials is made by sampling at sites ranging from the shore in a seaward (makai) direction both at the surface as well as at depth. In general, inputs form land will create concentration gradients because inorganic nutrients occur in low concentrations in offshore oceanic waters. Thus, a number of samples taken in an onshore to offshore series sampling both surface and "at depth" waters will serve to identify inputs coming from land (i.e., sample through any existing gradients).

Establishing these onshore-offshore water sampling "transects" at locations with high groundwater input provide the most useful data. This is because future inputs from land will most likely be carried by the groundwater and first appear at the shoreline at these points. In addition, erection of these water quality sampling transects near the north and southern boundaries of the project site will allow identification of materials being carried into the study area from elsewhere. To address the question of materials being generated *in situ*, the boundary samples can be compared to samples taken in transects established offshore of the central part of the project site.

Low salinity groundwater often has relatively high inorganic nutrient concentrations relative to seawater. Being lighter, low salinity groundwater will overlie denser, warmer seawater. Mixing by wind and waves will serve to break down this stratification with time. Thus the highest nutrient waters are often at the surface in a lower-salinity layer which is best developed close to shore. Because of this, samples should be collected from just under the surface in the low salinity water layer (if existing) and should also be taken below the surface sample at depth (usually about 1 m above the bottom) from sample sites where depths exceed 1 m.

Baseline water quality sampling will be carried out at four onshore-offshore "transects" to meet the objectives as given above. Each transect will be comprised of seven water quality samples; one sample collected on the surface at the shoreline, a second approximately 10 m offshore at the surface and a third just below the second about 1 m above the bottom (depths ranging from 2 to 12 m), a fourth sample collected about 75 m offshore at the surface and a fifth sample just below the fourth at about 1 m above the bottom. The sixth sample will be collected at the surface approximately 150 m from shore and the seventh sample collected beneath the sixth sample at depth about 1 m above the bottom. One transect will be established close to the northern boundary of the project site, a second near the southern boundary and the remaining two offshore of the central part of the project site. In addition, the seven remaining samples will be allocated between the quality assurance/quality control program as required by the Department of Health and for sites that may be discovered in the field surveys along the shoreline with unusual groundwater flows (see Figure 1).

This water quality sampling strategy concentrates the collection of samples in waters close to shore where inputs from land would be most evident and follows that as outlined in the West Hawaii Monitoring Protocols (1992). Such a sampling scheme, which allows the scaling of water chemistry parameters to salinity or other conservative tracers (such as silica) is applicable to a hydrographic mixing model that has been established as an effective method of determining changes in chemical make-up of groundwater discharge (Dollar, Brock and Smith 1995). In addition, the method allows identification of chemical sources on land that are contributing to material input to the marine environment.

All samples will be collected and handled following Standard Methods (1985). Analyses in the laboratory will use a Technicon Autoanalyzer for nutrients, and AGE salinometer for salinity samples and a Monitek nephalometer for measurement of turbidity. Measurement of temperature, dissolved oxygen concentration and pH will be made in the field with hand held meters. Sample processing will be done by an EPA/DOH approved laboratory.

The preconstruction water quality sampling program will be scheduled to occur during the low rainfall or dry season as well as during the wet season. For the South Kona District, the period of greatest rainfall occurs during the months of June through October. Because rainfall is driven by orographic processes, most of it falls in the uplands or mauka area well away from the coast. The preconstruction baseline will include, at a minimum, field sampling during one dry and one wet period (i.e., two sample periods per year). If the commencement of the construction phase is more than one year away, preconstruction baseline water quality data will continued to be collected during once per year during the wet and dry seasons. This continued effort will provide a more statistically-rigorous baseline.

From the data collected, dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) will be calculated for each sample taken. High DON concentrations are indicative of sewage input and thus can be useful for identifying sources of high nitrate, ammonia or total nitrogen, especially where both dry fertilizers and dilute treated sewage effluent (used for irrigation) are both used on the project site. Data will be analyzed using non-parametric statistics which avoids some of the assumptions of normality and

homogeneity of variances.

2. Pesticide Sampling

Pesticides (i.e., insecticides and herbicides) and heavy metals (e.g., mercury and arsenic) are a concern of regulatory agencies and the public particularly for coastal developments where the potential for movement of these materials from the site of application to the adjacent ocean and marine biota is high. Presumably, no pesticide or heavy metal use has occurred in the past the Keopuka project site, however a pre-development baseline of several commonly used pesticides and heavy metals in sediments taken from the near shore area will be carried out. These data will serve as a baseline against which later required pesticide sampling can be compared. Naturally occurring arsenic and mercury in areas of recent volcanism may be quite variable and often relatively high. Arsenic is a common active ingredient of many herbicides used today. Having some baseline information on the pre-development concentration of this element as well as others will assist in understanding relatively high concentrations that may be encountered later in the study.

Pesticide analyses will be carried out on three sediment samples collected from the near shore waters fronting the project site with one of these samples being collected in Kealakekua Bay near the Cook Monument to serve as a control. Sediments will be collected from similar depths as close to shore as is feasible. Pesticide samples will be collected once during the preconstruction baseline and once a year during the construction phase from the same locations.

3. Proposed Coastal Monitoring Wells

To most effectively address the objective of determining if any impact will emanate from the project site either during the construction process or later with the subsequent maintenance of the completed project, we propose that two to three coastal monitoring wells be developed along with one well in the more inland or mauka portion of the project site. The strategy here is to utilize any well developed along the inland or mauka portion of the development (usually used as a source of low salinity irrigation water) and compare water quality data from this site to data from shallow wells developed for monitoring purposes along the makai or seaward edge of the project site. In general, groundwater flows from the inland areas through the lava strata down slope to the sea. The inland irrigation well(s) would serve as a sampling point for groundwater as it enters the project site. The shallow makai wells would sample the groundwater as it leaves the project site but prior to its entry into the ocean. Comparison of water chemistry data taken in the mauka well(s) to that collected in the makai wells will readily show any inputs coming from the activities on the project site. Further comparison of the makai well data to the data collected in the ocean will demonstrate the fate of these materials as they enter the ocean. (Often, materials identified in coastal wells never appear in the ocean due to dilution and uptake). These data will also value if a constituent is found to be elevated at the shoreline of the site once human activities have commenced; without the mauka and makai wells, the supposition will be that the elevated materials are coming from the project site where they may otherwise be already in the groundwater prior to its entry under the Keopuka project site. Parameters to be monitored are the same as those for marine waters with the exception of chlorophyll-*a* which is a measure of phytoplankton biomass and well samples have not been exposed to sunlight and thus would not have any chlorophyll-*a* present.

The Department of Health has proposed new guidelines for water quality standards for the West Hawaii coast. These guidelines are based on local ecological conditions and utilize regression techniques to determine what local water quality standards should be for waters with salinities less than 32 ppt. These guidelines require groundwater samples drawn from inland wells that serve as the undisturbed controls as well as sampling in coastal marine locations. If these proposed guidelines are accepted, the proposed monitoring plan will adhere to the new ecologically-based standards as well as undertake sampling for the parameter, total suspended solids which is not now being sampled. Development of monitoring wells on the project site will bring the project into conformance with the proposed guidelines if they are enacted.

As suggested above, coastal monitoring wells have an additional benefit; if sufficient quantities of low salinity groundwater are present, they may serve as a source of irrigation water for golf courses or other vegetation. It is proposed that consideration be given to drilling one well in the mauka portion of the project site and two to three wells be drilled in the makai part of the development.

4. Marine Community Monitoring

The objectives of the marine biological monitoring program are to: (1) determine the status of marine communities in the waters fronting the project site, and once the "during construction" phase is initiated, (2) to quantitatively ascertain any changes that occur to these communities over the life of the program and (3) if change occurs, determine the causal mechanism(s) and/or source(s) for these changes and if activities on the project site are responsible, suggest mitigation measures to alleviate the problems. In all probability, if

activities on the Keopuka project site are responsible for change occurring in the marine communities, the mechanism responsible will be changes in water quality. Thus detection of these changes in the water quality studies are the first signal of potential impact to marine communities.

The first step in any quantitative delineation of marine communities is to define the major zones or biotopes present in the study area. This is accomplished by towing (or swimming) a diver through the study area from shore to the outer boundary (here the 20 m isobath). Biotopes are quantitatively defined partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each defined biotope, a number of permanently marked stations are established and quantitative studies conducted at each including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance is made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments are carried out suing SCUBA. Permanent stations are usually marked by use of steel pins, nylon cable ties , and small subsurface floats tied to the substratum which allows for repeated sampling of the same location.

Benthic and fish communities will be quantitatively evaluated at each permanently marked station using a combination of 1 x 1m quadrats to estimate coverage by sessile benthic species including algae and corals, counts of diurnally-exposed motile macroinvertebrates and censuses of fishes occurring in a 4 x 25m transect area. The fish census method to be used is a modification of Brock (1954; see Brock 1982) and includes the delineation of numbers of individuals of each species seen as well as an estimate of the length of each fish counted. The length data are later used in making estimates of biomass for each species present coupling the length data with species specific regression coefficients (Ricker 1975, Brock and Norris 1989).

During the course of fieldwork, notes are taken on the number, size and location of any threatened or endangered species (such as spinner porpoises, humpback whales or green sea turtles) seen within or near the study area. Biological data will be subjected to nonparametric statistical analysis; analyses will focus on changes at a given location through time as well as changes that may occur across locations at any time. Nonparametric methods are used to avoid some of the assumptions regarding normality of data.

These methods will provide quantitative information on the status of the marine communities in the waters fronting the project site as well as point out any change that may occur. Once activities on the project site have commenced, any statistically significant negative change encountered in the marine communities (usually seen as a decrease in abundance of a species, etc.) will be examined in light of the water quality data to determine source(s) of these changes. If the source is from the Keopuka project site, the developer, contractor, and appropriate regulatory agency personnel will be immediately contacted and mitigative measures will be suggested to reverse the problem(s)

It is expected that from six to twelve permanently marked transect sites will be established in the water fronting the project site and the monitoring of these sites will occur annually as per the West Hawaii Coastal Monitoring Protocol (1992). All marine biological methods used in this study will follow the recommendations as given in the above protocol.

PART II. PROPOSED "DURING CONSTRUCTION" MONITORING PROGRAM

A. Approach

The objective of any marine life/water quality monitoring program is to insure that construction does not significantly impact water quality or aquatic biota. If the preconstruction baseline has adequately defined the limits of natural variability, the "during construction" monitoring will be a matter of determining whether a particular measurement is outside of the envelope of natural variability and if so, whether the change is statistically significant.

The construction phase of the proposed development of Keopuka Lands is expected to continue for some unknown period of time because it is phased to match market demand, thus there will undoubtedly be periods of time with little or no construction activity. Much of the coastal development in Hawaii is undertaken over relatively short periods of time and water quality/marine life monitoring programs are employed with routine sampling schedules (such as quarterly) and under those conditions are cost-effective and environmentally acceptable. However, there may be a protracted construction period with little or no activity for the Keopuka Lands development.

The proposed approach to the monitoring of water quality and marine communities during the construction phase of the Keopuka Lands project is one of focusing the field sampling on periods when problems would be most likely to occur. During construction, these periods coincide with the exposure (uncovering) of soil coupled with heavy rainfall. Similarly, during the operation of the golf course but prior to build out, these periods will also coincide with heavy rainfall. Heavy rainfall is usually requisite to the manifestation of

most human mediated changes in the quality of adjacent marine waters along relatively dry leeward coasts. It follows that the most cost-effective "during construction" water quality monitoring would occur just after heavy rainfall events especially since the construction period is projected to continue for some unknown period of time. We propose to undertake the majority of the "during construction" water quality field monitoring following heavy rainfall events as well as when significant construction is occurring.

For purposes of this protocol, a heavy rainfall event is deemed to have occurred when a minimum of 1.25 inches of rainfall has occurred in a 24-hour period as measured from a standard rain gage located on mauka region of the adjacent Hokuli'a project site. This rain gage is monitored daily and the data are used for a water quality monitoring program at Hokuli'a and is located about 250 m north of the northern Keopuka project boundary. This same monitoring strategy is proposed herein for the Keopuka project site. In this proposed monitoring strategy, if the rainfall equals or exceeds 1.25 inches in a 24-hour period, it would trigger a water quality sampling event. In this case, sampling would occur within 48 hours of the triggering rainfall event and will be carried out by Dr. Richard Brock with assistance from others.

Water quality sampling sites to be monitored include all marine and groundwater monitoring well sites (yet to be developed) on the project site. It is expected that any water feature that may be developed on the project site and uses water captured from the golf course or from agricultural areas will be included in the water quality monitoring program. The monitoring program will also sample any reclaimed water (i.e., treated and diluted sewage effluent) that may be used for irrigation purposes on the project site. These latter samples would provide information on the quality of the irrigant being used. The approximate locations of all sample sites are given in Figure 1.

Within any sampling event, several water quality samples will be collected in triplicate to assist in our quality assurance/quality control (QA/QC) program. These "blind" samples will be collected, handled, and forwarded to the laboratory where they will be processed along with all others. Comparative analysis of the replicated "blind" samples affords a measure of QA/QC. This, coupled with the fact that all sample processing is carried out by Department of Health approved laboratories should insure that all sample handling and processing is in conformance with accepted procedures and limits.

Samples for pesticide analysis will be taken annually and the samples will be examined for the four to six most heavily used materials on the golf course. The analysis will require receiving lists of the materials used, where and quantities used from the golf course maintenance personnel prior to the annual pesticide sampling. The sampling will focus on sediment taken from the near shore waters fronting the project site.

The proposed construction activities will require a NPDES permit seeking coverage under the general permit for discharges of storm water associated with construction activity (i.e., the clearing, grading, and excavation of the project site). The NPDES permit is usually applied for just prior to the start of each phase or segment of construction and since the permit application requires detailed information on scheduling, grading areas, and measures to control pollutants, it will not be addressed further here. Suffice it to say, the Department of Health requires the NPDES permit application (Notice of Intent) to be filed not less than 30 days prior to the start of construction.

The Department of Health also requires that the Notice of Intent include a construction site Best Management Practices (BMP) Plan. The BMP Plan is a site specific plan that will be designed, operated, and maintained by the developer with the objective of insuring that construction storm water runoff from the construction site does not violate the applicable state standards of the receiving waters. The BMP Plan is site specific and also requires detailed information on scheduling, grading and erosion control plans. Because the phasing of construction for this project may be extended for an unknown period of time, we cannot develop the site specific BMP Plan at this time. The construction plans for the development will include grading and erosion control plans that must be reviewed and approved by the County of Hawaii before any grading occurs.

In general the BMP Plan will include descriptions of construction management techniques for sediment and erosion control. The erosion and storm water runoff controls will include the following elements:

- Minimization of area that is disturbed at any one time. Within each construction area, the grading shall be phased to the maximum extent possible to minimize the exposure of soil at any time.

- Provide for temporary and permanent grassing of graded areas as well as utilize other means of holding soil in place including use of bagasse and hay bales.

- Install cut-off ditches to minimize the runoff through graded areas and to route runoff and sediment to retention ditches and basins.

- Develop an approved water quality monitoring program to insure that any runoff from the site does not violate applicable state standards of the receiving waters.

- Designate individuals responsible for the management and implementation of the BMP Plan.

There are two levels of safeguards to insure protection of water quality and the marine communities of the receiving waters. The first is the application of the BMP Plan which includes proactive approaches to minimize soil erosion and storm water runoff from the site by the development of temporary and permanent features to keep these materials on site. Secondly, the water quality monitoring program insures that any storm water escaping from the project site is not significantly altering the quality of the receiving waters. If significant change occurs in water quality that is attributable to on-site construction activities, a second step in the monitoring program is to determine if these changes have impacted the marine communities of the receiving waters. Any significant change in either water quality or marine communities is immediately reported to the developer and regulatory agencies for appropriate mitigative action.

This proposed monitoring plan is based on experience gained from more than 15 years of water quality monitoring on the Kona, Hawaii coast. Surface water runoff from the project site entering the ocean is not anticipated due to (1) the intervening flat coastal plain along much of the project site, (2) the porous nature of much of the project site surface and (3) the required and instituted BMP Plan which should strive to keep all surface runoff on-site thus minimizing any impact to the receiving waters. Furthermore, groundwater entering the sea along the Kona coast originates from upland rainfall. An average time between upland rainfall and its appearance on the coastline is about 10 years. Rainfall occurring in closer proximity to the shoreline and contributing to groundwater recharge takes less time to efflux into the sea. Despite these facts, concerns over surface runoff reaching the sea from the project site will be addressed by sampling within 48 hours of the time of the triggering rainfall event. If impact to the receiving waters is apparent, remedial actions will be immediately initiated and will involve the developer, his agents, regulatory agencies and any concerned citizen's groups.

Triggers for remedial action would be based on statistically significant changes in water quality relative to baseline conditions and a demonstration that these changes are due to activities on the project site. A statistically significant transitory change in a water quality parameter (such as turbidity) would then trigger a quantitative re-examination of water quality parameters within a week of the initial finding. A parameter that continues to differ significantly from the baseline conditions would trigger a quantitative re-examination of benthic communities in the vicinity of the marine area where the change(s) were noted as well as a notification of the appropriate regulatory agencies. A statistically significant change in benthic communities would trigger a remedial action on the part of the developer.

The mitigative action taken could depend on the nature of the problem but could involve changes in construction practices, etc. The monitoring program will document the effectiveness of any mitigation that may be instituted. However, an obvious input such as surface runoff into the sea will trigger remedial action even without the documentation of a statistically significant change in the water quality data. In this case, remedial actions will probably focus on altering the strategies as given in the BMP Plan and will be implemented on a short time scale to immediately alleviate the situation.

Since it is proposed that the field water quality sampling program be related to the degree of soil exposure and rainfall, thresholds for these parameters must be established. Initially, the collection of water quality samples in the "during construction" period will be triggered when construction activities have exposed more than 5 acres of soil and 1.25 inches of rain as measured on the adjacent Hokuli'a project site has fallen in a 24-hour period. These initial conditions are partially based on the fact that storm water runoff permits are required for projects with a minimum area of 5 acres. The 1.25-inch rainfall event is deemed not to be unusual and may cause runoff from the project site in the predevelopment stage. If no significant change occurs in water quality, the triggers for sampling increase as given in Table 1 by 10-acre increments (above 10 acres) and/or by 0.5-inch rainfall increments.

It is proposed to use the standard rain gage that is established at the Hokuli'a project site which is at the same elevation and about 250 m to the north of the north boundary of the Keopuka Lands project be used to measure local rainfall. The Hokuli'a gage is read daily for the same purpose as proposed here, i.e., to serve as a rainfall trigger for water quality monitoring. Thus if rainfall is at or exceeds 1.25 inches in a 24-hour period (the initial triggering level), water quality sampling will be undertaken. Data analysis of the resulting report will include a discussion of rainfall at the project site and will relate these findings to the rain gage at Kainaliu where long term records of rainfall exist. The rain gage at Kainaliu Agricultural Station is just up slope and north of the Keopuka project site (mauka of the Belt Highway). Because most Kona rainfall is orographic (i.e., falls due to winds impinging on the mountainside, rising and cooling and eventually releasing rain), the rainfall at the Kainaliu gage would be expected to be greater than on the project site which is down slope and south of the gage. Indeed, rainfall at the project site is about 35 inches per year and the 50-year mean for the Kainaliu gage is 66.6 inches per year with the range from 94 inches in 1951 to a low of 39 inches in 1977. Thus, mauka portion of the project site realizes about one-half of the rainfall measured at the Kainaliu gage.

A summary of heavy rainfall events as measured at the Kainaliu gage is given in Table 2. Data from which this table was derived covers the period from January 1993 through July

1998 -- a five and on-half year period. The frequency of 24-hour rainfall events for each month of the year are presented in the body of the table and are divided into one-inch categories, i.e., 1 to 1.99 inches, 2 to 2.99 inches, 3 to 3.99 inches, 4 to 4.99 inches, 5 to 5.99 inches and 6 to 6.99 inches. The highest 24-hour period of rainfall recorded at the Kainaliu gage occurred on 6 October 1993 when 6.05 inches fell. Summarizing the data in Table 2, there were 32 times in this 67-month period when 1 to 1.99 inches of rain fell, 15 times when 2 to 2.99 inches was recorded, 7 times when 3 to 3.99 inches fell, and one time each when 4 to 4.99 inches, 5 to 5.99 inches and 6 to 6.99 inches were recorded. Rainfall events of 2.5 inches or greater in a 24-hour period occurred 15 times in this 67-month period. Utilizing these data, if the preliminary rainfall sampling "trigger" was one-half of the rainfall measured at the Kainaliu gage (2.5 inches or greater which would translate to about 1.25 inches of rain on the upper portion of the project site), we would sample about 2.7 times in the average year. If the threshold trigger is not met during any year, a minimum of one water quality sampling event will be undertaken.

If no significant change is apparent in the quality of the receiving water that is attributable to the project site at these initial "trigger" values, then the threshold should be increased. The proposed schedule of incremental thresholds to trigger field sampling are given in Table 1. An unusually large rainfall event (i.e., 2.5 inches in 24 hours or greater as measured at the Hokuli'a project gage) would trigger a field sampling event.

The success of the program requires that the environmental monitor employed by the developer be in close contact with the construction manager as well as with the Hokuli'a rainfall gage monitor. Since 1989, an open line of communication has been established with the State of Hawaii Water Data Center under the Department of Land and Natural Resources for the acquisition of rainfall data on short notice from a number of Hawaiian localities for other projects (including the development at Hokuli'a). The addition of the appropriate monitored Kona gage to the present program is a simple matter and again these data would be used as a second measure of rainfall in the general area (albeit mauka) of the project site. As construction schedules are developed, a prior knowledge of the anticipated amount of land to be cleared in a given phase will be available; this knowledge coupled with periodic contact with the construction managers should provide the needed information regarding the area exposed soil at any given time. Also the periodic "check-in" with the construction managers would provide information on any unusual and/or potential environmentally hazardous situations that may require field sampling.

Where applicable, field sampling will utilize the methods as outlined in the West Hawaii Coastal Monitoring Protocols (1992) and will focus on the standard Department of Health parameters including nitrate nitrogen, ammonium, total nitrogen, total phosphorus, turbidity, chlorophyll-*a*, salinity, temperature, dissolved oxygen, pH as well as the conservative groundwater tracer, silica and biologically important orthophosphorus. The same locations sampled during the baseline will be resampled along with any additional coastal wells or coastal groundwater sources that may be available. If the environmental monitor deems that sampling of additional sites or parameters is necessary for a better understanding of a given field situation, these will be sampled. Thus the field monitoring program will have the discretion to undertake additional sampling but this will be done with the concurrence of the developer and regulatory agencies.

B. Deliverables

As with all the proposed monitoring, the regulatory agencies and developer would be kept apprised of all findings so that remedial action(s) can be implemented on short order if needed. Reports summarizing findings will be prepared following all field monitoring efforts. These reports will be distributed to the Planning Department, County of Hawaii and to the Clean Water Branch, Department of Health as well as to any community group, other county, state or federal agency if requested. The reports will include statistical analyses as well as propose mitigative actions if needed. Data from these reports will be available for incorporation into any local area, citizen-based, marine life management program as needed.

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TABLE 1. Threshold levels of rainfall (cumulative total for a 24-hour period as measured at the Hokuli'a rainfall gage at the same elevation as the mauka portion of the Keopuka project site and about 250 m to the north) and area of exposed soil that trigger field water quality sampling. Progressively greater thresholds may only be used if no statistically significant changes in water quality were noted at the previous (lower) threshold levels that were attributable to the project site.

	Area Exposed		Measured at Hokuli'a Rainfall (in/24hr)
Initial Condition	5 acres	AND	1.25 inches

Subsequent Conditions - Combination of any two lowest values

5 acres	Greater than 1.25 inches
10 acres	1.25 inches or greater
20 acres	1.25 inches or greater
30 acres	1.25 inches or greater
40 acres	1.25 inches or greater
50 acres	1.25 inches or greater
60 acres or more	1.25 inches or greater

NOTE:

1. Rainfall trigger is in 0.5-inch increments.
2. Any rainfall event greater than 2.5 inches will require field sampling.
3. Average annual rainfall at the project site is 35 inches and at the Kainaliu gage mauka and north of the project site it is 66.6 inches (50-year mean).
4. If no impact has been detected with 100 acres exposed and a rainfall event of 2.5 inches, sampling will occur only with soil exposure in 50 acre increments and rainfall events above 2.5 inches.

EXAMPLE:

If 20 acres is initially uncovered by construction activities and a 1.25-inch rainfall event occurs, water quality sampling will be undertaken. If this 20 acre, 1.25-inch combination has not resulted in any significant change in water quality, the trigger threshold is increased. The next sampling event will occur when either 30 or more acres is uncovered and 1.25 inches of rain occurs or when the original 20 uncovered acres receives a rainfall event greater than 1.75 inches in a 24-hour period.

TABLE 2. Frequency of occurrence of 24-hour rainfall events by month based on data collected from January 1993 through July 1998. These data are presented in seven categories by rainfall as measured at the Kainaliu gage in a 24-hour period: greater than 1 inch but less than 2 inches, greater than 2 inches but less than 3 inches, greater than 3 inches but less than 4 inches, greater than 4 inches but less than 5 inches, 5 inches or more but less than 6 inches, greater than 6 inches but less than 7 inches and a summary of rainfall events of 2.5 inches or greater. Probability of an event occurring in a given month based on these data is presented at the foot of the table. Data courtesy of Mr. Neal Fujii, DLNR.

	MONTH											
Event	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 to 1.99 inch	1	1		1	1	3	6	4	8	3	3	1
2 to 2.99 inch	3		1			2	2	3	3			1
3 to 3.99 inch			2				1	1	2			1
4 to 4.99 inch										1		
5 to 5.99 inch						1						
6 to 6.99 inch										1		
No. of events 2.5 inches or greater	1		3			3	1	2	3	2		
Probability of a 2.5-inch or more event occurring in any given month (%)	1.5		4.5			4.5	1.5	3.0	4.5	3.0		

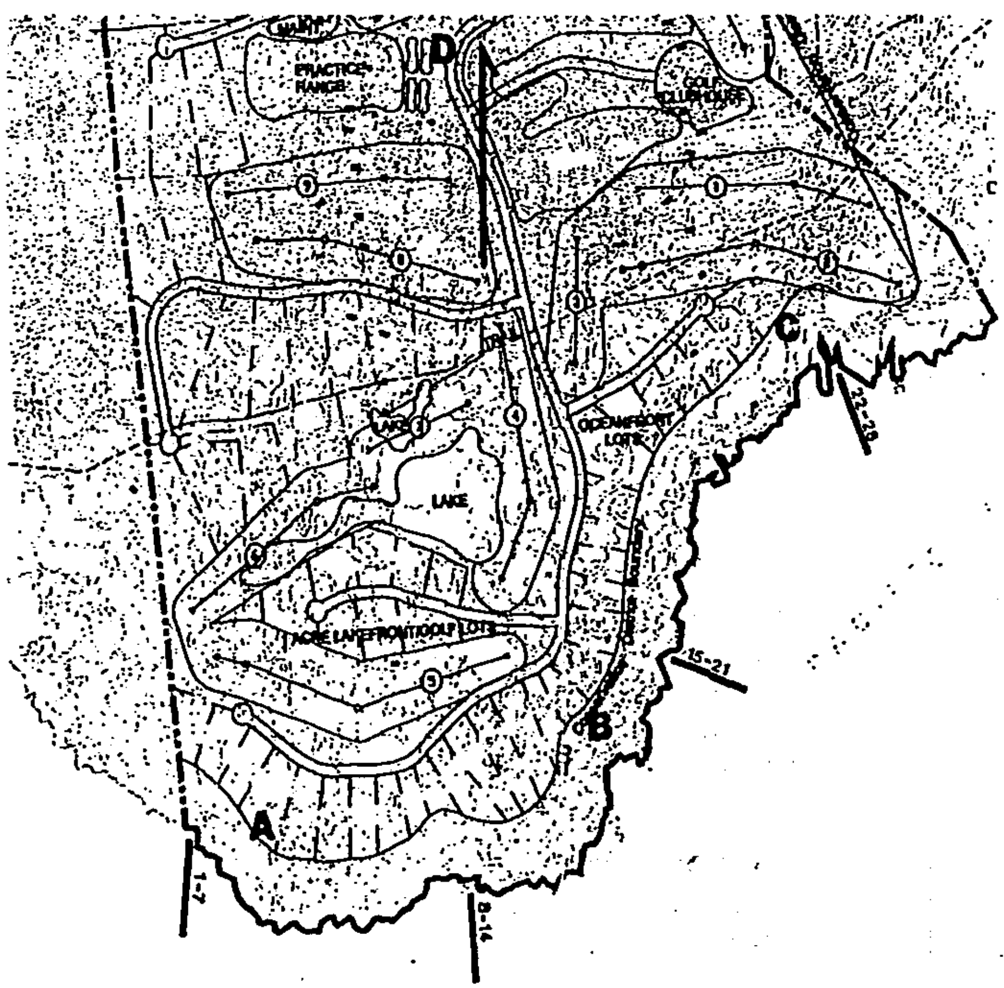

FIGURE 1. Map of the project site showing the approximate locations of thirty-nine water quality sample sites. Four "transects" each with 7 sample sites are shown as well as 7 locations not yet assigned for QA/QC. Note that the acceptance and location of three coastal monitoring wells (sites A through C) and one irrigation well (site D to be located upland) are unknown, so the locations as given are tentative. The numbers and locations of the permanently marked marine biological monitoring stations are also unknown at this time and thus are not shown.

APPENDIX E

Environmental Best Management Practices Report

Environmental Best Management Practices

For

The Keopuka Lands

Keopuka, South Kona, Hawaii Island

Produced for Pacific Star LLC

By

William Berndt Associates
International Management Consulting

7133-40 J Penner Lane
Fort Myers, Florida USA 33907

May 31, 2000

Executive Summary

Keopuka will use a variety of best management practices to preserve human health and environmental quality during the construction and management of its golf course. Best management practices or BMPs are strategies used to prevent the occurrence of adverse environmental impacts resulting from golf course activities. The problems that have been identified in relation to golf course activities include:

- Erosion of soil and destruction of soil stability
- Impacts to non-targets from exposure to eroded sediments
- Runoff or leaching of fertilizer nutrients or pesticides into groundwater or ocean water
- Health impacts to humans from exposure to fertilizer nutrients or pesticides
- Reduced water quality from intrusion of sediments, fertilizer nutrients, pesticides, or salts
- A decline in the volume of drinking water from irrigating turf and landscape plants
- Loss of wildlife habitat and native vegetation
- Destruction of historical sites and artifacts

Strategies to be used to prevent these impacts from occurring will consist of:

- Employing an environmentally responsible staff to construct and maintain the golf course
- Designing the golf course and landscape sites to prevent the occurrence of any impacts
- Practicing environmentally safe golf course construction methods to prevent erosion and related impacts
- Practicing environmentally safe turfgrass management activities to prevent the runoff or leaching of nutrients or pesticides and related impacts into groundwater or ocean water
- Utilizing management facilities designed to prevent the occurrence of any negative impacts
- Monitoring the environment to ensure that negative impacts to the environment do not occur

Adopting a BMPs approach to golf course construction and management provides the most complete attempt at preventing environmental deterioration. Using the approach described in this document should prevent a decline in the quality of water or other environmental resources. It will help to maintain a high quality of life and also provide residents and golfers with the best possible conditions for golf and other recreational activities. The body of this document contains an expanded description of the BMPs to be used to prevent impacts to the environment at Keopuka.

Table of Contents

The Keopuka Lands: A Golf Course Community

The Keopuka Lands is being developed by Pacific Star LLC. This residential golf community has been designed within the boundaries of a 660-acre parcel located at Keopuka, South Kona, Hawaii Island, makai of the town of Captain Cook. Proposed uses for this property include:

- Agricultural lots: approximately 125 ranging from 1 to 5+ acres; lot sizes will be varied to allow for additional open space uses
- Golf course: 18 holes plus clubhouse, practice area, and related amenities
- Lodge: 100 units and related amenities
- Coastal open space: the coastal area is designated for recreational and public access uses
- Agricultural areas: the portion of the project mauka of the Mamalahoa Highway Bypass will be developed as a macadamia orchard with large lots

Currently, the mauka portion of the property is in macadamia production while the makai areas are vacant of any use. See Appendix A for a description of site soils and climactic conditions.

The presence of the golf course at Keopuka will provide several benefits to the surrounding communities including short term and long term employment. There are expected to be 20-25 full time jobs, as well as several part-time jobs for the golf course. For this reason the golf course will directly:

- Bolster the local housing market and construction industry
- Provide for additional tax-based revenues
- Stimulate the local economy with reference to sales and services

In short, development of the golf course at Keopuka will translate into a positive economic impact for the area.

In addition to the economic benefits, the presence of the golf course will have a positive impact on the environment. For example, well maintained turfgrass will absorb pollutants, fix carbon dioxide, generate oxygen, provide a cooling effect, slow the velocity of runoff, encourage percolation, trap dust, dampen noise, and stabilize soil. An appropriate design will help to prevent run-off and the transport of sediment originating at higher elevations. This in turn will help to preserve the pristine character of the ocean. The presence of the golf course will also enhance the quality of habitat and sanctuary for many species of wildlife. This will help to increase diversity as well as overall wildlife population levels.

Environmental Impacts in Golf Course Landscape Systems

Even though the golf course will offer many positive benefits, the construction of the golf course and the subsequent use of fertilizers, pesticides, and water for turfgrass maintenance can pose a risk to the environment if not properly managed. Several potential detrimental effects of golf course construction activities have been identified for which mitigation needs to be adopted and employed:

- Loss of soil from erosion and destruction of soil stability
- Reduction in water quality from runoff of eroded of sediments
- Reductions in the health and vigor of non-target organisms, plants, and animals from exposure to eroded sediments
- Reduction in air quality from the presence of fugative dust and noise
- Destruction of historical sites or artifacts
- Loss of wildlife habitat and native vegetation

Additional effects from turf maintenance activities such as fertilizing and pest management also need to be addressed:

- Runoff and leaching of fertilizer nutrients and pesticides
- Impacts to human health from exposure to fertilizer nutrients and pesticides
- Impacts to the health of other non-targets from exposure to fertilizer nutrients or pesticides
- Reduced water quality from the presence of fertilizer nutrients, pesticides or salts
- A decline in the volume of drinking water from irrigating turf and landscape plants with fresh water
- Development of pest populations with resistance to chemical controls from the use of pesticides

Preventing Environmental Impacts

Because the impacts listed above can occur Keopuka will construct and then maintain its golf course and associated landscape areas using a variety of modern best management practices, or BMPs. These are strategies and practices used to prevent undesirable environmental impacts from occurring. Adopting this kind of approach to golf course construction and management provides the most complete attempt at preventing environmental deterioration. It should avert a decline in the quality of water or other environmental resources. It will help to maintain a high

quality of life and also provide residents and golfers with the best possible conditions for golf and other recreational activities.

Best Management Practices

The general BMPs to be used at Keopuka during the construction and management of the golf course include:

- Employing an environmentally responsible, well educated and experienced staff
- Implementing course design that is conducive to preventing environmental impacts
- Practicing environmentally sound golf course construction methods
- Practicing environmentally responsible turfgrass management activities
- Utilizing state-of-the-art management facilities
- Monitoring the environment to ensure impacts do not occur

The remainder of this document contains an expanded description of the BMPs to be used to prevent impacts to the environment at Keopuka.

Key Management Personnel

People are an important environmental determinant. The behavior and actions of the developers, designers, contractors, and golf course employees will directly determine whether construction and management activities pose a threat to the quality of the Island environment. Because of this, Keopuka will employ people who:

- Have a sensitive, knowledgeable, responsible attitude towards the environment
- Are knowledgeable, experienced, and well educated in the design and construction of golf courses, and in ensuing golf course operations

People will enact the BMPs as described in this document. People must also bear ultimate responsibility for the occurrence of any adverse impacts. Thus, using agents and employees with education, experience, and common sense will in itself be a most important BMP for Keopuka.

Golf Course Superintendent

The golf course superintendent may likely be the single most important environmental influence on the golf course on a day to day basis. Because of this, the superintendent employed by Keopuka will possess the traits as outlined in the above section. In addition, he or she will be able to effectively communicate with all other course employees, residents, and upper level management. The ability to communicate effectively coupled with an extensive environmental knowledge base and continuing education will be required for performing the daily duties that are necessary in preserving the environment.

Support Staff

The golf course superintendent will be supported in his/her daily endeavors by the actions of several key staff members including:

- Assistant superintendent(s): responsible for the care of the turfgrasses
- Equipment technician(s): responsible for equipment/tool maintenance
- State certified pesticide applicator(s): responsible for mixing, loading, and applying pesticides on the golf course
- Irrigation system technician(s): responsible for distributing water to the golf course and the upkeep and maintenance of the irrigation system
- Horticulturist(s): responsible for care and maintenance of the ornamental plants
- Consultant(s): responsible for assisting with all aspects of the management process when needed

Keopuka will be committed to filling employee positions with highly qualified, experienced, environmentally responsible people.

GOLF COURSE DESIGN

The design of the golf course is another important environmental determinant. For example, the way in which the course is designed can influence area runoff. This can in turn influence the health and vigor of organisms, plants, and animals. Therefore, the intent will be to design the course to preserve environmental quality. Strategies to be used to accomplish this include:

- Avoiding sensitive environmental areas or historical sites with respect to routing the golf course and locating associated landscape areas
- Separating sensitive environmental areas or historical sites from golf course maintenance activities using designated buffer zones
- Conserving select wildlife habitat and native vegetation by incorporating it into the design where practical
- Terracing the golf course within the site to help prevent and contain runoff originating upslope
- In sensitive areas diverting any runoff entering onto the golf course to designated internal collection sites using swales, berms, and vegetated buffers

- Routing golf course runoff and sub-surface drainage waters in sensitive areas from designated collection sites to irrigation ponds via an internal drainage system for recycling
- Establishing appropriate turf types including bermudgrasses
- Installing a computerized irrigation system for turf and ornamentals

Incorporating these design elements along with traditional design features like flexibility and golf shot value will provide a good golf course that not only preserves the environment but enhances it as well.

GOLF COURSE CONSTRUCTION

The construction process is a third environmental determinant, and an important one. As already described there are several potential detrimental effects that can result from construction activities. The involuntary movement of soil is a major concern for several reasons. Runoff of sediments can negatively impact the quality of surface waters, including the ocean. Exposure to sediment-laden runoff may also adversely impact the health and vigor of non-target organisms, plants and animals. Fugative dust is a nuisance that degrades air quality. In addition, erosion represents a direct loss of Island natural resources. For these reasons Keopuka will establish and follow an environmentally safe erosion control plan during the construction phase.

Erosion Control

The plan will be implemented in compliance with county and state guidelines and regulations. The goal of this plan will be to prevent the erosion of soil. There is very little soil on site so erosion control will primarily be focused on the soil brought to the site for the purpose of grading, and establishing grass and plants. In doing so a related decline in the quality of water or air will be prevented. Related impacts to non-targets will also be avoided. BMPs to be used in this plan will include:

- Avoiding construction activities in or near sensitive environmental areas
- Using construction methods which minimize the need for disturbance of soils
- Stabilizing soils using erosion control devices or soil stabilizing devices
- Using accepted dust abatement practices during earthwork where required
- Preventing the extended exposure of open earth as much as is practical during construction
- Establishing turfgrass and other plants on open earth as soon as possible

Erosion Control Devices

To prevent erosion on disturbed areas the contractors will utilize several temporary erosion control devices, soil stabilization devices, and dust control methods where appropriate. Temporary erosion control devices include things like:

- Silt fencing and sediment catchments to trap sediment
- Check dams or terraces to slow the velocity of run-off
- Erosion matting or mulching and temporary vegetation to stabilize soils if needed

Long term stabilization structures could include:

- Rip-rap
- Bulkheads
- Planting of trees
- Planting of turfgrass

The appropriate method to be used will be dependent on the specific site and the specific needs for that site. It will be important for the contractors to maintain the erosion control arrangements so that they function properly. It will also be important to maintain vegetation on steeper soil slopes, which may be prone to erosion. As construction wanes, it will be important to establish a permanent vegetation cover as quickly as practical. Establishing turfgrass and other vegetation is a highly effective BMP for slowing runoff, preventing erosion, and stabilizing soil.

Noise

Noise from construction activities or subsequent maintenance activities will occur at such a time as to minimize disturbances to local residents.

Historical Sites and Artifacts

In addition to preventing erosion Keopuka will be committed to preventing the destruction of historical sites and artifacts. The intent will be to identify and inventory sites during the development process and then avoid them during design, construction and subsequent maintenance. An extensive survey of the site using mapping, cataloging, and positioning will be conducted prior to any construction to identify sites. Buffer zones will be deployed as required between historical sites and any construction or management activities.

Habitat and Vegetation

With regard to wildlife habitat the intent will be to preserve it to the extent possible in the design process, and enhance it during its management. Another goal will be to expand the diversity of the habitat and vegetation thus expanding the diversity of species. The management strategies to be used to realize these goals will include:

- Identifying and inventorying species of plants and animals
- Identifying and positioning rare and endangered species, and unique habitats if any
- Discouraging the introduction of exotic species and pests
- Re-vegetating the landscape with a diversity of native materials

TURFGRASS AND LANDSCAPE PLANT MANAGEMENT

As the construction phase ends the golf course turfgrasses and other landscape plants will be established. Like construction, the maintenance of golf course turf and landscape plants can result in adverse impacts to the environment unless properly managed. Irrigating turf with fresh water also represents a direct loss of drinking water. In addition, drawdown from irrigating can allow salt water to intrude into the freshwater lens or aquifer, degrading its quality. For these reasons Keopuka will be committed to practicing environmentally responsible turf and plant management activities, especially with regards to fertilizing, irrigating, and managing pests.

Grasses and Landscape Plants

Turfgrasses such as *Champion* hybrid bermudagrass or *Seagreen* seashore paspalum will be used for creating the turfgrass surface on greens. Turfgrasses such as *Tifway 419* hybrid bermudagrass or *Seaway* seashore paspalum will be utilized for creating turf on the remainder of the course, including tees, approaches, fairways, and roughs. A summary of establishment, grow in practices, and cultural practices relevant to turfgrasses is presented as Appendix B. A variety of landscape plants will be established on the site according to the landscape architecture plan.

Fertilization of Turf and Plants

The application of fertilizer nutrients, such as nitrogen, potassium, and phosphorus is in itself a BMP for culturing healthy, vigorous turf and ornamental plants. However, the runoff or leaching of fertilizer nutrients could seriously degrade the quality of drinking water resources unless properly managed. For this reason Keopuka will be committed to enacting an environmentally safe fertilization plan. The main focus of this plan will be to preserve human health by preventing the runoff or leaching of fertilizer nutrients. Additional goals will be to:

Table 1. Estimated nitrogen totals for various turf management areas at Keopuka. Nitrogen totals are in pounds actual nitrogen per 1,000 square feet.

Green Surface	6-12
Collar	6-12
Green Surround	4-8
Tee Surface	6-12
Tee Surround	4-8
Approach	4-10
Fairway	4-10
Rough	3-6
Amenity Turf	3-6
Ornamental Lawn	4-10

- Preserve the overall quality of water resources
- Prevent non-targets from being exposed to fertilizer nutrients
- Culture healthy, pest resistant turfgrasses and ornamentals

The BMPs used to meet these goals will include:

- Utilizing slow-release nitrogen carriers
- Using a light, frequent approach to applying nitrogen
- Basing the need for fertilizer nutrients other than nitrogen on the results of soil testing and plant tissue testing
- Precisely controlling the timing and duration of irrigation events after fertilizer application events
- Precisely calibrating fertilizer application devices, and using computer driven delivery devices to the extent practical
- Paying strict attention to weather events
- Keeping detailed records of fertilization schedules and applications

<u>Irrigating Turf and Plants</u>

The judicious, precise distribution of irrigation water is another essential management practice for establishing and sustaining healthy, vigorous turf and ornamental plants. However, using fresh water for maintaining the grasses and plants on the golf course could possibly diminish the sustainable level of available drinking water. In addition, draw-down from irrigation wells can allow salt water to intrude into freshwater lenses or aquifers thereby reducing quality. Inefficient irrigation can also result in leaching or runoff of fertilizer nutrients or pesticides possibly resulting in impacts to human health. For these reasons Keopuka will be committed to enacting an irrigation plan designed to:

- Conserve fresh water resources by using brackish water for irrigation
- Preserve the quality of water resources
- Prevent the runoff or leaching of fertilizer nutrients and/or pesticides

The BMPs to be used to realize these goals include:

- Utilizing a state-of-the-art irrigation system coupled to a computer generated scheduling system and electronic weather station, and powered by computerized pump stations
- Utilizing brackish sources of irrigation water

- Designing the irrigation system to deliver water within the bounds of the golf course proper avoiding the irrigation of wildlife habitats
- Considering use of non-potable water sources such as waste water effluent
- Utilizing drip type irrigation for landscape plants to the extent practical

Golf Course Irrigation System

The professionally designed irrigation system(s) at Keopuka will be governed by a scheduling computer and powered by a computerized pumping station. The computers allow for adjusting the system to provide only the amount of irrigation that is necessary for any given area at any given time. The basis for this will be to replace only the amount of water that has evaporated from the site or been utilized by the plant. With such a system the turfgrass manager will have the utmost in irrigation system flexibility and control. In turn the wasting of water and electricity will be prevented. Data bases compiled with input from on-site, electronic weather stations will provide accurate, reliable computer scheduling information.

Irrigation Water Sources

There are two potential sources of water for irrigation purposes besides potable ground water. These include wastewater effluent and brackish well water. Many developments utilize wastewater effluent for irrigation purposes. The use of this water source for irrigation is often coupled with a need for disposal. It can be an excellent source for irrigation provided that:

- The level of sanitary treatment is sufficient
- The nutrient load is acceptable
- There are no residual industrial contaminants
- Sufficient water is available

If wastewater effluent is utilized Keopuka will adhere to all guidelines for the use of reclaimed water as established by the Hawaii Department of Health. Brackish groundwater may be the most feasible source to develop initially, as long as water quality in terms of salinity and sodium level is not limiting for turfgrass growth.

In addition, the selected irrigation source must have sufficient capacity to sustain the peak irrigation demands through the lifetime of the course. Thus, the sustainable yield of the source based on perceived use rates will be calculated and documented as a part of the plan.

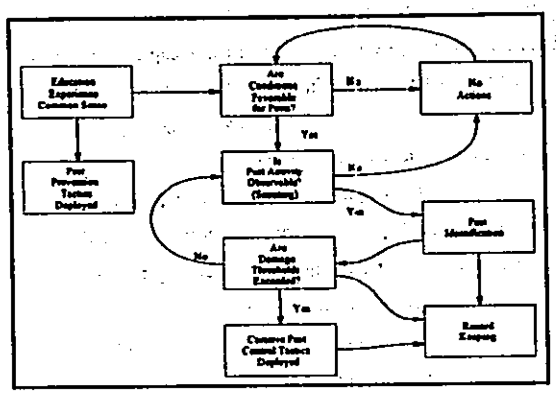

Figure 1. Simplified flow diagram of the IPM process.

Managing Pests of Turf and Plants

The style of pest management to be practiced at Keopuka is termed *Integrated Pest Management* (IPM). Integrated pest management is a blending of modern pest control processes and strategies that emphasizes the avoidance of environmental pollution. It is a decision making process for determining which pest control measures are most appropriate for a given pest on a given site at a given time (see Figure 1 and Table 2). As such, IPM is one of the truly vital environmental management strategies.

The IPM philosophy does not advocate eradication of pest populations. Rather, IPM favors suppression of pests to the level that resulting damage is acceptable in terms of economics, aesthetics, and function. With reference to golf courses, IPM is the latest and most complete attempt at managing pest populations while at the same time preventing environmental impacts that can be associated with pest management tactics. It is also a primary method for sustaining premium quality turfgrasses and ornamental plants, which are essential to the existence of a golf course.

Turf and Ornamental Plant Pesticides

The judicious use of pesticides helps to culture high quality turfgrasses and ornamentals that resist imposed pest-related stresses. Thus, the occasional use of pesticides as part of the IPM process will be necessary at Keopuka. Unless properly managed, the runoff or leaching of pesticides could seriously degrade the quality of groundwater resources and ocean water. For these reasons Keopuka will be committed to enacting a pesticide use plan intended to:

Table 2. The basic elements of the IPM process at Keopuka.

- Defining the management areas: Defining individual management areas to which an IPM process will be applied. Each specific area of the golf course at The Keopuka Lands (i.e., greens, water features, ornamental plantings) will require a unique IPM process, according to intensity of management and expectations of quality.
- Initial information gathering: Compiling background information on potential pests and non-target entities. Such information would include identifying species, documenting life cycles, finding appropriate cultural and biological controls, finding applicable chemical controls, documenting prior pest pressure histories, documenting prior records of successful and unsuccessful pest control, and obtaining any other applicable information which contributes to the knowledge base.
- Monitoring pests and non-target entities: Making observations in order to determine which pests are present, to what extent they are present, where they are, and how active they are in that area. Monitoring pests is made easier with the use of diagnostic kits and computerized pest prediction models.
- Establishing economic damage thresholds: Establishing the degree of pest injury, which becomes unacceptable. Differing management areas will tolerate differing levels of pest damage, depending on quality expectations.
- Establishing action levels: Correlating the pest population level, along with other variables such as weather or cultural practices, with the degree of injury deemed unacceptable from that pest. This procedure often takes a long time with constant work.
- Establishing effective treatments: Development of biological, cultural, genetic, or chemical treatment regimes and strategies. The ideal direction behind implementing effective treatment strategies involves mixing pest control methods, which are most effective against the target, least disruptive to non-targets, and produce minimal impacts to the environment.
- Making a decision: The aforementioned components, when coupled with practical experience, should facilitate an informed decision making process.
- Evaluating treatment assessment: A follow-up to the treatment phase, and could be considered highly integrated with the monitoring phase. In essence, it will be an evaluation of how effective the treatments were in impacting the target, and in bypassing the non-target or minimizing environmental impacts.
- Record keeping: This is one of the most important phases to deal with in IPM. The Keopuka Lands will keep highly accurate, very detailed records on all aspects of it's pest control program.

- Preserve human health
- Prevent the runoff or leaching of pesticides
- Prevent the subsequent exposure of non-targets to pesticides
- Ensure pesticide effectiveness against target species
- Reduce pesticide effects on non-target species
- Preserve the quality of water resources

The strategies used to meet these goals will consist of:

- Reducing the overall use of pesticides
- Employing a modern pesticide storage facility
- Maintaining a low-volume inventory of pesticides on site
- Utilizing personal protective equipment during application events
- Loading and mixing pesticides at established sites that feature containment

Table 3. General elements of safe pesticide use at Keopuka.

- Store pesticides in the original container. Follow all storage requirements as prescribed by the label and OSHA or EPA regulations.
- Read the entire information label before handling or using a pesticide. Using a pesticide in contradiction to the label or in a manner inconsistent with label directions is a violation of law.
- Handle pesticides in compliance with local, state, and federal regulations, including OSHA and EPA regulations.
- Never smoke, eat, or drink while handling or applying pesticides.
- Use personal protective equipment as recommended by the label when working with pesticides. Avoid direct contact with pesticides. Bathe and change into clean clothing after application.
- Calibrate application equipment precisely. Use closed systems for loading and mixing pesticides when appropriate.
- Avoid spills. If spills occur take immediate action to contain the spill. Make proper notification, if necessary.
- Dispose of all used containers according to label directions.
- Treat all agricultural chemicals with caution.

Note: Modern pesticides are developed and tested under strict protocols designed to provide maximum safety to users. However, care and common sense should prevail during their handling and use.

Table 4. Management guidelines for using turfgrass pesticides at Keopuka.

- All pesticide applicators will be properly trained in the use and application of pesticides. Only pesticides specifically labeled for use on turfgrass in Hawaii will be considered for application. All local, state, and federal regulations pertaining to pesticide use, storage, handling, and disposal will be strictly followed.
- Application equipment will be precisely calibrated and maintained to ensure precise distribution at the intended rate. Pesticide use rate will be determined by label instructions. Application equipment will possess flow regulation devices (when available) to ensure accurate delivery.
- Pesticide application will be accurately timed relative to climactic conditions to help prevent leaching, run-off or drift. Pesticide application will be restricted prior to anticipated storm events, or during high winds.
- An established buffer zone between water bodies or non-target zones and application zones will be maintained to increase the transport distance of pesticides and to prevent contamination via pesticide movement.
- Selection of pesticides will be based on education and experience using a risk analysis concept. Additionally, the user will consider efficacy of treatment and the criteria that reduce off-site movement and potential adverse impacts.

- Using pesticides strictly according to label directions
- Using pesticides with low-rate technology to the extent possible
- Properly calibrating pesticide application devices
- Avoiding pesticide application to non-target areas
- Precisely controlling the timing and duration of irrigation events after pesticide application
- Paying strict attention to the weather in terms of rainfall and wind
- Placing only licensed, qualified, responsible people in charge of pesticide applications

A partial listing of commercially available pesticides for use on turfgrasses and ornamental plants and a listing of pests of turf and ornamentals is presented in Appendix C and D.

Golf Course Maintenance Facility

The golf course maintenance facility represents another potential impact to the environment at Keopuka. This is due to the fact that a variety of potentially hazardous substances will be stored in the facility. For example, pesticides and fertilizers will be housed at the facility. So will fuels,

Table 5. Turfgrass pest tolerance matrix. This array describes the projected acceptable levels of pest activity in specific areas. The acceptable level of pest activity in any given management area is dependent upon quality expectations. High quality areas such as greens can not tolerate pest activity. Lower quality areas such as roughs can tolerate a greater degree of pest activity.

Management Area	Weed Pests	Insect Pests	Diseases
Green Surface	NT	NT	NT
Collar	NT	NT	NT
Green Surround	NT	Low	NT
Approach	NT	Low	Low
Tee Surface	NT	NT	NT
Tee Surround	Low	Low	Low
Fairway	Low	Low	Low
Rough	Medium	Low	Medium
Amenity Turf	Medium	Medium	Medium
Ornamental Lawn	NT	NT	NT

- For weeds: NT indicates no tolerance for weeds; Low indicates that up to 3 weeds per 1,000 s.f. is acceptable; medium indicates that up to 6 weeds per 1,000 s.f. is acceptable; high indicates that up to 12 weeds per 1,000 s.f. is acceptable.
- For insects and diseases: NT indicates there is no tolerance for pest activity; Low indicates a low level of tolerance for pest activity, Medium indicates successively higher tolerance; High indicates a high level of tolerance for pests. In general, pest population numbers are not considered for insects and diseases because treatment action levels have not been sufficiently developed.

Table 6. Relative levels of pesticide input for various turfgrass management areas at Keopuka.

	Insecticide	Fungicide	Herbicide	Fumigant	Nematicide
Greens Surface	high	high	medium	initial	medium
Collar	high	high	medium	initial	medium
Green Surround	medium	low	high	none	low
Approach	medium	medium	medium	none	medium
Tee Surface	high	high	medium	initial	medium
Tee Surround	medium	low	high	none	low
Fairway	medium	high	medium	none	medium
Rough	low	low	low	none	low
Amenity Turf	low	low	low	none	low
Ornamental Lawn	medium	low	medium	initial	low

oils, coolants, batteries, and a variety of other materials directly necessary for golf course operations. The washing and general maintenance of carts and golf course equipment will also take place near the maintenance yard. Unless properly managed the washing of carts and equipment could initiate the inadvertent release of grease, oil, or other contaminants from the machinery. Because of these concerns Keopuka will be committed to creating a state-of-the-art maintenance facility designed to prevent potentially adverse impacts. Design elements to be used in the creation of the facility will include:

- Containment
- Limited access
- Recycling

Storage Areas and the Mechanics Shop

The areas used to store and maintain carts, golf course equipment, tools, and supplies will be configured to contain the inadvertent release of potential environmental contaminants such as oil, grease, hydraulic fluid, gasoline, coolant, or other materials associated with equipment storage, upkeep, and repair. This will be done by:

- Constructing all floors to contain any spilled fluids such as coolant or oil
- Coating floors with materials that resist the penetration fluids such as coolants or oils
- Using commercial containment devices for the storage of bulk oils, hydraulic fluids and other materials like waste batteries
- Using self-contained hazardous material bins and cabinets for storing flammable substances like gasoline and hazardous materials like coolants

These shop areas will limit access only to authorized persons, and recycling of shop materials like solvents used in cleaning parts will be employed to the extent that is reasonable.

Equipment Wash Bay

The equipment wash rack will be configured to contain contaminants such as oil and grease from being released into the environment during the washing of carts and equipment. The wash bay is typically configured as a pitched cement pad with a recovery sump. Drainage water from the washing operation is collected in the sump and then filtered prior to either terminal discharge or storage for re-use. By collecting and filtering wash waters, any oils or other non-soluble hydrocarbon type contaminants can be prevented from being discharged to the environment. Recycling of wash waters also promotes conservation of water resources.

Storage and Dispensing of Fuels

Codes for the development of fuel storage and dispensing facilities will be strictly followed. Above ground storage for petroleum products featuring secondary containment for all fuels will be utilized. The fuel depot will also feature limited access.

Storage of Pesticides and Fertilizers

The portion(s) of the maintenance area used for storing pesticides and fertilizers will be configured to follow any existing regulations. These storage areas will:

- Be located away from water sources
- Be separate from the general facility
- Emphasize limited access

- Feature complete containment of pesticides
- Be properly ventilated and posted as required by law
- Be equipped with proper shelving and lighting, and locking doors or gates
- Feature ready access to personal protective clothing, spill response kits, fire extinguishers, and first aid kits or other emergency supplies, including the course's Hazard Communication Program

The most modern trend for storing pesticides and other hazardous substances is to use pre-manufactured buildings and suitable containment devices designed specifically for housing these hazardous materials. An accurate inventory of all pesticides stored in the facility will be kept. Pesticide labels and MSDS sheets will compliment the inventory records. A most important "Best Management Practice" in reference to pesticide storage is maintaining a *low-volume* inventory. Allowing pesticide distributors to store pesticides until their use is warranted is an innovative strategy for reducing potential exposure of pesticides.

Pesticide Loading and Mixing Area

An area of the maintenance facility will also be devoted exclusively for the loading and mixing of pesticides. The Chemical Mixing Facility (CMF) area will emphasize limited access and complete pesticide containment. In most instances the CMF is configured as an impervious concrete pad with a 1-2% pitch to a center recovery sump. The sump is generally designed to hold 110% of the volume of the largest pesticide application device used at the site. Pesticides inadvertently spilled within the confines of the pad during the mixing/loading operation can be rinsed to the sump. Collected pesticide rinseate can then be pumped from the sump into an application device for approved application to an intended target. Pesticide application devices can also be rinsed free from pesticide residues on this pad, and again, the rinseate can be collected and applied to an intended target.

The water source used for filling pesticide application devices at the CMF is to be fitted with anti-back siphon devices to protect it from contamination. This area is to be completely separate from the equipment wash pad. It will also have close proximity to the area used for pesticide storage, to minimize transport distances.

Green Waste

In addition, an area of the maintenance facility will be dedicated to the management of green wastes. The green waste generated at Keopuka will be composted on-site and reused on the golf course and in landscape areas (as mulch and soil conditioner) to the extent practical.

MONITORING THE ENVIRONMENT

Environmental monitoring will be a major BMP for maintaining environmental quality at Keopuka. Constant monitoring is the only way to know whether the other BMPs are functioning in the manner that they should. Monitoring is also the only way to know when mitigation of environmental problems is warranted.

Water Quality Monitoring

In order to assure that adverse impacts to the quality of Island water do not occur Keopuka will establish a comprehensive water quality monitoring and mitigation plan. The objective of the plan will be to ensure that the quality of both groundwater and surface water does not deteriorate as a result of golf course construction or maintenance activities. A secondary goal will be mitigate any problems the monitoring has detected in an expedient manner.

In this plan coastal waters and other water sources will be inspected for changes in baseline quality on a prescribed basis. The inspections would include, for example, testing for the intrusion of fertilizer nutrients, pesticides, sediments, salts, and other potential contaminants like oils and fuels. The success of monitoring will depend on:

- Establishing a valid background index of water quality in terms nutrients, pesticides, sediments, salts, and other potential contaminants like oils and fuels
- Implementing a rigorous water sampling schedule at appropriate locations with appropriate frequencies using wells and or lysimeters
- Testing water samples using appropriate analytical methods and equipment
- Keeping accurate records of all monitoring
- Accurately comparing background indices with collected data in a timely fashion
- Developing a procedure to notify appropriate parties in the event of a decline in the quality of water

The analysis conducted in this manner will help to preserve water quality and human health by:

- Alerting the developers to changes in water quality relative to background indices
- Providing initiative for investigating the potential cause of the problems

- Allowing for the mitigation strategies to be instituted in a timely manner

The specific mitigation strategies to be utilized in the event of detecting environmental impacts would depend on the specific problem to be identified.

SUMMARY

In summary, Keopuka intends to integrate a variety of BMPs in order to prevent the occurrence of impacts to the environment during the construction and operation of its golf course and landscape areas. Within this approach environmentally responsible people will construct and then manage a golf course that is designed to prevent impacts and avoid sensitive areas. They will utilize environmentally sound construction methods that prevent erosion and related problems. They will adopt environmentally friendly turf maintenance activities, with special reference to avoiding impacts related to fertilizing, irrigating, and managing pests. Their operations will be headquartered in a series of management facilities designed to prevent impacts by containing hazardous materials. Finally, They will constantly monitor the environment to ensure the BMPs do what they are supposed to.

This approach represents the best possible attempt at preventing environmental deterioration. However, it should be stressed that this approach is dynamic. As new BMPs are developed and proven reliable they must be included. Failure to do so would be contrary to the best interest of the environment.

Appendix A: Site Soils and Climactic Data

Soil Types

The soils in the upper one-half of the property are organic soils and volcanic ash over a'a lava and dense rock. This section of the property contains macadamia, coffee, avocado and mango. Only the macadamia orchards are maintained as commercially viable operations. These crops transition into Christmas berry, ohia, kukui, Guinea grass, koa haole and various weed species including morning glory and lantana.

The classifications for these soils are:

- Kainaliu extremely stony silty clay loam, 12 to 20 percent slope.
- Kaimu extremely stony peat, 7 to 25 percent slope.

The soils in the lower one-half of the property are pahoehoe and a'a lava with small pockets of organic matter deposited by decaying plants. Vegetation is sparse.

The classifications for these soils are:

- Lava flows, A'a.
- Lava flows, Pahoehoe.

Climatic Conditions

The rainfall in this area varies from approximately 50 inches at the upper boundary to 15 to 25 inches at the shoreline. Due to the recent drought conditions actual rainfall has been much lower. In the current year there has been no recorded rainfall as of May 4, 2000.

The normal winds in this area are typical of the Kona district with distinct day and night patterns. The daytime winds usually are light (0 to 10 miles per hour) and somewhat variable but with a prevailing west to east on shore direction. The night winds generally flow from east to west down the slope and are light (0 to 5 miles per hour). During the winter low-pressure systems occasionally can increase the wind velocity to in excess of 50 miles per hour. These strong winds are generally associated with storm systems that affect the entire state. The direction of these storm winds is usually southerly and/or westerly.

Solar patterns for the property vary according to elevation. The upper elevations are usually clear and sunny in the morning with cloud cover by mid-day. Skies become clear again with sunshine by late afternoon. At the lower elevations (500 feet to sea level) clear skies and sunshine are predominant.

(Site and climate data courtesy David Reltow and Agricon Hawaii LLC)

Appendix B: Turfgrass Management Practices

Establishing Grass Sprigs

Hybrid bermudgrasses are vegetatively propagated. The methods of propagation include:

- Sprigging: is the process of introducing live (soil free) stems, stolons and rhizomes into a finely prepared seedbed. The planting rate is usually 400-800 bushels per acre. Timely irrigation is essential to a successful establishment. Grow-in is accomplished in from 8-12 weeks. Practiced on greens, tees, and fairways.
- Row Planting: is the process of introducing springs into golf course fairways. In this process, sprigs are introduced into small slits in the fairways. This one-step process is rapid. The existing grass surface may be sprayed with a non-selective herbicide or with a growth retardant to minimize its competition with the newly planted grass. Generally the grow-in period required from planting at six-inch centers is one to one-and-a-half years.
- Hydro Sprigging: is the process of using modified hydro mulch machines to apply sprigs and mulch and fertilizers in one process. Soil must be in seedbed condition. Added mulch insures minimal erosion risk during early stages of grow-in. This process is relatively expensive and slower than the conventional sprigging process.
- Sodding: provides the quickest cover. This process, although expensive, does ensure playability of the golf course within fifteen to thirty days. Erosion control and a visually pleasing result are immediate.
- Suggested Planting Rates:

Site	Type of Sprig	Planting Rate*
Greens	Tifdwarf 'Champion'	15-30 bushels/1000 sf
Tees	Tifway 419	10-20 bushels/1000 sf
Fairways	Tifway 419	400-800 bushels/acre
Roughs	Tifway 419	200-400 bushels/acre

- Higher rates result in quicker grow-in and earlier opening for play. Rates are also increased as the planting season draws to a close to insure establishment, preventing wind and water erosion during winter months.

Grow-in of Grass Sprigs

- The objective of the grow-in phase is the establishment of a high quality turf cover in the shortest possible time. The conditions necessary to establish this objective are good seedbed preparation, proper planting procedures, timely watering, and close attention to post-planting maintenance recommendations.
- The seedbed should be freshly prepared before planting, and free of roots, rocks, weeds, and other debris. It should have a favorable soil pH (6.0-7.0), adequate N-P-K fertility, good soil moisture and be soft enough to permit penetration of the grass stolons to an adequate depth.
- Timely watering of newly planted areas is of utmost importance after planting. Insure maximum return on the investment by watering as soon after planting as possible. Experience indicates that the rate of survival of stolons in a good seedbed is approximately as follows:

Watered within 10 minutes after planting	90-95 percent
Watered within 30 minutes after planting	80-90 percent
Watered within 1 hour after planting	70-80 percent
Watered within 2 hours after planting	60-70 percent
Watered within 4 hours of planting	40-60 percent
Watered within 1 day after planting	30-40 percent
Watered within 48 hours after planting	5-20 percent

- Planted areas should be kept continuously moist for a period of three weeks. This means frequent light watering rather than soaking the soil when it becomes dry. The amount and frequency of water application will vary somewhat with the soil texture. After three weeks, water each area at least once per day until the grass is completely covered.

- One week after planting, fertilize with ammonium nitrate (33-0-0) at the rate of 150 pounds per acre. This application should be repeated each week for three weeks. On the fourth week after planting, fertilize with a complete (10.10-10) fertilizer at the rate of 500 pounds per acre. Repeat the above cycle (3 applications 33-0-0 one week apart followed by 10-10-10 or 8-8-8) until the grass has covered. To avoid burning, fertilize when the grass is dry and water immediately following application.
- Inspect the grass daily for the presence of worms. For control use insecticides such as Dursban, Lannate, or Proxol.
- Three to four weeks after planting start the weed control program. However, do not begin spraying for weeks if the bermudagrass has not greened-up and become established. Also, be sure the soil contains adequate moisture before each application of spray.
- Grassy Weeds such as crabgrass, goosegrass and watersedge in Tifway or Tifway II bermudagrass, apply Monosodium Methanearsonate (MSMA) at the rate of one to two pounds active ingredient per acre. Repeat the application every 5-7 days until the weeds are controlled. For grassy weed control in Tifton 328, Tifton 328 II or Tifton Dwarf, use MSMA at the rate of one pound per acre.
- Broadleaf Weeds such as mouse-ear chickweed, pennywort and Carolina geranium in Tifton 419 can be controlled using Buctril at the rate of one-half pound active ingredient per acre, 2,4-D should be used at the rate of one-eighth pound per acre. Of the two materials, Buctril is safer than 2,4-D for use on bermudagrass; however, for effective control, it must be applied when the weeds are in the one to two leaf stage.
- To help control weeds and promote lateral growth, begin mowing when the grass is approximately one to one-half inches high. Mow at regular intervals using a reel-type mower set to cut at one inch for Tifton 419. For Tifton 328, Tifton 328 II or Tifton Dwarf set the mower to cut at one-half inch height.
- To provide a smooth, firm surface for future play and operation of mowing equipment, all areas will need to be rolled. The first rolling should begin when the grass is approximately 25 to 50 percent covered.

Cultural Practices for Greens and Tees

- Mowing Height: 0.10 to 0.31 (1/10-5/16) in.
- Mowing Frequency: Daily.
- Mowing Pattern: Alter at each mowing in each of four directions.
- Clippings: Remove.
- Grain Control: Use vertical putting as needed up to once per week for control of grain and variable growth. Adjust to produce very light combing effect. Combing or brushing may also be advisable.
- Nitrogen: Apply 0.5 to 1.2 lb. N/1,000 sq. ft. Use 0. 0.5 lb. N/1,000 sq. ft./10-15 growing days for water-soluble carriers, or 0.5 to 1.2 lbs. N/1,000 sq. ft./20 to 30 growing days for slow release carriers.
- Phosphorus: Apply at rate based on soil test. Spring or fall timing best. Usually part complete analysis fertilizer.
- Potassium: Apply at rate based on soil test where fine-textured clay soils are involved. Coarse textured soils require 4 to 8 lbs. K20/1 000 sq. ft./yr., usually split into to six applications over growing season.
- Iron: Apply 2 to 4 oz. iron carrier/1,000 sq. ft. as needed to correct developing iron chlorosis.
- Other Nutrients: Apply if specific nutrient deficiency diagnosed.
- pH Correction: Maintain pH between 6.0 and 7.0. Apply limestone or sulfur materials as needed based on annual soil test.
- Irrigation: Moisten to full depth of root zone with each irrigation; time prior to development of visual wilt symptoms.
- Topdressing: Apply two to six times per year as needed for smoothing and thatch control. Minimum of twice per year suggested, with spring and late summer applications at 0.3 to 0.5 cu. yd./1, 000 sq. ft. Use as follow-up to cultivation whenever possible with higher application rate. May be applied as often as every three to four weeks during periods of rapid shoot growth at rate of 0.1 cu. yd./1, 000 sq. ft.
- Cultivation: Utilize two to six times per year. Higher frequencies needed on intensely trafficked greens grown on fine-textured soil. Core or slice a minimum of twice yearly in spring a late summer. Avoid cultivation within thirty days of scheduled winter overseeding.
- Spiking: Practice as needed up to weekly to prevent developing surface compaction or impermeable problem.
- Weed Control: Control broadleaf and annual weedy grasses as they appear with either pre-emergent or post-emergent herbicides. Be sure to apply late summer treatments sufficiently early avoid phytotoxicity to winter overseeded cool-season grasses.

- Disease Control: Control Use corrective or preventive disease control program, former generally being preferred, especially in arid and semiarid climates.
- Insect Control: Apply appropriate insecticide as needed to correct developing insect problem.
- Winter Overseeding: Usually used in southern half of warm humid climatic region. Accomplish adequate thatch control and soil compaction correction well in advance of scheduled winter overseeding. Follow overseeding procedures discussed in previous section.

Cultural Practices for Fairways and Roughs

- Mowing Height: 0.5 to 1.0 in. (1.3 to 2.5 cm).
- Mowing Frequency: Daily to two-three times per week, if irrigated; weekly to biweekly, if not irrigated
- Mowing Pattern: Mow longitudinally; cross mowing especially desirable.
- Clippings: Return.
- Nitrogen: Apply 10 to 40 lbs. N/acre/growing month; use lower rate if not irrigated.
- Phosphorus: Apply at rate based on soil test.
- Potassium: Apply at rate based on soil test, usually at 50 to 70 percent of nitrogen rate.
- Iron: Apply only when visual deficiency symptoms appear. Deficiencies most likely on alkali soils and following spring greenup.
- Other Nutrients: Apply if specific nutrient deficiency diagnosed (rare occurrence).
- pH Correction: Maintain pH between 6.0 and 7.0. Apply limestone or sulfur materials based on soil test.
- Irrigation: May or may not be irrigated. If irrigated, moisten to full depth of root zone prior appearance of visual wilt symptoms (footprinting stage).
- Thatch Control: Vertical cutting may be needed if thatch problem develops. Best accomplish during first half of growing season. Thatch most likely to develop with improved bermudagrasses, especially at higher nitrogen and irrigation levels. Topdressing not normally practiced.
- Cultivation: Core/slice as needed to correct developing soil compaction problem. Special attention needed on sites subject to intense cart traffic. Best accomplished during first half summer.
- Weed Control: Apply herbicide only as needed to control developing weed problem. Best accomplished during first half of growing season. Control of winter annual weeds may required after bermudagrass enters winter dormancy, assuming overseeding not practice
- Disease Control: Fungicides used infrequently. Spring dead spot can be problem; thatch control a maintenance of moist soil conditions reduce severity.
- Insect Control: Apply appropriate insecticide as needed when potentially serious insect injury symptom first appear. Major problems include bermudagrass mites, sod webworms, armyworm and grubs.

Note: These practices as outlined in this appendix will be modified as necessary and as better information becomes available to produce the desired turfgrass results while providing environmental and employee protection.

APPENDIX C: PESTS OF TURF AND ORNAMENTALS

Weed pests of turfgrasses. Weeds are comprised of three basic types: grassy weeds, sedges, and broadleaf weeds. Not all weeds will be present at any given time.

BROAD GROUP	COMMON NAME	SCIENTIFIC NAME
GRASSY WEEDS	Annual Bluegrass	*Poa annua*
	Bahiagrass	*Paspalum notatum*
	Dallisgrass	*Paspalum dilitatum*
	Goosegrass	*Eleusine indica*
	Henry's Crabgrass	*Digitaria adscendens*
	Hilograss	*Paspalum conjugatum*
	Kikuyugrass	*Pennisetum clandestinum*
	Lovegrass	*Eragrostis pilosa*
	Smutgrass	*Sporobolus poiretti*
	Rattailgrass	*Sporobolus africanus*
	Stargrass	*Chloris divaricata*
	Swollen Fingergrass	*Chloris barbata*
	Vaseygrass	*Paspalum urvillei*
SEDGES	Green Kyllinga	*Kyllinga monocephala*
	Purple Nutsedge	*Cyperus rotundus*
	Yellow Nutsedge	*Cyperus esculentus*
	White Kyllinga	*Cyperus brevifolius*
BROADLEAF WEEDS	Alternanthera	*Alternanthera repens*
	Asiatic Pennywort	*Centella asiatica*
	Broadleaf Plantain	*Plantago major*
	Buttonweed	*Borreria laevis*
	Creeping Indigo	*Indigofera endecaphylla*
	Dandelion	*Taraxacum officinale*
	Drymaria	*Drymaria cordata*
	Garden Spurge	*Euphorbia hirta*
	Kaimi Clover	*Desmodium canum*
	Marsh Pennywort	*Hydrocotyle sibthorpiodes*
	Pink Woodsorel	*Oxalis martiana*
	Prostrate Spurge	*Euphorbia prostrata*
	Prostrate Pigweed	*Amaranthus graecizans*
	Purslane	*Portulaca oleracea*
	Sensitive Plant	*Mimosa pudica*
	Spiny Pigweed	*Amaranthus spinus*
	Spotted Spurge	*Euphorbia maculata*
	Synderella	*Synderella nodiflora*

Insect pest of turf and ornamentals. Broad groups consist of caterpillars and worms, beetles, mites, and scale type insects.

BROAD GROUP	COMMON NAME	SCIENTIFIC NAME
CATERPILLARS & WORMS	Bagworm	*Brachycyttarus spp.*
	Black Cutworm	*Agrotis ipsilon*
	Fiery Skipper	*Hylephila phyleus*
	Grass Webworm	*Herpetogramma licarsisalis*
	Lawn Armyworm	*Spodoptera mauritia*
	Sod Webworm	*Herpetogramma phaeopteralis*
BEETLES	Chinch Bug	*Blissus insularis*
	Hunting Billbug	*Sphenophorus venatus*
	Rhodesgrass Mealybug	*Antonina gramini*
MITES	Bermudagrass Mite	*Eriophyes cynodoniensis*
	Stunt Mite	*Aceria neocynodonis*
SCALES	Bermudagrass Scale	*Odonaspis ruthae*

Diseases of turf and ornamental plants. Turfgrass diseases can be caused by fungi, bacteria, and other micro-organisms.

BROAD GROUP	COMMON NAME	SCIENTIFIC NAME
FUNGI	Anthracnose	*Colletrichum graminicola*
	Bermudagrass Decline	*Gaeumannomyces graminis*
	Brown Patch	*Rhizoctonia spp.*
	Dollar Spot	*Lanzia spp.*
	Localized Dry Spot	*various fungi*
	Fairy Ring	*Basidiomycetes spp.*
	Grey Leaf Spot	*Bipolaris spp. & Dreschslera spp.*
	Pythium	*Pythium spp.*
	Spring Dead Spot	*Leptosphaeria korrea*
	Rust	*Puccinia spp.*
	Cercospora Leaf Spot	*Cercospora spp.*
	Southern Blight	*Sclerotium rolfsii*
	Yellow Tuft	*Sclerophthora macrospora*
BACTERIA	Bacterial Wilt	*Xanthamonas spp.*
	Bacterial Stripe	*Xanthamonas spp.*
	Slime molds	*Mucilago spp.*
VIRUSES	St. Augustine Decline	Panicum Mosaic Virus
MISCELLANEOUS	Algae	*Thallophyta spp.*
	Black Layer	Sulfate-reducing Bacteria
	White Leaf	Mycoplasma

CONTROL OPTIONS FOR SELECTED PESTS

INSECTS:
Bermudagrass Mites:
- control may be warranted when 4-8 witchesbroomed tufts occur per square foot of turf
- predaceous mites (i.e., *Neocunaxoides andrei* and *Stenotarsonemus spirifex*) have been used as biocontrol agents with limited success
- traditional pesticides such as fluvalinate (Mavrik®) or dicofol (Kelthane®) are needed for control

Tropical Webworm:
- BT type microbial toxins (i.e., B.t. var. *spodoptera*–Javelin® or Steward®) are used for control
- insect parasitic nematodes (i.e., *Steinernema* spp) are also effective contorl agents when applied at 10^9 juveniles per acre
- contact insecticides (i.e., acephate-Orthene®; chloropyrifos-Dursban®) give good control when applied onto turf during early evening

Armyworms:
- BT type microbial toxins give some control
- poison baits also give limited control
- contact/stomach poisons (i.e., acephate-Orthene®; chloropyrifos-Dursban®) control actively feeding larvae
- apply pesticides in late evening and do not irrigate after application
- liquid pesticide more effective than granular types

Bermudagrass Scale:
- water and fertilize turf and apply conventional insecticides such as Dursban®
- irrigate pesticide into thatch immediately after application

DISEASES:
Bermudagrass Decline:
- preventative measures are necessary (i.e., preventative application of a DMI type fungicide)
- raise mowing height during stress periods
- enhance drainage
- do not raise pH

Brown Patch:
- avoid excessive use of quick release N
- use contact fungicides (i.e., chlorothalonil-Daconil 2787®) at regular intervals

Pythium:
- improve drainage
- reduce level of irrigation
- use contact fungicides labeled for Pythium (i.e., ethazole-Koban®)
- reduce nematode pest populations

Spring Dead Spot:
- avoid low mowing heights
- avoid excessive summertime fertilization
- DMI type fungicides necessary for control

Nematodes:
- must sample for accurate population estimates
- irrigate to promote healthy root system
- avoid stresses to the turf
- apply adequate potassium
- fenamiphos (i.e., Nemacur®) is registered for control

WEEDS:

Crabgrass:
- apply pre-emergent herbicide
- avoid verticutting turf or core-cultivation during time of crabgrass germination
- reduce N applications when crabgrass is most competitive
- hand pick to extent possible

Goosegrass:
- apply pre-emergent herbicide
- post-emergent herbicides effective when applied prior to tillering (i.e., diclofop methyl-Illoxan®)
- releive soil compaction
- hand pick to extent possible

Dallisgrass:
- Post-emergent control in bermudagrass via MSMA (i.e., monosodium methanearsonate) + Lexan® (metribuzin)

Nutsedge:
- improve drainage
- lower height of cut and increase mowing frequency
- use post-emergent herbicides (i.e., imazaquin-Image®)

Spurge:
- relieve compaction
- use post-emergent herbicide containing 2,4-D + dicamba

PESTICIDE SCREENING INDEX AND PESTICIDES

One simple model employed for indexing pesticides is termed Attenuation Factor (AF). The AF was proposed by Rao et al. in 1985. AF is a model, which does not predict the occurrence of ground water contamination, but instead expresses the relative potential for pesticides to intrude into ground water. The intent behind its development was to enable regulatory agencies to evaluate large numbers of pesticides to select chemicals for ground water monitoring programs. The Hawaii Department of Agriculture has used AF to help identify "pesticides of concern" regarding ground water contamination. AF has also served as a simplistic predictor of the mass fraction of pesticides lost below the rootzone. In order to calculate AF, values for the following inputs are needed:

- Pesticide Coefficient of Adsorption (K)
- Pesticide Soil Half Life (T in days)
- Soil Dry Bulk Density (B in g cm^{-3})
- Soil Organic Carbon Fraction (C in %)
- Soil Volumetric Water Holding Capacity (V in %)

- Depth of Rootzone (L in cm)
- Rate of Evapotranspiration (Q in cm day^{-1})

With these inputs the AF can be calculated by the following equation:

$$AF = \exp\{[(L)[1 + (BCK/V)](V/Q)](0.693/T)\}$$

where:

$$[1 + (BCK/V)] = \text{Retardation Factor (RF)}$$

and:

$$(L)(RF)(V/Q) = \text{Travel Time (TT)}$$

In all calculations:

$$0.0 < AF < 1.0$$

Large calculated values for AF values reflect greater potential for pesticide persistence in a given rootzone, and/or greater potential for movement through the rootzone, hence a greater overall potential for intrusion of pesticides to ground water (via leaching). Lesser values indicate a greater relative potential for pesticides to be adsorbed to sediments or organic debris, or other substrates, in the rootzone. Although it is not labeled for use on turfgrasses, the AF value for the pesticide atrazine has been termed a "trigger of concern." Pesticides with calculated AF values greater than the value calculated for atrazine (for a given soil type) are considered to have a high degree of mobility and persistence, and as such theoretically have a relatively greater potential for leaching. Pesticide having AF values > atrazine can be given special consideration in the overall pest management scheme.

Included with this document is a copy of an Attenuation Factor program on diskette. This simple Windows based program has been provided so that the turf managers at Keopuka can reliably "index" the various pesticides at any time. As long as the partition coefficient and the half-life of the pesticide of interest are known, and as long as there is an accurate indication of environmental factors including depth of the rootzone, Et rate, soil bulk density, and the organic carbon content of the soil, program users can easily calculate the AF for any pesticide. An example is provided at the end of this appendix.

The intention behind presenting this program would be to correlate the AF results with toxicity data and the results of other environmental models. Examining the calculated AF along with toxicity data and other model results should give a reliable indication to the environmental behavior of pesticides.

Considerations in regard to prior indexing work include the following:
- Each broad group of pesticides (i.e., insecticides, fungicides, herbicides) contains pesticides having calculated AF values that exceeded the atrazine trigger criteria for each soil.
- Insecticides as a group may have the greatest number of "pesticides of concern." Lindane, ethoprop, isazofos, and isofenphos produce AF values greater than the respective atrazine trigger levels. The insecticide which generally shows the least overall tendency for potential movement via leaching is chloropyrifos (Dursban).
- Three popular fungicides have AF values that exceed an atrazine trigger. These are fenarimol, propiconazole, and metalaxyl. Most fungicides exhibiting movement potential greater than atrazine are systemic in nature.
- Most herbicides showing a movement potential greater than atrazine are post-emergent types.
- Increasing the values of bulk density, organic carbon, and rootzone depth act to reduce the value of AF (decrease leaching). Of these inputs, organic carbon appears to exert the most influence on the calculated value of AF. Increasing the rate of Et acted to increase the value of AF (increase leaching).
- The majority of screened pesticides pose relatively little threat to ground water resources when an atrazine trigger level is considered.
- The results of prior indexing work compare favorably with the qualitative assessments known as the SCS Leaching Rating, and the GUS Ranking (see the listing of pesticides). Pesticides classified by SCS or GUS systems as "small" or "nonleacher" (respectively) generally have small AF values.

AN EXAMPLE:

Consider the pesticide EDB (ethylene di-bromide) for which:

K = partition coefficient = 44
T = half life = 3,650 days

Partial listing of pesticides available for use at Kropuka. Select environmental data are also included.

	Common Brand Names	Coefficient of Adsorption (K_{oc})	Solubility in Water (mg L^{-1})	Half Life in Soil (days)	SCS Runoff Rating		SCS Leaching Rating	GUS Ranking	Persistence Ranking	Toxicity LD50-Rat Oral mg/kg
					Sediment	Soluble				
INSECTICIDES										
acephate	Orthene TT&O		650,000							1030-1447
bendiocarb	Turcam	570	40	3-21	small	large	small	nonleacher	3-5	141-250
bifenthrin	Talstar T&O									> 5000
carbaryl	Sevin 80WSP	79-570	32-40	6-110	small	medium	small	nonleacher	4	281
chloropyrifos	Dursban Turf	6,070-14,800	1.1-4.8	6-139	medium	small	small	nonleacher	2-4	530-940
cyfluthrin	Tempo 2									647-695
ethoprop	Mocap 10G	26-120	700-750	14-63	small	medium	large	intermediate	2-4	160-425
fenamiphos	Nemacur 10G	26-249	400-700	3-30	medium	large	large	leacher	3-5	10-14
fonofos	Crusade 5G									205-465
imidcloprid	Merit 75 WSP									1858-2591
isofenphos	Oftanol 5G	17-536	20-24	30-365	medium	large	medium	intermediate	1-3	565-821
lindane	Gamma Mean	1,300		266						
trichlorfon	Dylox 80	2-45	15,400 to 154,000	3-27	small	medium	large	leacher	3-5	395-933
FUNGICIDES										
chlorothalonil	Daconil 2787	500-14,000	0.6-1.2	5-90-1.3	medium	medium	small	nonleacher	2-4	4200
etriazole	Koban 1.3	1,000-4,400	50-200	20	medium	medium	small	nonleacher	3	1077
fenarimol	Rubigan	600-1,030	14	360	medium	large	large	intermediate	1	
fosetyl Al	Alliette T&O	20	120,000	1	small	medium	small	nonleacher	5	2860
iprodione	Chipco 26019	500-1,300	13-14	7-50	small	large	small	nonleacher	3-4	> 5000
mancozeb	Fore	1,000-2,000	0.5	28-139	large	large	small	nonleacher	1-2	> 5000
maneb	Maneb-4	2,000	0.5	12-56	large	large	small	nonleacher	2-4	
metalaxyl	Subdue 2E	29-287	7,100-8,400	7-160	medium	large	large	leacher	1-4	1290-3000
propamocarb	Banol	1,000,000	700,000 to 1,000,000	30	medium	small	small	nonleacher	3	2000-8550
propiconazole	Banner	387-1,147	100-110	109-123	large	large	medium	intermediate	1	1310
thiophanate methyl	Fungo 50	1,000-1,830	3.5	<10	medium	medium	small	nonleacher	4	6640
triademefon	Bayleton 25	73-517	70-260	6-28	small	large	medium	intermediate	3-4	2828-3668
HERBICIDES										
2,4-D	Weedone	0.1-6,900	0.2-3,000,000	2-30	small	medium	medium	intermediate	3-5	
benefin	Balan 2.5	781-15,500	<1	2-130						> 5000
bensulide	Betasan	740-10,000	5.6-25	30-180						
bentazon	Basagran T&O									2063
dicamba	Banvel	0.4-470	4,500-850,000	3-315						
dithiopyr	Dimension		138							3600
glyphosate	Round-Up	2,000-24,000	12,000-900,000	30-50	large	large	small	nonleacher	2-4	> 5000
imazaquin	Image	460	60	60						> 5000
isoxaben	Gallery 75									> 5000
mecoprop	Lescoplex	3-130	620-790,000	12-21	small	medium	large	leacher	3	
metribuzin	Sencor	41-95	1,200-1,220	24-30						2379-2794
MSMA	Daconate 6	2,000-300,000	57,000-1,400,000	1,000	large	small	small	nonleacher	1	1820
Oxidiazon	Ronstar 50	3,241-5,300	0.7	30-180	large	medium	small	nonleacher		> 5000
Pendimethalin	Pre-M 3.3	5,000	0.275-0.5	8-480						3956
Pronamide	Kerb				medium	large	large	leacher		> 16000
Simazine	Princep	135-890	3.5-5	32-75	medium	large	large	leacher	2-4	

X

and consider a soil to which EDB is applied, for which:

B = bulk density = 1.2 grams per cubic centimeter
C = organic carbon content = 1.5% (i.e., use 0.015)
V = volumetric water content = 35% (i.e., use 0.35)
Q = evapotranspiration = 0.1 centimeter per day
L = depth of the rootzone = 61 centimeters

The calculated value of AF = 0.88

IX

APPENDIX F-1

Avifauna and Feral Mammal Survey (1992)

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT KEOPUKA, NORTH AND SOUTH KONA, HAWAII

Prepared for

PBR Hawaii

and

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by

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4 March 1992

INTRODUCTION

The purpose of this report is to summarize the findings of a two day (29 February, 1 March 1992) bird and mammal field survey of approximately 660 acres of property located at Keopuka, North and South Kona, Hawaii (Fig.1) Also included are references to pertinent literature as well as unpublished faunal reports from similar habitat.

The objectives of the field survey were to:

1- Document what bird and mammal species occur on the property or may likely occur given the type of habitats available.

2- Provide some baseline data on the relative (estimated) abundance of each species.

3- Determine the presence or likely occurrence of any native fauna particularly any that are State or Federally listed as "Endangered" or "Threatened".

4- If any special or unique wildlife habitat or resources occur on the property locate such sites and note their possible value for wildlife in this region of the island.

GENERAL SITE DESCRIPTION

Figure One indicates the limits of the approximately 660 acres surveyed for birds and mammals. The upper (mauka) portion of the property contains a mixture of second growth forest and Macadamia Nut orchards. The middle section has both native forest Ohia (*Metrosideros polymorpha*) and exotic trees such as Kukui (*Aleurites moluccana*) and Christmas Berry (*Schinus terebinthifolius*). The lower (makai) region is barren lava with dry grass and Kiawe (*Prosopis pallida*). No wetlands occur on the site.

Weather during the field survey was variable with clear and cloudy periods. Winds were light and from the West.

STUDY METHODS

Field observations of birds were made with binoculars and by listening for vocalizations. These observations were concentrated during the peak bird activity periods of early morning and late afternoon. Attention was also paid to the presence of tracks and scats as indicators of bird and mammal activity. At various locations eight minute counts were made of all birds seen or heard (Fig.1). Between these count (census) stations any unusual observations of birds were also noted. These data provide the basis for the relative (estimated) abundance figures given in this report (Table 1).

Published and unpublished reports of birds known from similar habitat on lands elsewhere in West Hawaii were also consulted in order to acquire a more complete picture of the possible species that might occur in the area and their relative abundance (Bruner 1989a, 1989b, 1989c, 1989d, 1990a, 1990b, 1990c, 1991a, 1991b; Pratt et al. 1987; Hawaii Audubon Society 1989; David 1989, 1990). Observations of feral mammals were limited to visual sightings and evidence in the form of scats, tracks and skeletal remains. No attempts were made to trap mammals in order to obtain data on their relative (estimated) abundance and distribution. One evening was devoted to searching for the presence of owls and the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*).

Scientific names used herein follow those given in Hawaii's Birds (Hawaii Audubon Society 1989); A field guide to the bird of Hawaii and the Tropical Pacific (Pratt et al. 1987); Mammal Species of the World (Honacki et al. 1982) and Hawaiian Forest Plants (Merlin 1977).

RESULTS AND DISCUSSION

Resident Endemic (Native) Birds:

The only endemic species recorded on the property was the Short-eared Owl or Pueo (*Asio flammeus sandwichensis*). Two pueo were seen foraging near the Macadamia Nut orchards. This habitat attracts rodents and may in part explain the presence of Pueo. However, this owl can also be found in grasslands and native forest (Hawaii Audubon Society 1989). 'Io or Hawaiian Hawk (Buteo solitarius) may also occur from time to time on this property. This endemic and endangered species hunts over a wide range on natural and disturbed habitats (Pratt et al. 1987).

Migratory Indigenous (Native) Birds:

Only one shorebird was recorded, a single Pacific Golden Plover (Pluvialis fulva) seen flying over the property. The dense brush which covers most of the site,except for the open lava flows along the coastal section, restricts the use of this area by shorebirds. The rocky shoreline is too steep for migrant waders such as plover, Ruddy Turnstone (Arenaria interpres) and Wandering Tattler (Heteroscelus incanus).

Resident Indigenous (Native) Birds:

No indigenous species were recorded. The only species in this category is the Black-crowned Night Heron (Nycticorax nycticorax). The absence of wetland habitat precludes the occurrence of this species or any other waterbird.

Resident Indigenous (Native) Birds:

A total of eleven species of exotic birds were recorded during the field survey (Table 1). The most abundant species were Japanese

White-eye (Zosterops japonicus), Zebra Dove (Geopelia striata), House Finch (Carpodacus mexicanus) and Northern Cardinal (Cardinalis cardinalis). The large numbers of the latter two species is most likely due to the abundance of Christmas Berry trees.

Based on the location and type of habitat found on the property as well as from data gathered elsewhere in West Hawaii (Bruner 1989a, 1989b, 1989c, 1989d, 1990a, 1990b, 1990c, 1991a, 1991b; and information provided in Pratt et al. 1987; Hawaii Audubon Society 1989 and David 1989, 1990) the following exotic bird species might also occur on or near the property: Barn Owl (Tyto alba), Wild Turkey (Meleagris gallopavo), California Quail (Callipepla californica), Black Francolin (Francolinus francolinus), Northern Mockingbird (Mimus polyglottus), Saffron Finch (Sicalis flaveola), Yellow-fronted Canary (Serinus mozambicus), Warbling Silverbill (Lonchura malabarica), Lavender Waxbill (Estrilda caerulescens) and perhaps Red-billed Leiothrix (Leiothrix lutea).

Feral Mammals:

Small Indian Mongoose (Herpestes auropunctatus) and feral cats were observed. The skeletal remains of goats were found in lava tubes and pig tracks were seen along the dusty road. No trapping was conducted in order to assess the relative abundance of mammals.

Records of the endemic and endangered Hawaiian Hoary Bat are sketchy but the species has been reported regularly from West

Hawaii (Tomich 1986; Kepler and Scott 1990). No bats were found on the survey. The nearby Hokukano property was surveyed in October 1991 and four bats were recorded foraging near shore (Bruner 1991b).

CONCLUSION

A brief field survey can provide only a limited perspective of the wildlife which utilize the area. Not all species will be observed and information on occurrence and use of the site must be sketched together from brief observations and the available literature. The number of species and the relative abundance of each species may vary throughout the year due to available food resources and reproductive success. Species which are migratory will quite obviously be a significant part of the faunal picture only at certain times during the year. Exotic species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987; Moulton et al. 1990). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. Nevertheless some general conclusions related to bird and mammal activity on this property can be offered:

1- All major habitats were visited and census stations were distributed along roads and trails so as to provide a reasonable

sample from which to estimate the relative abundance of bird populations.

2- The only endemic bird recorded on the property was the Pueo. The virtual absence of migratory shorebirds was due to a lack of suitable habitat. Following development and the subsequent creation of more open habitats and lawns, species such as Pacific Golden Plover and Ruddy Turnstone should increase in number at this site.

3- The property supports the typical array of exotic birds one would expect in this type of environment in Hawaii. Some potential species were not recorded. This could have been due to the fact that the survey was too brief, or that their numbers are so low that they went undetected or a combination of these and other factors. It is also quite possible these unaccounted for species simply at present do not occur on this property. The abundance of Japanese White-eyes and Northern Cardinals should decline with the clearing of dense patches of Christmas Berry.

4- In order to obtain more definitive data on mammals a trapping program would be required. The endangered Hawaiian Hoary Bat was not recorded but may occur on the property based on observations from nearby lands.

5- No particularly unique wildlife habitat was discovered on this property. The dense forest and brush provide habitat for a variety of birds. The occurrence of large Ohia trees suggest that some sections of the land have not experienced extensive clearing for ranching and other agricultural activities in recent years.

RECOMMENDATION

The central section of the property contains a number of large native Ohia trees. This endemic plant should be retained and incorporated in the development plans for this site. Although no endemic birds aside from the Pueo were recorded on this survey Ohia are an important tree for native wildlife. The use of native vegetation in the landscaping gives a much better impression to those who value the natural environment.

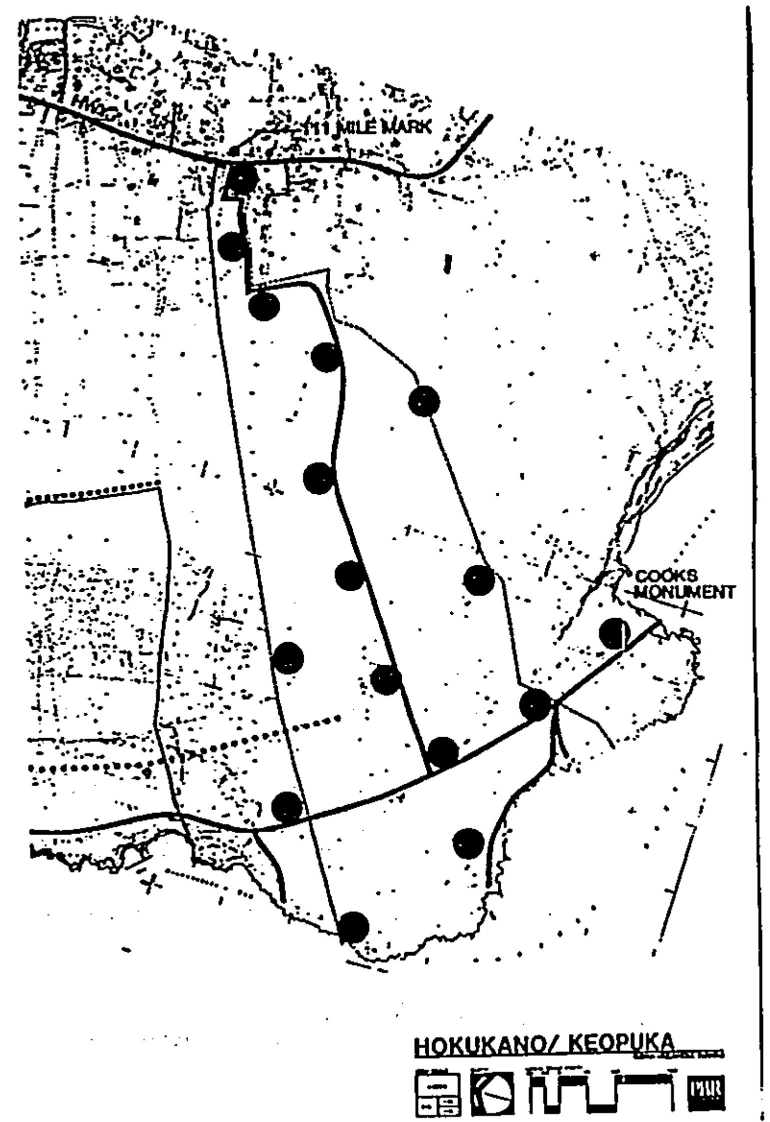

Fig. 1. Location of faunal survey with faunal census (count) stations shown as solid circles.

KEY TO TABLE 1

Relative (estimate) abundance = Number of times observed during survey or average number on eight minute counts in appropriate habitat.

A = abundant (ave. 10+) number which follows is average of data from all survey days

C = common (ave. 5-10) number which follows is average of data from all survey days

U = uncommon (ave. less than 5) number which follows is average of data from all survey days

R = recorded (seen or heard at times other than on 8 min. counts or on one count only) number which follows is the total number seen or heard over the duration of the survey

TABLE 1

Exotic (introduced) birds recorded at Keopuka, North and South Kona, Hawaii

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*
Ring-necked Pheasant	Phasianus colchicus	R = 1
Kalij Pheasant	Lophura leucomelana	R = 1
Gray Francolin	Francolinus pondicerianus	U = 2
Spotted Dove	Streptopelia chinensis	U = 4
Zebra Dove	Geopelia striata	A = 12
Common Myna	Acridotheres tristis	C = 6
Northern Cardinal	Cardinalis cardinalis	A = 10
Yellow-billed Cardinal	Paroaria capitata	R = 6
Japanese White-eye	Zosterops japonicus	A = 18
Nutmeg Mannikin	Lonchura punctulata	R = 12
House Finch	Carpodacus mexicanus	A = 14

*(see page 11 for key to symbols)

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APPENDIX F-2

Avifauna and Feral Mammal Survey (2000)

UPDATED SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT KEOPUKA, SOUTH KONA, HAWAII

Prepared for:

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and

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by:

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28 April 2000

INTRODUCTION

The purpose of this report is to present the findings of a two day (24-25 April 2000) bird and mammal field survey of approximately 660 acres located at Keopuka, South Kona, Hawaii. Included in this report are references to pertinent literature and unpublished reports including an earlier field survey of this property (Bruner 1992).

The objectives of the field survey were:

1- Update information on species composition and relative abundance of birds and mammals located on the property.

2- Search for any new species not recorded but known from this region of the island.

3- Note any changes in the habitats since the 1992 survey.

GENERAL SITE DESCRIPTION

Three fairly distinct habitats were identified on the 1992 survey (Bruner 1992). These divisions of the landscape persist today. The understory of the Ohia forest section of the property appears to have become dense and dominated by exotic weeds. Generally speaking, the property has not changed dramatically in the past eight years. Introduced plants, birds and mammals still dominate the landscape.

STUDY METHODS

The protocol for this current investigation of Keopuka followed that used in 1992. The same census stations shown in Fig. 1 of the 1992 report were sampled in this 2000 survey. The data presented in Table 1 come from the census stations and additional observations made between the stations. The site was walked from mauka boundary to the shoreline on both days of the survey. Evening observations were made on 24 April 2000. The purpose of the evening studies were to look for the presence of the endangered and endemic (native) Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) and owls.

Scientific names used in this report follow Pyle (1997) and Honacki et al. (1982). Unpublished references cited in the 1992 report were reviewed and data from the 1992 report were compared with results from this 2000 survey (Table 1).

RESULTS AND DISCUSSION

Resident Endemic (Native) Birds:

Four Hawaii Amakihi (*Hemignathus virens virens*) were recorded in the Ohia forest section of the site. All of these species is a member of the endemic subfamily *Drepanidinae*. Many members of this family are extinct or endangered. The Amakihi, however, is not endangered or threatened. It is one of the most common *Drepanidinae* remaining. The major limiting factors on native forest birds are introduced diseases spread by mosquitoes. Amakihi may have developed some immunity to these diseases in

recent years since they are frequently recorded in lower elevation habitats where mosquitoes and presumably bird diseases are present. In 1992 two Pueo or Short-eared Owls (*Asio flammeus sandwichensis*) were observed. None were noted on this 2000 survey. Pueo and the endemic and endangered Hawaiian Hawk or Io (*Buteo solitarius*) could forage in this area. They hunt over a wide variety of habitats from sea level to upland forest.

Migratory Indigenous (Native) Birds:

One Pacific Golden Plover (*Pluvialis fulva*) was heard flying over the coastal lava flows on 25 April. This species typically departs for its summer breeding grounds in western Alaska around the 25th of April. The lowland habitat could support a few plover. The forested areas do not contain appropriate habitat for this species. Plover are not threatened or endangered.

Seabirds:

On 25 April a pair of Red-tailed Tropicbirds (*Phaethon rubricauda*) were observed flying and occasionally landing in the lava along the coast. Whether or not they were prospecting for a suitable nest site was not determined. This species is not endangered or threatened.

Resident Introduced (Non-native) Birds:

A total of 16 introduced species were recorded on this survey (Table 1). This compares to 11 species found on the 1992 survey. None of these species are threatened or endangered. Table 1 shows the relative abundance of these species both in 1992 and 2000. These data were obtained on brief surveys and only reflect relative abundance. Those species not seen in 1992 may have been present but were not detected due to either their low numbers or the limitations of the survey protocol.

Feral Mammals:

A total of eight Small Indian Mongoose (*Herpestes auropunctatus*) were tallied on this 2000 survey. This species was also observed on the 1992 survey. Two pigs (*Sus scrofa*) were seen on the evening of 24 April in the upper (mauka) portion of the property. The endemic and endangered Hawaiian Hoary Bat was not observed. This species utilizes a variety of habitats at all elevations. They are frequently seen along the Kona coast. Four bats were recorded on the nearby Hokukano property on a 1991 survey (Bruner 1991). It is likely that this species also forages and roots on the Keopuka property.

SUMMARY/CONCLUSIONS/RECOMMENDATIONS

The purpose of this 2000 survey was to update data obtained in an earlier field survey (Bruner 1992). Little change in the habitats were noted. The native Amakihi and

Red-tailed Tropicbirds were new additions to the bird list from this site along with several new exotic species. The feral mammals found on the survey conformed to the 1992 observations.

In 1992 I mentioned the native Ohia forest should be retained. The presence of Hawaii Amakihi in this forest in 2000 would seem to justify the importance of this patch of native habitat. The understory around the Ohia is dominated by alien species and their removal would improve the habitat. Introduced vines were seen entangling several Ohia. Native plants should be used to replace alien understory vegetation.

TABLE 1

A list of exotic (introduced) birds recorded in 1992 and 2000 at Keopuka, South Kona, Hawaii. Relative abundance estimates are also noted.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE* 1992	2000
Gray Francolin	*Francolinus pondiceranus*	U=2	U=4
Kalij Pheasant	*Lophura leucomelana*	R=1	U=2
Red Junglefowl	*Gallus gallus*	not seen	R=3
Ring-necked Pheasant	*Phasianus colchicus*	R=1	not seen
Common Peafowl	*Pavo cristatus*	not seen	R=2
Spotted Dove	*Stretopelia chinensis*	U=4	C=6
Zebra Dove	*Geopelia striata*	A=12	C=6
Red-billed Leiothrix	*Leiothrix lutea*	not seen	U=4
Northern Mockingbird	*Mimus polyglottos*	not seen	R=6
Common Myna	*Acridotheres tristis*	C=6	C=5
Japanese White-eye	*Zosterops japonicus*	A=18	A=14
Northern Cardinal	*Cardinalis cardinalis*	A=10	C=9
Yellow-billed Cardinal	*Paroaria capitata*	R=6	C=7
Saffron Finch	*Sicalis flaveola*	not seen	A=11
House Finch	*Carpodacus mexicanus*	A=14	C=8
Lavender Waxbill	*Estrilda caerulescens*	not seen	C=9
Nutmeg Mannikin	*Lonchura punctulata*	R=12	U=3

*(see page 7 for key to symbols)

KEY TO TABLE 1

Relative (estimate) abundance = Number of times observed during survey or average number on eight minute counts in appropriate habitat.

A= abundant (ave. 10+) number which follows is average of data from all survey days

C= common (ave.5-10) number which follows is average of data from all survey days

U= uncommon (ave. less than 5) number which follows is average of data from all survey Days

R= recorded (seen or heard at times other than on 8 min. counts or on one count only) number which follows is the total number seen or heard over the duration of the survey

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APPENDIX G

Botanical Report

BOTANICAL RECONNAISSANCE
KEOPUKA LANDS
KEOPUKA/ONOULI, SOUTH KONA, HAWAII

by Ron Terry, Ph.D., and Patrick Hart, M.A.
May 2000

Introduction

This report describes the result of a botanical reconnaissance of a property of approximately 660 acres, identified as TMKs 8-1-07: 01, 54, & 55, located makai of the Mamalahoa Highway north of Kealakekua Bay. The property extends in elevation from sea level to about 1,390 feet above sea level. The botanical survey was undertaken at the request of Pacific Star L.L.C. to supply information for an Environmental Impact Statement and applications for various land use approvals.

Purpose and Methodology

The objectives of the survey were to 1) describe the vegetation; 2) list all species encountered; 3) confirm the accuracy of the 1991 survey conducted by Evangeline Funk for the former property owners; 4) identify and flag threatened or endangered species; 5) assess the value of the vegetation for native vertebrate habitat; and 6) list the presence or absence of and provide distributional information for important native and Polynesian plants. Consequently, the survey paid special attention to identifying any relict native forests or shrublands, areas containing Hawaiian ethnobotanical species, and areas within the 300 feet of the coast, which are contained in the Conservation District.

Fieldwork was conducted in March of 2000 by a two-person team. Transects were walked from the 4-wheel drive road which traverses the site from east to west, and also from a trail which runs from north to south. Transects were also walked along the sea cliffs. All parts of the site were visited, and 95 to 100 percent of the study area vegetation was examined. Species were identified in the field and, as necessary, collected and keyed out in the laboratory.

Geology, Climate, and Vegetational History

Most of the surface is a barely weathered 'a'a flow between 400 and 750 years in age. A 50-70 acre kipuka of lava about 5,000 years old is enclosed by this flow at elevations 320-500 feet above sea level. Annual rainfall at the coast is about 50 inches, increasing to about 75 inches at the mauka end. Evapotranspiration is high, especially in the lower elevations, where hot and sunny conditions prevail. The flow is only lightly vegetated between sea level and 900 feet in elevation, but mauka of this, it quickly becomes covered with a dense canopy.

Based on rainfall and geologic substrate, the mauka half of the area probably supported a Lowland Mesic Forest (Gagne and Cuddihy 1990) before human alteration, with 'ohi'a (*Metrosideros polymorpha*) and lama (*Diospyros sandwicensis*) as co-dominants. The lower half appears to have been vegetated very sparsely for at least the last 400-700 years, when the 'a'a lava flow occurred.

Humans have substantially altered the vegetation, either directly (e.g., clearing for ranching) or indirectly (alien plant introduction). The coastal area appears to have been the site of traditional Hawaiian settlement and possibly agriculture. Ranching and macadamia nut farming occurred in the past in the upper quarter of the property. Other than a few unpaved roads, little direct human alteration of the vegetation has taken place over most of the property, but alien plants have come to dominate the vegetation anyway.

Current Vegetation and Flora of the Area

A macadamia nut orchard occupies much of the land from the highway down to approximately 1,100 feet in elevation. This topmost quarter of the property is dominated by agriculture and a dense cover of introduced shrubs and trees, with few natives. All land from this orchard to approximately 900 feet in elevation is dominated by small trees and shrubs such as Christmas berry (*Schinus terebinthifolius*), 'opiuma (*Pithecellobium dulce*), and koa haole (*Leucaena leucocephala*), interspersed with large 'ohi'a trees. The understory is comprised largely of lantana, (*Lantana camara*), and grasses such as Natal red top (*Rhynchelytrum repens*), molasses grass (*Melinus minutiflora*), and Guinea grass (*Panicum maximum*). Also common are the introduced love-in-mist (*Passiflora foetida*) and huehue haole (*Passiflora suberosa*) vines. With the exception of large, emergent 'ohi'a trees, few native Hawaiian plant species are found in this area.

From approximately 900 feet in elevation to sea-level, Christmas berry, 'opiuma, koa haole, lantana, and the introduced grasses thin out significantly and become more patchy, and the abundance of many native plant species increases. Most of the coastal area is very sparsely vegetated. However, the southern end consists of a pahoehoe shelf averaging a hundred feet wide. Behind this is an area of 'a'a covered with a veneer of littoral deposits, including sand and coral chunks, which is densely vegetated, probably as a result of tapped groundwater.

A list of most species observed on the property is provided at the end of this report.

Comparison with Funk Report (1991)

With respect to perennial species, there has been little apparent change at this site since the early 1990's. Some change in composition of the annual herb and grass flora appears to have occurred. A small number of weeds detected by Funk were not observed in the current survey, and vice versa. Changes in weed composition would be expected in a nine-year interval in any disturbed lowland area in Hawaii. It is important to note, however, that the current survey was undertaken near the end of the Kona dry season (March 2000), whereas Funk's was done early in the dry season (November 1991). Consequently, seasonal variation may account for some of the differences between the present study and that of Funk. With respect to natives and ethnobotanically important plants, there does not appear to be any substantial difference.

Threatened and Endangered Species

As discussed above, the principal objective of the survey was to search for plants classified as listed, proposed or candidate threatened and endangered species by the U.S. Fish and Wildlife Service. No State of Hawaii or federally listed threatened or endangered plant species were found on the site (USFWS 2000).

Value of Area for Native Vertebrate Habitat

Native shorebirds, hawks and a native owl were observed on the site, and bats are probably present. Some native forest birds may also use the area. However, the area in general appears to have limited value as habitat for native vertebrate fauna. The alien-dominated vegetation at higher elevations does not offer high-value habitat and the lower elevations are sparsely vegetated and offer few resources for food or nesting.

Important Native and Polynesian Plants

The following is a summary of the important endemic, indigenous, and Polynesian introduced plants encountered during this survey. The traditional cultural uses follow Abbott (1992) and Neal (1965).

Capparis sandwichiana (Maiapilo). Endemic. Found from sea-level to approximately 250 m. The abundance of patches of Maiapilo is a notable aspect of the vegetation of this area. Maiapilo was used as a poultice applied to joints to cure broken bones.

Erythrina sandwicensis (Wiliwili). Endemic. The light-weight wood of this species was used for building canoes and surfboards. A single individual was located in a Kukui grove at approximately 200 m elevation. This tree is a last remnant of the dry forest that once dominated this area.

Metrosideros polymorpha ('Ohi'a). Endemic. Used primarily in house construction. Large trees up to 70 cm dbh (diameter at breast height) were common above approximately 175 m elevation.

Wikstroemia sandwicensis ('Akia). Endemic. Used for cordage and fish poison. Found from 175 to approximately 275 m elevation.

Cocculus trilobus (Huehue). Indigenous. Used for cordage in house construction. Found from 125 m to approximately 300 m.

Heteropogon contortus (Pili grass). Indigenous. Used to thatch the roof and sides of houses. Locally abundant from sea-level to approximately 100 m.

Osteomeles anthyllidifolia (Ulei). Indigenous. The long, slender branches of this shrub were bent into hoops for fish nets. Ulei was occasionally encountered between 200 and 275 m elevation.

Pandanus tectorius (Hala). Indigenous. This tree is of great cultural value and its leaves are still used for weaving mats and other items. A one-half acre Hala grove was found near a lava tube at approximately 275 m elevation north of the jeep road.

Peperomia leptostachya ('Ala 'ala wai nui). Indigenous. Certain species of this genus were used in traditional medicine. Found from approximately 50 – 275 m.

Plectranthus parviflorus ('Ala 'ala wai nui). Indigenous. Found in patches from 75 m to approximately 275 m, often in association with Peperomia.

Plumbago zeylanica (Ilie'e). Indigenous. Used as a traditional "baby medicine" and to blacken tattoos. Primarily found in the shade of Kukui groves, from 200 – 300 m elevation.

Sida fallax ('Ilima). Indigenous. The orange flowers of this species are important in lei-making. Like Noni, 'Ilima was scattered from sea-level to approximately 275 m.

Waltheria indica ('Uhaloa). Indigenous. This plant is used in traditional Hawaiian medicine. It was one of the most abundant native plants on this site, occurring from sea-level to approximately 300 m elevation.

Aleurites moluccana (Kukui). Polynesian introduction. This tree has a wide variety of traditional uses. It was important in canoe making, fire building, and is still used medicinally. Kukui was found in scattered groves from 200 – 300 m elevation.

Morinda citrifolia (Noni). Polynesian introduction. Used as a dye plant. Also, the fruit may be eaten or taken medicinally. Noni was scattered from sea-level to at least 300 m.

Tephrosia purpurea ('Auhuhu) – Polynesian introduction. Its leaves were ground up by Hawaiians to poison tide-pool fish. Locally abundant from sea-level to approximately 200 m.

Recommendations

The property in general is dominated by areas that have little value in terms of conservation of native plants or species with important traditional uses. However, patches of native plants are present in certain areas. Areas containing native plants should be considered during project planning. In order of importance, we recommend consideration of the following:

- Preserve as part of open-space planning several large patches in the middle elevations of the project that contain kukui, wiliwili, and 'ohi'a, along with various native shrubs and herbs;
- Preserve 'ohi'a trees to the maximum extent practicable in the context of the project's design;
- During any landscaping activities in the coastal Conservation District, identify and preserve native species to the maximum extent practicable;
- Preserve at least some areas of natural terrain in the sparsely vegetated 'a'a, especially those that contain native species;
- Select native species that occur naturally on the property as landscaping elements in areas that are disturbed.

In addition, standard Best Management Practices to control soil erosion or dust generation, which are usually implemented for other reasons, are merited in terms of the effect on vegetation as well.

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KEOPUKA LANDS SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	ABUNDANCE
	FERNS	
PSILOTACEAE	PSILOTUM FAMILY	
**Psilotum nudum*	Moa	Occasional
POLYPODIACEAE	COMMON FERN FAMILY	
Microsorium scolopendra	Laua'e	Common
**Nephrolepis exaltata*	Sword fern	Abundant
Phlebodium aureum	Hare's foot fern	Common
	MONOCOTYLEDONS	
AGAVACEAE	AGAVE FAMILY	
Agave sisalana	Sisal	Rare
Cordyline fruticosa	Ti	Occasional
ARECACEAE	PALM FAMILY	
Cocos nucifera	Coconut	Uncommon
Phoenix sp.	Phoenix palm	Rare
COMMELINACEAE	SPIDERWORT FAMILY	
Commelina benghalensis	Hairy honohono	Uncommon
Commelina diffusa	Honohono	Uncommon
CYPERACEAE	SEDGE FAMILY	
**Fimbristylis cymosa*	Mau'u 'aki 'aki	Locally abundant
PANDANACEAE	SCREW PINE FAMILY	
**Pandanus tectorius*	Hala	Uncommon
POACEAE	GRASS FAMILY	
Botriochloa pertusa	Pitted beardgrass	Occasional
Cenchrus ciliaris	Buffelgrass	Occasional
Cynodon dactylon	Bermuda grass	Locally abundant
Eleusine indica	Wiregrass	Locally abundant
Eragrostis pectinacea	Carolina lovegrass	Locally abundant
**Heteropogon contortus*	Pili grass	Locally abundant
Melinus minutiflora	Molasses grass	Abundant
Oplismenus hirtellus	Basketgrass	Locally abundant
Panicum maximum	Guinea grass	Abundant
Pennisetum setaceum	Fountain grass	Locally abundant
Rhynchelytrum repens	Natal redtop	Abundant
Sporobolus indicus	West Indian dropseed	Locally abundant

ZINGIBERACEAE	GINGER FAMILY	
Hedychium flavescens	Yellow ginger	Uncommon
	DICOTYLEDONS	
ACANTHACEAE	ACANTHUS FAMILY	
Thunbergia fragrans	White thunbergia	Uncommon
AMARANTHACEAE	AMARANTH FAMILY	
Amaranthus spinosus	Spiny amaranth	Uncommon
ANACARDIACEAE	MANGO FAMILY	
Mangifera indica	Mango	Uncommon
Schinus terebinthifolius	Christmasberry	Abundant
APOCYNACEAE	DOGBANE FAMILY	
Catharanthus roseus	Madagascar periwinkle	Occasional
Plumeria sp.	Plumeria	Occasional
ASTERACEAE	SUNFLOWER FAMILY	
Emilia fosbergii	Pualele	Uncommon
Pluchea symphytifolia	Sourbush	Uncommon
Sonchus oleraceus	Pualele	Uncommon
Tithonia diversifolia	Tree marigold	Occasional
BIGNONIACEAE	BIGNONIA FAMILY	
Jacaranda mimosifolia	Jacaranda	Rare
BORAGINACEAE	BORAGE FAMILY	
Cordia subcordata	Kou	Rare
Tournefortia argentea	Tree heliotrope	Rare
CACTACEAE	CACTUS FAMILY	
Opuntia ficus-indica	Panini	Occasional
CAPPARACEAE	CAPER FAMILY	
**Capparis sandwichiana*	Maiapilo	Abundant
CARICACEAE	PAPAYA FAMILY	
Carica papaya	Papaya	Occasional
CARYOPHYLLACEAE	PINK FAMILY	
Drymaria cordata	Pipili	Locally abundant

CHENOPODIACEAE	GOOSEFOOT FAMILY	
Chenopodium murale	'Aheahea	Uncommon
CLUSIACEAE	MANGOSTEEN FAMILY	
Clusia rosea	Autograph tree	Rare
CONVOLVULACEAE	MORNING GLORY FAM.	
Ipomoea alba	Moon flower	Uncommon
Ipomoea indica	Koali 'awa	Common
Ipomoea obscura	(none)	Uncommon
CRASSULACEAE	ORPINE FAMILY	
Kalanchoe pinnata	Air plant	Locally abundant
CUCURBITACEAE	GOURD FAMILY	
Momordica charantia	Balsam pear	Uncommon
EUPHORBIACEAE	SPURGE FAMILY	
Aleurites moluccana	Kukui	Locally abundant
Chamaesyce hirta	Garden spurge	Locally abundant
Chamaesyce hypericifolia	Graceful spurge	Uncommon
Euphorbia heterophylla	Kaliko	Uncommon
Ricinus communis	Castor bean	Occasional
FABACEAE	PEA FAMILY	
Acacia farnesiana	Klu	Locally abundant
**Caesalpinia bonduc*	Kakalaioa	Occasional
Chamaecrista nictitans	Partridge pea	Abundant
Crotalaria incana	Fuzzy rattlepod	Locally abundant
Crotalaria pallida	Smooth rattlepod	Locally abundant
Delonix regia	Royal poinciana	Rare
Desmodium tortuosum	Florida beggarweed	Locally abundant
**Erythrina sandwicensis*	Wiliwili	Rare
Indigofera suffruticosa	Indigo	Abundant
Leucaena leucocephala	Koa haole	Abundant
Mimosa pudica	Sensitive plant	Occasional
Pithecellobium dulce	'Opiuma	Abundant
Prosopis pallida	Keawe	Locally abundant
Samanea saman	Monkeypod	Occasional
Senna septemtrionalis	Kolomona	Common

Tephrosia purpurea	'Auhuhu	Locally abundant
LAMIACEAE	MINT FAMILY	
Hyptis pectinata	Comb hyptis	Occasional
**Plectranthus parviflorus*	'Ala 'ala wai nui	Locally abundant
Salvia coccinea	Scarlet sage	Uncommon
Salvia occidentalis	West Indian sage	Uncommon
LAURACEAE	LAUREL FAMILY	
Persea americana	Avocado	Uncommon
MALVACEAE	MALLOW FAMILY	
Abutilon grandifolium	Hairy abutilon	Locally abundant
**Sida fallax*	'Ilima	Locally abundant
MENISPERMACEAE	MOONSEED FAMILY	
Cocculus trilobus	Huehue	Abundant
MORACEAE	MULBERRY FAMILY	
Ficus microcarpa	Chinese banyan	Occasional
Morus alba	White mulberry	Occasional
MYRTACEAE	MYRTLE FAMILY	
**Metrosideros polymorpha*	'Ohi'a	Common
Psidium cattleianum	Strawberry guava	Uncommon
Psidium guajava	Common guava	Occasional
NYCTAGINACEAE	FOUR-O'CLOCK FAMILY	
Boerhavia coccinea	(none)	Occasional
Bouganvillea sp.	Bougainvillea	Occasional
PASSIFLORACEAE	PASSION FLOWER FAMILY	
Passiflora edulis	Liliko'i	Rare
Passiflora foetida	Love-in-a-mist	Abundant
Passiflora suberosa	Huehue haole	Abundant
PHYTOLACCACEAE	POKEWEED FAMILY	
Rivina humilis	Coral berry	Locally abundant
PIPERACEAE	PEPPER FAMILY	
**Peperomia leptostachya*	Peperomia	Common
PLUMBAGINACEAE	PLUMBAGO FAMILY	

**Plumbago zeylanica*	Ilie'e	Locally abundant
PORTULACACEAE	PURSLANE FAMILY	
Portulaca oleracea	Pigweed	Common
ROSACEAE	ROSE FAMILY	
**Osteomeles anthyllidifolia*	'Ulei	Uncommon
RUBIACEAE	COFFEE FAMILY	
Coffea arabica	Arabian coffee	Uncommon
Morinda citrifolia	Noni	Common
SOLANACEAE	NIGHTSHADE FAMILY	
Lycopersicon pimpinellifolium	Currant tomato	Uncommon
Solanum americanum	Popolo	Uncommon
STERCULIACEAE	CACAO FAMILY	
**Waltheria indica*	'Uhaloa	Abundant
THYMELAEACEAE	'AKIA FAMILY	
**Wikstroemia sandwicensis*	'Akia	Common
VERBENACEAE	VERBENA FAMILY	
Lantana camara	Lantana	Abundant
Stachytarpheta dichotoma	Owi	Occasional

Notes: In the species list, the plant families have been arranged alphabetically within three groups: Ferns, Monocotyledons, and Dicotyledons. The genera and species have been arranged alphabetically within the families. The taxonomy and nomenclature follow that of Wagner et al. 1990. For each taxon the following information is provided:

- The distributional status. An asterisk before the plant name indicates it is either a Hawai'i endemic or indigenous species. No asterisk indicates it was a human introduction to Hawai'i.
- The scientific name.
- The Hawaiian name or the most widely used common name.
- Species abundance. Abundance ratings are for this site only and have the following eanings.
  - Rare – Three or fewer individuals were encountered during the course of the survey.
  - Uncommon – Fewer than five individuals encountered per survey day.
  - Occasional – Approximately 1 – 4 individuals encountered per survey hour.
  - Common – Frequently encountered over large areas but never abundant (5-15 encounters per survey hour).
  - Locally abundant – Found in large numbers within limited areas.
  - Abundant – Found in large numbers throughout the survey site (> 15 encounters per hour).

APPENDIX H

Lava Tube Arthropod Resources Report

REPORT:

Survey of Lava Tube Arthropod Resources Keopuka, South Kona, Island of Hawai'i

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March 2000

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Tables

Introduction:

This report summarizes the findings of a two day and one night reconnaissance survey of arthropod species conducted on the proposed Keopuka Lands Project Site (THK 3-8-1:01, 54 and 55), located in the district of South Kona, Island of Hawai'i. Fieldwork was conducted on March 2nd and 3rd 2000.

The primary purpose of this effort was to survey a number of lava tubes identified during the course of previously completed surveys of the site for subterranean cave arthropod species (Walker and Rosendahl 1990, Hammatt *et al.* 1995). A secondary focus was to identify any arthropod species currently listed as endangered, threatened, proposed, or candidate which may be utilizing either surface or sub-surface resources within the proposed development site. Special attention was given to searching for the endangered Blackburn's hawk moth (*Manduca blackburni*) and it's requisite host plants.

General Site Description:

The study site encompasses approximately 267 hectares, located in portions of three ahupua'a, Keopuka 1st and 2nd and a small portion of Onouli 2nd. The eastern boundary of the site abuts the Mamalahoa Highway at an elevation of approximately 424 meters above mean sea level, and extends west to the shore line just north of Kealakekua Bay.

The terrain slopes steeply from east to west and is composed of a mix of pahoehoe and a'a lava flows dating from the Holocene age (200-750 years ago). There is a small outcrop of a much older flow close to the eastern boundary of the site dating from between 5,000 to 10,000 years ago (Holocene and Pleistocene ages) (Wolfe and Morris 1996).

The vegetation on the site is composed of a mix of alien (introduced to Hawai'i by man) and native species. Vegetation is thickest and most diverse on the eastern or upper reaches of the property, with plant density and diversity decreasing in the lower elevations. In the upper areas 'ohi'a lehua (*Metrosideros* sp.), Christmas berry (*Schinus terebinthifolius*) and 'uhaloa (*Waltheria indica*) predominate, with small amounts of scattered 'ilima (*Sida fallax*), and numerous alien grasses, including Natal redtop (*Agrostis stolonifera*) and molasses grass (*Melinis minutiflora*). About 50 clumps of fountain grass (*Pennisetum setaceum*), a noxious alien species, were seen in two road sites. In the lower sections off the property there are sparsely scattered Indian mulberry (*Morinda citrifolia*), Maiapilo (*Capparis sandwichiana*) and huehue (*Cocculus trilobus*).

Methods:

Steven Lee Montgomery, Ph.D., conducted the field surveys with field assistance from Reginald E. David. A reconnaissance level survey was made of the surface habitat, using

both ambulatory searches and vehicular travel over existing 4 wheel drive roads and trails. Given the time available, emphasis was placed on lava tube searches..

S. Montgomery entered 5 lava tubes which he considered representative and searched for arthropod fauna by inspection of decaying roots, walls and floors of each of these lava tubes. Baits based on putrefied shrimp were left in likely locations in 2 lava tubes. One deep lava tube identified by the archeologists as site # 50-10-47-17235 B (Hammatt *et al* 1995) will require ropes to safely enter and properly explore. This lava tube was not surveyed during the course of this survey due to the difficulty of entering the tube.

Surface searches were conducted during two days by visual inspection, sweep net and during one night by light trapping. Sweeping was concentrated on areas supporting native vegetation such as 'ilima. An MV light was run for 8 hours adjacent to the 'ohi'a trees up-slope from site # 50-10-47-17235 B. Weather was clear and dry during a moonless night, presenting reasonable collecting opportunities. Incidental and casual observations were also made of non-lava tube arthropod fauna in the area

Results:

Few native arthropods were observed during the course of this survey effort. Animals did not come to our bait stations, and none of their telltale feeding damage was detected. All the native arthropods taken or observed during this survey came from the lava tube identified as # 50-10-47-17229 by Hammatt *et al* (1995), The most abundant introduced arthropod present in the higher elevations was the big-headed ant (*Pheidole megacephala*) which tends sap-sucking insects, and predates most other insects that they encounter. At lower elevations longlegged ants (*Anoplolepis longipes*) were the dominant alien species recorded. Lava tube baits and rotten roots attracted mostly cockroaches (large *Periplaneta* sp.) and sowbugs (isopods) which were clustered near decaying roots, very likely of Christmas berry. In site # 50-10-47-17213 a lone springtail (*Collembola*) was seen resting on a Christmas berry rootlet, but managed to elude capture.

During the course of surface sweeps Blackburn's hawk moths were not recorded, nor were either of it's host plants, tree tobacco (*Nicotiana glauca*) or 'aiea (*Nothocestrum* sp.) encountered. The most common native plant encountered on the site huehue, is not known to be a host for native arthropods. Maiapilo which is scattered throughout the lower half of the site showed clear evidence of having had their leaves lightly chewed by caterpillars of a micro-moth in the *Plutella capparidis* complex. In areas in North Kona this native plant is known to have roots reaching into cave systems, no such incursions were seen in the lava tubes investigated on this site.

Table 1 lists arthropods encountered, including the most prominent alien species, and the few native or endemic invertebrates that were collected or observed.

Incidental observations included a Hawaiinn hoary bat (*Lasiurus cinereus semotus*) flying at twilight, and old exoskeletons of land crabs within several lava tube passages.

Discussion:

The lava tubes visited are in relatively young pahoehoe lava flows, situated in an extremely dry environment which has been extensively impacted by man and feral ungulates. There has not been sufficient time or the moisture required, for a lava tube ecosystem sufficient to support native arthropod species to develop on the subject property. Such a subterranean ecosystem requires as it's foundation, the nutrients contained in plant roots, and attendant moisture that enter the tube from vegetation growing above them. The lava tubes inspected contained very few roots; consequently the low numbers of arthropods recorded is not surprising. Additionally, the presence of predatory ant species which prey on other arthropod species, contributed to the low number and densities of native arthropod species detected. The interior of the lava tubes were dry, with very little evidence of water run-off or collection.

The subterranean habitat inspected, with it's minimal root growth supports a few common scavenging sow bugs. The habitat currently present above ground also supports a few native arthropods. Areas in North Kona and Kohala have historically supported Blackburn's hawk moth larvae on solonaceous host plants *Nicotiana glauca* and *Nothocestrum* sp. both plants are absent on the subject property.

No arthropod species protected under either State of Hawaii or federal statutes were detected on the property (Federal Register 1998, DLNR 1986). The relatively dry conditions found within the lava tube complexes, coupled with the young age of the flow and the paucity of native vegetation root systems within the lava tubes makes it unlikely that the subterranean habitat present on site supports any endangered or rare native arthropod species.

Recomendations:

The lava tube identified as site # 50-10-47-17235 B by Hammett *et al.* (1995) may contain an undisturbed and dark environment, it is possible that a different ecosystem may be found there. Baiting should be conducted in the unexplored lava tube, if the surface area above it will be impacted by development. Baits checked after 1 week or in the wet season might produce additional species undetected during the course of this survey.

The incipient fountain grass invasion is still controllable. This African alien pyrophitic grass represents a severe fire hazard to natural habitats, and following development to physical property constructed. The small number of plants currently established on the

site could easily be removed now, before they spread beyond control and present a threat to natural and developed assets.

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Table 1: List of Invertebrates for the Keopuka lava tube area South Kona, Hawai'i

			Tube or Surface
	INSECTA (INSECTS)		
Pheidole megacephala	Big headed ant		S
Anoplolepis longipes	Longlegged ant		S
Periplaneta large sp.	Cockroach	not collected	T
Collembola sp.	Springtail	not collected	T
Oliarus sp.	Cixiid planthopper	under 'Ohi'a	S
Agrotis sp. near *microreas*	Cutworm moth	2 males at light	S
	ARACHNIDA (SPIDERS)		
Araneae *Pholcus phalangiodes*	Long legged spider		T
	CRUSTECEA		
Decapoda	Land crab exoskeleton		T
Isopoda	sowbugs	4 specmns on dead roots	T

APPENDIX I-1

Mauka Area Archaeological Survey

Archaeological Field Inspection Survey
Keopuka Lands Parcel

Lands of Onouli 2nd and Keopuka 1st & 2nd
South Kona District, Island of Hawaii

PHRI
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INTRODUCTION

BACKGROUND

At the request of Ms. Libbie Kamisugi of Libbie & Company, Paul H. Rosendahl, Ph.D., Inc. (PHRI) recently conducted an archaeological field inspection survey of the Keopuka Lands Parcel, situated within the Lands of Onouli 2nd and Keopuka 1st and 2nd, South Kona District, Island of Hawaii (TMK:3-8-1-07:1,54,55). The survey field work was conducted on February 27, 1990 by Supervisory Archaeologist Alan T. Walker and Field Archaeologist Ranae Ganske. Approximately 16 man-hours of labor were expended in carrying out the field work.

The primary objectives of the survey were (a) to determine the general nature and extent of archaeological remains in the project area, and to determine the implications of any such remains with regard to the feasibility of development, and (b) to estimate the general scope and cost of any subsequent archaeological work that might be appropriate and/or required in the course of future development. Such further work could include an inventory-level survey, and if required, further data collection involving detailed recording of sites and features and selected test excavations; and possibly subsequent mitigation—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.

PROJECT AREA DESCRIPTION

The Keopuka Lands Parcel project area consists of c. 660 acres and extends from Hawaii Belt Road (Mamalahoa Highway) to the coast (Figures 1-3). It is bounded on the west by the Pacific Ocean, on the east by Hawaii Belt Road and additional land within Keopuka 1st and 2nd, on the north by the Land of Onouli 1st and additional land in Onouli 2nd, and on the south by the Land of Kaawalea. Vegetation within the project area is dense above c. 650 ft AMSL (above mean sea level) and consists primarily of Christmas-berry (*Schinus terebinthifolius* Raddi), koa-haole (*Leucaena glauca* [L.] Benth.), lantana (*Lantana camara* L.), guava (*Psidium guajava* L.), various vines, and the native 'ohi'a-lehua (*Metrosideros collina* [Forst.] Gray subsp. *polymorpha* [Gaud.] Rock) and kukui (*Aleurites moluccana* [L.] Willd). Inland areas have been mechanically modified and consist of macadamia nut orchards or pastureland. With the exception of several kiawe (*Prosopis pallida* [Humb. & Bonpl. ex Willd.] HBK) and koa-haole thickets along the coast, vegetation in the seaward portion of the project area, below c. 650 ft AMSL, is sparse and consists predominately of 'uhaloa (*Waltheria americana* L.), noni (*Morinda citrifolia* L.), and various grasses.

The project area rises in elevation from sea level to c. 1,350 ft AMSL. The terrain is undulating and consists of two classifications of soil—Kaimu extremely stony peat (6-20% slopes), representing the Kaimu series of well-drained, thin organic soils over aa lava, and lava flows, both aa and pahoehoe varieties (Sato et al. 1973). Rainfall in the seaward portion of the project area is c. 50-65 inches per year and c. 65-85 inches per year in the inland portion. The mean annual temperature is approximately 75 degrees F. (Armstrong 1983:63,64).

The entire project area is within the boundary of the Kona Field System and partly within the boundary of the Kealakekua Bay Historic District. Previously declared eligible for inclusion on the NRHP (National Register of Historic Places), the Kona Field System (Site 6601*) is a complex of aboriginal Hawaiian dryland cultivation and habitation remains which covers and area approximately 3 by 18 miles, extending from the Kailua area south to Hookena. The Kealakekua Bay Historic District (Site 7000) is an extremely important historical district that was placed on the NRHP in December of 1974.

PREVIOUS ARCHAEOLOGICAL WORK

Previous archaeological work in the project area includes surface surveys by Reinecke (n.d.), Hawaii Register of Historic Places (HRHP 1971), Soehren (1980 and 1981), and Rosendahl and Jensen (1989). In 1929-30, J.E. Reinecke, while carrying out a survey of sites along the western coast of Hawaii Island for B.P. Bishop Museum, recorded about 30+ sites (Sites 132-161) along the shoreline of the present project area (Reinecke n.d.). Reinecke inspected only the immediate shoreline, no more than a few hundred feet inland, and his recording of sites was sketchy, making definite correlation of his features with features subsequently recorded in the area difficult.

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*State Inventory of Historic Places (SIHP) site designation system: four- and five-digit site numbers prefixed by 50-10-37- (50=State of Hawaii, 10=Island of Hawaii, 37=USGS 7.5' series quad map ["Kealakekua, Hawaii"]).

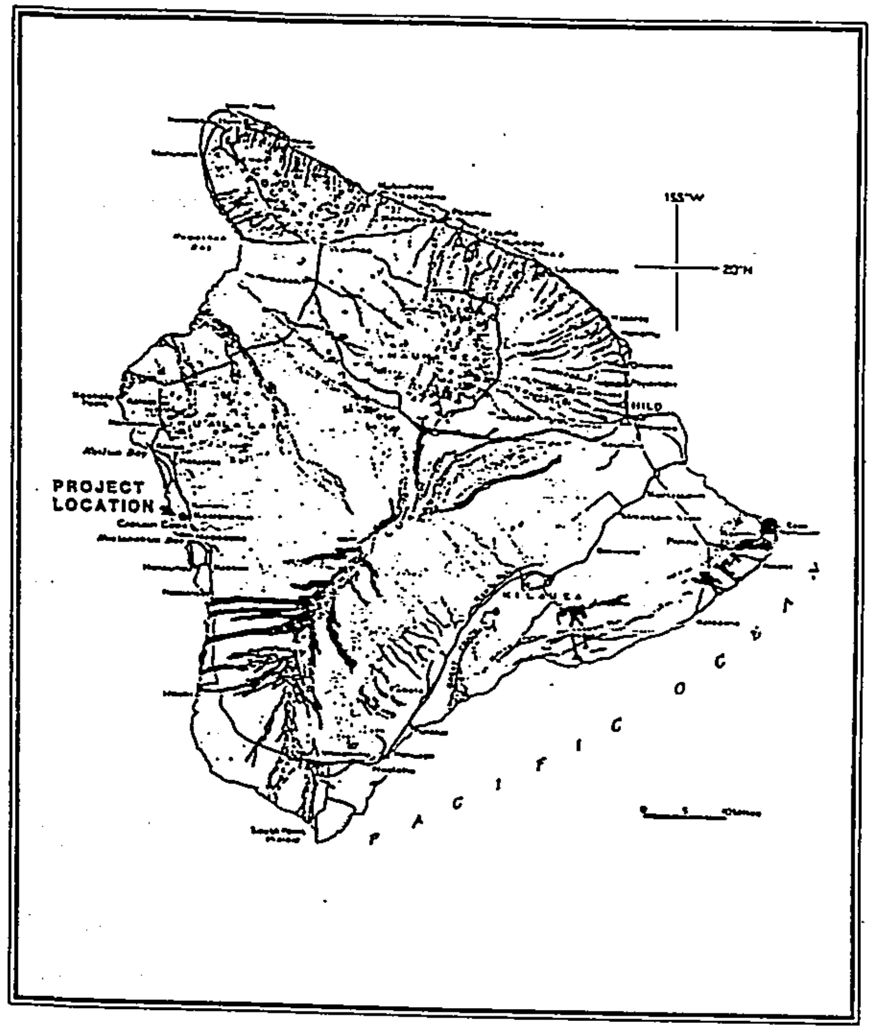

Figure 1. PROJECT LOCATION MAP

ARCHAEOLOGICAL FIELD INSPECTION SURVEY
KEOPUKA LANDS PARCEL
Lands of Onouli 2nd and Keopuka 1st & 2nd
South Kona District, Island of Hawaii (TMK:3-8-1-07:1,54,55)
PHRI Report 89-769 March 1990

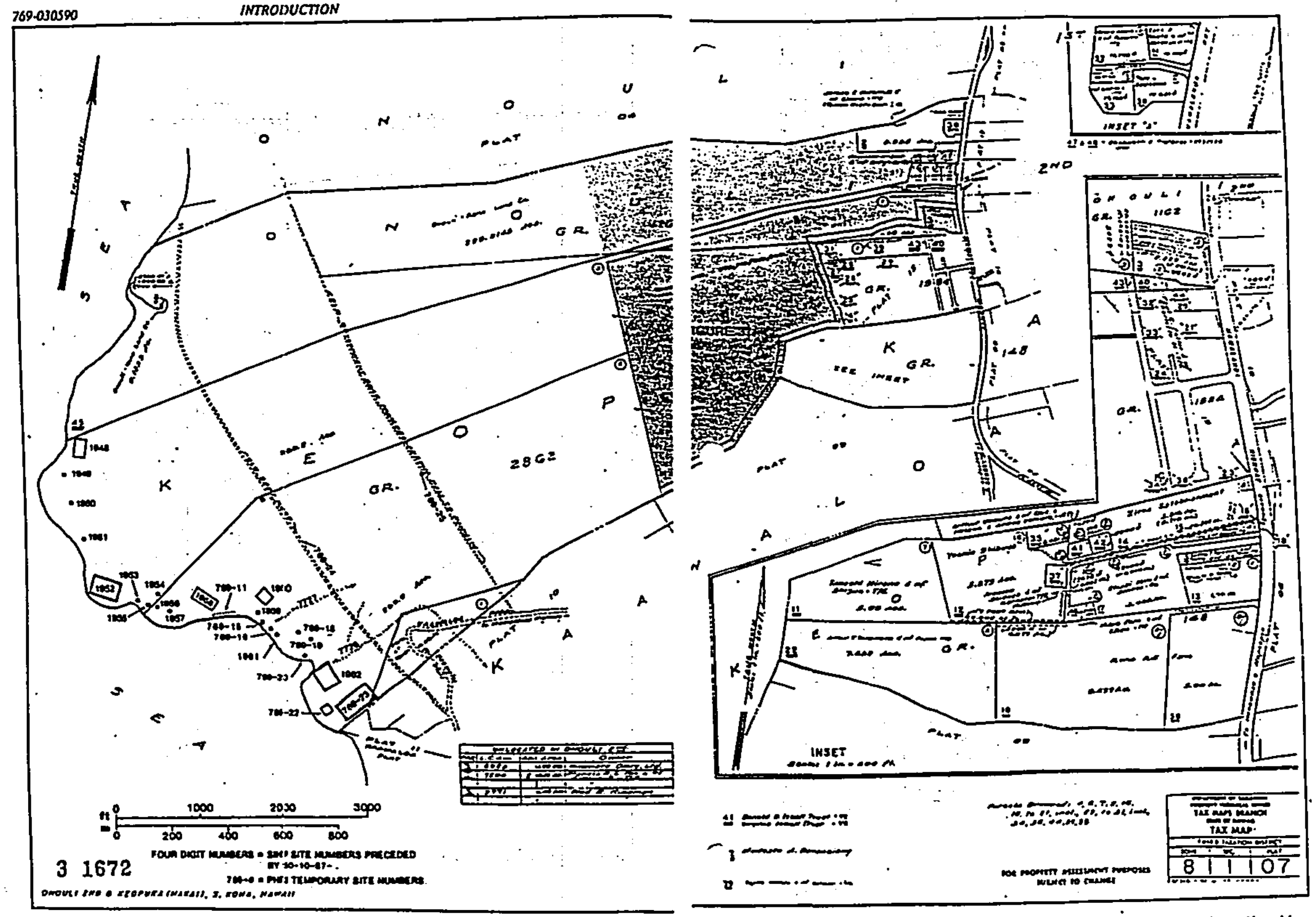

FIGURE 2. Project Area and Site Location Map

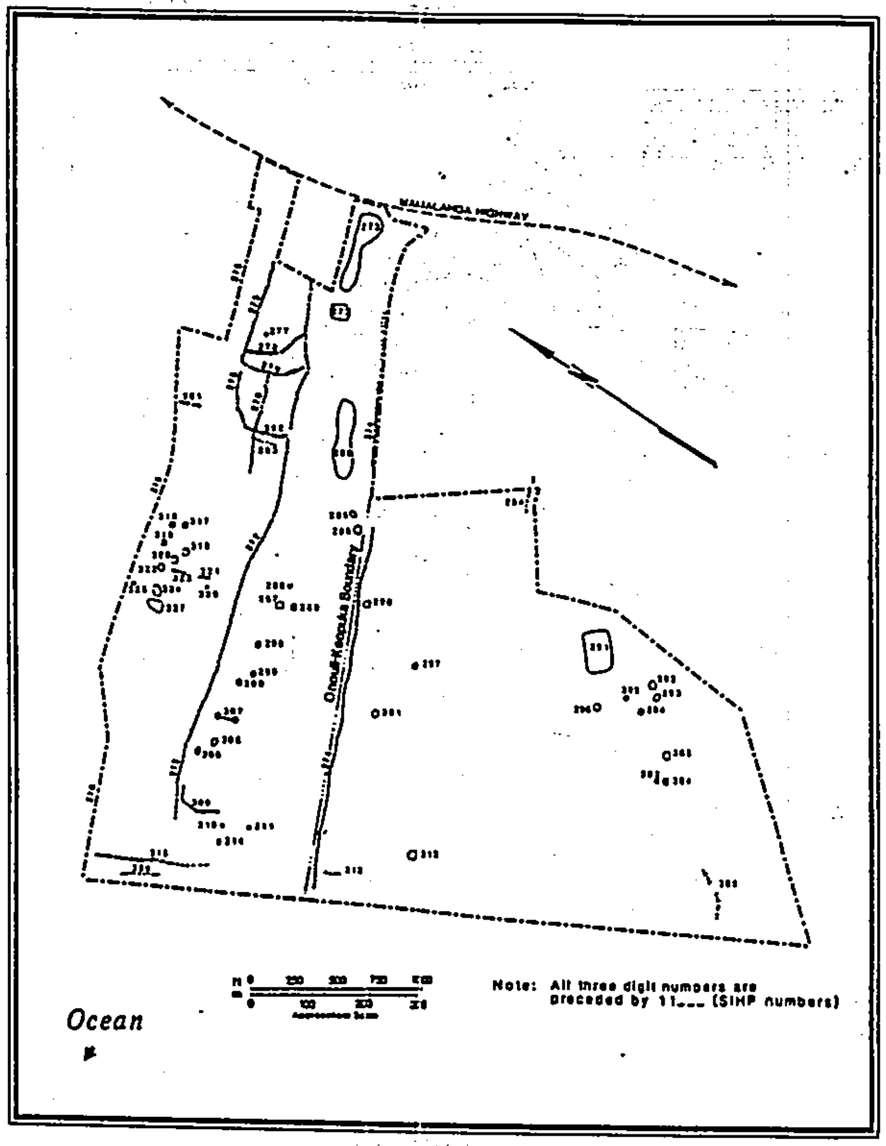

Figure 3. MAP TAKEN FROM ROSENDAHL AND JENSEN (1989)

The work by HRHP was conducted by State Historic Preservation Office (SHPO) staff archaeologists, who recorded about 15 site complexes (Sites 1948-1962) and the Kealakekua Bay Historic District (Site 7000) within the present project area (HRHP 1971). The records for these sites are available for inspection at the Department of Land and Natural Resources-Historic Sites Section/SHPO (DLNR-HSS/SHPO).

In mid-1980, L.J. Soehren conducted a surface survey of inland portions (above 850 ft AMSL) of the present project area. However, Soehren did not identify any archaeological remains and recommended no further work (1980:2). Subsequently, Soehren conducted a surface survey of seaward portions (below 850 ft AMSL) of the present project area.

Soehren (1981) identified two foot trails (Sites 7727 and 7728), three historic period roads or cart paths (no site designation), and relocated 15 sites identified by HRHP (1971). Soehren stated all previously identified HRHP sites "were classified 'reserve' or 'marginal' by the State, indicating they have little significance" (Soehren 1981:3), but he offered no other evaluations or recommendations.

Between December 1987-January 1988, PHRI conducted an inventory survey of the 248-acre proposed Onouli Subdivision project area, located in the Lands of Onouli and Keopuka, South Kona District, Island of Hawaii (TMK:3-8-1-07:Por.1,45)(Rosendahl and Jensen 1989). During the survey 57 sites were newly identified. The sites included both historic and prehistoric remains. Functional types present included boundary and/or ranching walls; agricultural complexes; agricultural enclosures, terraces, and an agricultural leveled area; habitation complexes, terraces, and enclosures; a modified sink and a walled depression used for habitation; a habitation cave, a refuge cave, and a burial cave; ranch clearing features; and transportation features (trails and a railroad bed). Fifty-one of the 57 sites identified were assessed as solely significant for information content. Further data collection was recommended for 51 of the 57 sites; no further work was recommended for one of the 51 sites (Site 11303, a wall). Of the six remaining sites, five sites (Sites 11291, 11302, 11305, 11312, and 11313) were assessed as (a) important for information content, (b) excellent examples of a site type, and (c) culturally significant (provisional assessment for Site 11291 because the site may contain burials). Further data collection and preservation with some level of interpretive development were recommended for these five sites. The final site (Site 11328), a historic railroad bed, was assessed as an excellent example of a site type; further data collection and preservation with some level of interpretive development was recommended for this site. (It should be noted that the evaluations and recommendations contained within Rosendahl and Jensen [1989] are tentative, as only a draft report on the survey was completed and it was never submitted by the client to DLNR-HSS/SHPO for review.)

Previous archaeological and historical documentary work conducted in the general vicinity of the present project area includes, but is not limited to, Hommon (1969), Hommon and Crozier (1970), Kaschko and Rosendahl (1987), Silverman (1968), Soehren and Newman (1968), and Yent and Ota (1981).

LIMITED HISTORICAL DOCUMENTARY RESEARCH

by Helen Wong Smith, B.A.

The ahupua'a of Keopuka in the South Kona District is bordered on the south by Kaawaloa and by Kealakekua, the site of Cook's infamous death in 1779 and one of the areas most frequently visited by foreign ships in the days of sailing. Historical documents relating specifically to Keopuka are rare indeed, but frequent reference is made to Kealakekua and its northern neighbor, Kaawaloa. For purposes of presenting a fuller account of the area's background, this report relies on the well-documented area of Kealakekua Bay in general.

Pukui, Elbert and Mookini (1974:109) interpret Keopuka as meaning "the perforated sand," explaining that the "o" has been shortened from "one," the Hawaiian word for sand. How this name originated is not known. Sometimes a proverb or saying associated with a place will provide an explanation, but Pukui's 'Olelo No'eau is silent in this instance.

Mythology

Handy relates the importance of Lono in Kona mythology:

> The most interesting mythological and legendary materials relating to Kona have to do directly or indirectly with Lono....The story of the origin of the Makahiki rain and harvest festival, bring Lono from Kahiki, whither he returns. From Kona we have the written record of a myth of Kumuhonua, [Earth Foundation, 36 generations before Wakea and Papa, who was the first man fashioned by the gods] whose writer says that Lono was a fisherman and yet ends his story by stating that the events related occurred before men peopled the earth.

> Lono is credited with introducing the main food plants, taro, breadfruit, yams, sugar cane and bananas to Hawaii and also 'awa. Hogs were likewise identified with Lono, but there is no mention of his having brought them to Hawaii (Handy and Handy, 1972:522).

John Papa Ii, historian and a member of Kamehameha II's court, gives the following tale of a canoe paddler with super-human strength who lived during the reign of Kamehameha I. It is the only historical documentary reference that mentions Keopuka specifically:

> Akalele, a man famous for his paddling strength, is said to have come from Kauai and to have lived with our first king. One night the king left Kawaihae and set forth with his double canoes. Daylight found his company outside of Kekaha, and they rested a little while at Kailua. Akalele was alone on a single canoe about 6 fathoms long and filled with baskets of sweet potatoes, fowls, dogs, and such gifts as people brought who came to see the king on the beach in Kona. When they arrived at Kahaluu, or Keauhou perhaps, the single canoe began to race with the double ones, to see which could first reach their goal, Awili in Kaawaloa. So they raced, the king with his canoe paddlers, Akalele alone. Although the single canoe was loaded with goods, the king desired this race....After they passed Keopuka and reached Kalaemano at Kaawaloa, they again turned shoreward. Near the harbor of Awili, where there is a narrow channel only large enough for a single canoe, the king called out, "O Akalele, turn your canoe into the narrow entrance! Glide in on a wave!" Akalele did as he was told and was first to arrive at Awili. The others took the longer way around and found him there carrying the things ashore. The king helped Akalele because he was a stranger (Ii 1959:131-2).

Early Historic Accounts

In the following excerpt, Handy and Handy (1972) describe native Hawaiian agriculture in the South Kona District, with liberal use of citations from early European visitors. Included are elevations of the various cultivated zones:

> In time of intensive native cultivation, South Kona was planted in zones determined by rainfall and moisture. Near the dry seacoast potatoes were grown in quantity, and coconuts where sand or soil among the lava near the shore favored their growth. Up to 1,000 feet grew small bananas which rarely fruited, and poor cane; from 1,000 to 3,000 feet, they prospered increasingly. From approximately 1,000 to 2,000 feet, breadfruit flourished.
>
> Taro was planted dry from an altitude of 1,000 to approximately 3,000 feet. An old method of planting taro in Kona, described to us by Lakalo at Ho'okena, was to plant the cuttings in the lower, warmer zone where they would start to grow quickly and then to transplant them to the higher forest zone where the soil was rich and deep and where moisture was ample for their second period of growth, in which their corms are said to have developed to an average of 25 pounds each.
>
> Above Ka'awaloa [ahupua'a abutting Keopuka to the south] some of Cook's officers saw the plantations in the intermediate zone. Cook (1784, Vol. 3 pp. 106-107) says that their plantations were divided from each other by thick, low walls of lava and that there they found the breadfruit trees, plantains, taro root, sweet potatoes, ginger root, and sugar cane.... Ellis, surgeon with Captain Cook in 1778, writes of the country above Kealakekua (Ellis, 1783, Vol. 2 pp. 91-96):
>
> After ascending part of the hill, which was covered in every direction with plantations of sugar-cane, sweet-potatoes, plantains, and breadfruit trees (which were by far the largest they had seen) they arrived at a spot of land entirely uncultivated, and overrun with long grass and ferns....They arrived at a long tract of plantain-trees, which far exceed the cultivated ones in size; they produce fruit like them, but it never arrives at perfection...but they took a different route to their former one, proceeding nearly in a W.N.W. direction, through innumerable plantations of the paper mulberry-tree, breadfruit, and plantain trees, which formed an extensive garden.
>
> The same region is described in detail by Menzies (1920:74-74) who accompanied Vancouver in 1793:
>
> The tract which extended along shore, if we might judge from its appearance and our knowledge of that which we had already traveled over, we were ready to pronounce a dreary naked barren waste, if we except a few groves of cocoa palms here and there near the villages. But that which stretched higher up along the verge of the woods from the

> manner it was industriously laid out in little fields, exhibited a more pleasing and fertile appearance ....On leaving this station, we soon lost sight of the vessels, and entered their breadfruit plantations, the trees of which were a good distance apart, so as to give room to their boughs to spread out vigorously on all sides, which was not the case in the crowded groves of Tahiti, where we found them always planted on the plains along the sea side. But here the size of the trees, the luxuriancy of their crop and foliage, sufficiently show that they thrive equally well on an elevated situation. The space between these trees did not lay idle. It was chiefly planted with sweet potatoes and rows of cloth plant. As we advanced beyond the bread-fruit plantation, the country became more and more fertile, being in a high state of cultivation. For several miles round us there was not a spot that would admit of it but what was with great labor and industry cleared of the loose stones and planted with esculent roots or some useful vegetable or other. In clearing the ground, the stones are heaped up in ridges between the little fields and planted on each side, either with a row of sugar cane or the sweet [ti] root of these islands where they afterwards continue to grow in a wild state, so that even these stony, uncultivated banks are by this means made useful to the proprietors, as well as ornamental to the fields they intersect.
>
> The walls (pa aina), seen today in Kona lowlands running across old boundary lines, were built to keep cattle out of the planting areas after they became a pest in the 19th century (Handy and Handy 1972:524-526).

In 1823, the Rev. William Ellis toured the island of Hawaii and kept a journal that is a valuable guide to Hawaiian culture and geographical features. In his comparison of the north and south portions of Kona, then a single large district, he writes:

> Kona is the most populous of the six great divisions of Hawaii, and being situated on the leeward side, would probably have been the most fertile and beautiful part of the island, had it not been overflowed by floods of lava....[It] extends along the western shore between seventy and eighty miles, including the irregularities of the coast.
>
> The northern part, including Kairua, Kearake'kua and Honaunau, contains a dense population, and the sides of the mountain are cultivated to a considerable extent; but the south part presents a most inhospitable aspect. Its population is thin, consisting principally of fishermen, who cultivate but little land, and that at the distance of from five to seven miles from the shore (Ellis 1963:126).

Here Ellis was no doubt referring to the coastal area south of Honaunau, which lacks both cultivation and vegetation.

In his archaeological and historical survey of Keopuka, Soehren describes part of the project area (portion 1) as "almost devoid of vegetation near the shore," blaming recent lava flows (1980:1). He continues:

> While the project area (TMK 8-1-07:portion 1) is within the Kona Field System, the ground is generally so rough and stony that it is highly improbable that it was utilized to any extent, if at all, by the aboriginal Hawaiian farmer. Better suited land was available immediately to the north and also farther to the south in Kaawaloa.

Soehren does recognize that despite the dominating aa fields, trails of various construction and time periods allowed access through Keopuka. At about the 400 foot elevation is the "old government road from Kealakekua pali to Kainaliu" beach, which Soehren believes dates from 1840. Nearer the coast is a similar trail linking the landing at Kaawaloa with the coastal villages to the north, including Kainaliu, Keauhou, and Kailua. Soehren also mentions a cart road attributed to Rev. John D. Paris that runs from Kaawaloa landing up the pali to Kuapehu, his residence (ibid:2).

Previous archaeological surveys of Keopuka were done by the Bishop Museum in 1929 and the State of Hawaii in 1971. Soehren summarizes their findings by saying, "[t]he great majority of the sites are typical of temporary camp sites used by fishermen." Soehren's list of sites recognized by the State is presented here. At the end, he has added two new sites (trails) that he identified during his survey in 1981. The prefix 10-47- in the State numbering system has been omitted from the site numbers:

> 1948 Keopuka complex 3. Camp site with stone wall windbreaks, enclosures, platforms. Some walls rebuilt since 1929.
>
> 1949 Small heiau, probably fishing shrine. NW and SW corners have been deliberately pulled down.

1950 Keopuka complex 4. Camp site with remains of low stone wall windbreaks.

1951 Keopuka shelter 1. Camp site with low stone wall windbreak.

1952 Keopua complex 5. Camp site with stone wall windbreaks, platforms, rock shelter. Scattered traces of other human activity over a wide area.

1953 Keopuka shelter 2. Rock shelter with stone wall windbreak.

1954 Keopuka shelter 3. Rock shelter with stone wall windbreak.

1955 Keopuka complex 6. Camp site with stone wall windbreaks, rock shelters and platforms.

1956 Keopuka platform 2. Probably a drying platform, not house.

1957 Keopuka habitation 2. Modern camp site with new three sided stone wall windbreak, possibly built on old site.

1958 Keopuka complex 7. Rock shelter, stone wall windbreaks disturbed by surf; three contiguous platforms are probably graves. Traces of other features in wave washed rubble.

1959 Keopuka shelter 4. Camp site, ruins of stone wall windbreak.

1960 Keopuka burials 2. Group of burial platforms & terraces on aa lava flow.

1961 Keopuka complex 8. Camp site with stone wall windbreaks, some still in use; platform, probably for drying.

1962 Keopuka house sites. Two house platforms surrounded by a stone fence on pahoehoe; other platforms, pavements and enclosures adjoining on south. Some surf damage. Trail 7727 begins at this site.

7727 Foot path across old pahoehoe to top of pali; some stepping stones of waterworn boulders and flat lava slabs. Mauka terminus unknown.

7728 Foot path across aa to top of pali, the southeast to Kaawaloa and perhaps to Napoopoo. Many waterworn steppingstones from the shore to the pali.

Land Commission Awards

During the reign of Kamehameha III, the most important event in the reformation of the land system was incorporated. "The Great Mahele" separated and defined the undivided land interests of the King and the high-ranking chiefs and konohiki (originally referred to the person in charge of a tract of land on behalf of the king or a chief; it is in the later statutes that the chiefs or landlords were referred to as "konohikis") (Chinen 1958:vii, and 1961). More than 240 of the highest ranking chiefs and konohiki in the kingdom joined Kamehameha III in this division. The first mahele was signed on Jan. 27, 1848 by Kamehameha III and Princess Victoria Kamamalu by her guardians Mataio Kekuanaoa and Ione II. The last mahele was signed by the King and E. Enoka on March 7, 1848 (Chinen 1958:16).

The Mahele did not convey any title to any land. The chiefs and konohiki were required to present their claims to The Land Commission and to receive awards for the lands quitclaimed to them by Kamehameha III. Until an award for these lands was issued, title remained with the government. Because there were few surveyors at the time of the Mahele, the lands were divided by name only, with the understanding that the ancient boundaries would control until a survey of such lands could be made in the future. This was done to expedite the work of the Land Commission in awarding lands to the chiefs and konohiki. However, these chiefs and konohiki were still required to pay commutations to the government for them to receive Royal Patents on their awards. These lands awarded to the chiefs and konohiki became known as Konohiki Lands (Chinen 1961:13).

Lands were identified and separated in 1848 as Crown Lands (for the occupant of the throne), Government Lands, and Konohiki Lands. These were all "subject to the rights of native tenants" (Laws of Hawaii, 1848:22). These rights were brought into question when the King, the government and konohiki began selling off parcels of land. To clarify the situation, the Privy Council, on December 21, 1849, adopted four resolutions as a means of protecting the rights of native tenants (Chinen 1958:29).

These resolutions authorized the Land Commission to award fee simple title to all native tenants who occupied and improved any portion of Crown, Government, or Konohiki

Lands. Except for the houselots located in the districts of Honolulu, Lahaina, and Hilo, these awards were to be free of commutation (ibid).

Before receiving awards for their lands from the Land Commission, the native tenants were required to prove that they actually cultivated those lands for a living. They were not permitted to acquire waste lands or lands which they cultivated "with the seeming intention of enlarging their lots." Once confirmed, they were required to be surveyed before the Land Commission was authorized to issue any award. These lands became known as "Kuleana Lands" (ibid.). Until its dissolution on March 31, 1855, the Land Commission issued thousands of awards to the native tenants for their kuleana. Even so, less than 30,000 acres of land were awarded to the native tenants as kuleana lands.

The ahupua'a of Keopuka 1 and 2 were classified as Government Lands during the Mahele. The project area lies within what was Grant 2862 (Board of Commissioners 1929). Additional historical research should include a search at the Land Management Division of the Department of Land and Natural Resources for the original grant, and consulting the records at the Bureau of Conveyances for subsequent land ownership and uses.

A partial list of land owners in Keopuka was provided by Jean Greenwell at the Kona Historical Society. It starts with the award of 739 acres in Grant 2862 to Awahu, whom she believes was the konohiki of the area. He willed the parcel to Likelike and his wife. They sold it to Charles Kanaina (heir of the Kalama lands) in 1863 for $219.25 to cover debts incurred by Awahu. Kanaina in turn sold the land back to Likelike in 1871 for the amount of $160. Likelike and her husband Archibald sold it in 1875 to an A. Todd for $350. He in turn sold it to Renee Rodant in 1896, who sold it to Kona Vineyard. A large increase in price (which included some land in Onouli) came with the sale to Julia J. DeSa in 1909 for $12,000. The mention of Kona Vineyard raises the possibility of the cultivation of grapes. In 1982, Mrs. Greenwell interviewed Joe Henriques, who remembers a man named Cooper growing grapes in Keopuka. Mrs. Greenwell also informs us that Thomas Jagger, the volcanologist for whom the National Park Visitor Center at Kilauea is named, had a parcel in Keopuka. The principal modern use for the ahupua'a has been cattle ranching by the Henriques family.

FIELD METHODS AND PROCEDURES

The present survey consisted of pedestrian inspection of only the immediate shoreline of the parcel. With the exception of the kiawe and koa-haole thickets, surface visibility was excellent due to the generally open, treeless lava terrain. As sites were identified they were flagged with pink-and-blue flagging tape and were assigned PHRI sequential temporary numbers prefixed by "769-", beginning with 769-1. Subsequently, all identified sites were designated by their previous SIHP permanent site numbers (Soehren 1981), or if none existed, the PHRI temporary site number was retained. All sites were plotted on a 1"=200' scale blueline contour map (5- and 10-ft contours) produced by R.M. Towill Corp. Site plotting was aided by a black-and-white aerial photograph (R.M. Towill Corp. Photo No. 6016-6; dated 9-20-73) of the project area. Sites were then listed on a PHRI Summary of Identified Sites and Features record form. Sites were tagged with an aluminum strip bearing the site number, PHRI project number (89-769), the letters PHRI, and the date.

FINDINGS

During the present survey, 25 sites were identified, of which 16 had been previously identified by Soehren (1981). Background research indicates there are an additional 60 previously identified sites in the project area (Soehren 1981; Rosendahl and Jensen 1989) (total sites: 85 consisting of numerous component features). Unsurveyed portions of the present project area are also likely to contain numerous additional sites. Figures 2 and 3 show the locations of all identified sites, and Table 1 (page 15) provides a summary of sites in terms of component features, formal and functional types, PHRI Cultural Resource Management (CRM) value mode assessments, and recommended field work tasks.

Formal feature types identified within the project area include C-shape, enclosure, terrace, platform, L-shape, cave, wall, walled terrace, walled overhang, boulder alignment, box C-shape, mound, double enclosure, trail, leveled area, walled depression, modified sink, railroad bed, modified outcrop, and road. Probable functional interpretations were determined for most features. Functional types encountered include habitation, ceremonial (possible heiau), possible burial, burial, transportation (trails and historic roads), boundary, ranching, agricultural, and refuge.

CONCLUSION

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). DLNR-HSS/SHPO uses these criteria for evaluating cultural resources. Sites determined to be potentially significant for information content 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 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 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" (ACHP 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."

In order to facilitate future client management decisions regarding site treatments, sites are further evaluated in terms of PHRI Cultural Resource Management (CRM) value modes, which are derived from the above federal evaluation criteria. Archaeological resources are evaluated in terms of potential scientific research, interpretive, and/or cultural values. Research value refers to the potential of archaeological resources for producing information useful in the understanding of culture 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 refers to the potential of archaeological resources to preserve and promote cultural and ethnic identity and values.

Fifty-seven sites which have minimally undergone inventory-level survey work include those sites within the project area identified by Rosendahl and Jensen (1989). For these 57 sites general significance assessments have previously been made and are presented here. Of the 57 sites, 51 have been assessed (Sites 11272-11290, 11292-11301, 11303, 11304, 11306-11311, 11314-11327) as being solely significant for information content. Further data collection has been recommended for 50 of these 51 sites; no further work has been recommended for one of the 51 sites (Site 11303, a wall). Of the six remaining sites, five (11291, 11302, 11305, 11312, and 11313) have been assessed as being (a) important for information content, (b) excellent examples of a site type, and (c) culturally significant (provisional assessment for Site 11291 because the site may contain burials). Further data collection and preservation with some level of interpretive development have been recommended for these five sites. The final site (Site 11328), a historic railroad bed, has been assessed as being an excellent example of a site type; further data collection and preservation with some level of interpretive development has been recommended for this site (Rosendahl and Jensen 1989:15). As mentioned previously, the evaluations and recommendations contained within Rosendahl and Jensen (1989) should be considered tentative, as only a draft report on the survey was completed and it was never submitted by the client to DLNR-HSS/SHPO for official review.

To provide definitive evaluations of site significance on the basis of a preliminary investigation such as a field inspection is usually not possible. Definitive evaluations usually require that sites undergo at least inventory-level survey, often including test excavations. Generalized assessments, however, can be made here. Based on the findings of the present field inspection, it is apparent that most, if not all, the sites in the project area are significant in terms of research value (information content). Some sites would probably be assessed as significant for cultural value. These sites would include, but would not be restricted to, transportation routes (trails), possible burials, and ceremonial sites. Sites significant as representative examples of site types (interpretive value) would include, but would not be restricted to, a representative variety (formal types) of sites which are in excellent structural condition, and unique and/or unusual sites. Such sites might include large platforms which may be heiau or high status residences, concentrated site complexes, trails, and also common sites such as C-shape wall shelters, terraces, enclosures, and walls. Sites within the project area that most likely would be assessed as significant for cultural value and/or as excellent examples of site types and most likely would subsequently be recommended for preservation with some level of interpretive development would include Sites 1949, 1952, 1958, 1960-

1958, 1960-1962, 7727, 7728, 769-11, 769-16, 769-18, 769-19, and 769-23 thru -25.

Regarding the burials and possible burials identified within the project area, if they are not preserved "as is," it would be required that the procedures of Section 43 of Chapter 6E (Historic Preservation, Haw. Rev. Stat., as amended) be followed. The DLNR-HSS/SHPO would be notified and would contact the Office of Hawaiian Affairs (OHA). A mitigation plan for burials, with osteological analyses, would be worked out with DLNR-HSS/SHPO. At least, a search for direct lineal descendants—consisting of publishing in a newspaper of general circulation a public notice to notify possible direct lineal descendants—would be conducted. If direct lineal descendants are found, the osteological analyses would be subject to their wishes. Lastly, a plan for final disposition of the remains would be developed in accordance with Section 43 of Chapter 6E. It is recommended that any remains found be reinterred within the project area. A disinterment permit may be required from the State Department of Health.

It should be noted that, other than areas surveyed during the Rosendahl and Jensen (1989) survey, the project area has not been subjected to inventory-level archaeological work. It is therefore likely that there are significant unidentified archaeological resources in the area. Due to this, it is recommended that, as an initial step, an inventory-level survey be conducted prior to any development activities within the project area. It should also be noted that upon official review of Rosendahl and Jensen (1989), DLNR-HSS/SHPO may require the collection of additional archaeological information for sites situated within inland portions of the project area.

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Table 1.

SUMMARY OF IDENTIFIED SITES AND FEATURES

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	*CRM Value Mode Assess. R	I	C	#Field Work Tasks DR	SC	EX
1948	Complex (5++)	Habitation	M/H	L	L	+	+	+
A	C-shape							
B	C-shape							
C	Enclosure							
D	Terrace							
E	Terrace							
1949	Platform	Ceremonial	M/H	H	H	+	-	+
1950	Complex (3)	Habitation	M	L	L	+	+	+
A	C-shape							
B	C-shape							
C	L-shape							
1951	Walled terrace	Habitation	M	L	L	+	-	+
1952	Complex (5)	Habitation	M	M/L	L	+	+	+
A	Blister cave							
B	Enclosure							
C	Terrace							
D	Wall							
E	Walled terrace							
1953	Walled overhang (Rock shelter with stone wall windbreak)	Habitation	M	L	L	+	+	+

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

#Field Work Tasks:
DR = detailed recording (scaled drawings, photographs, and written descriptions)
SC = surface collections
EX = limited excavations

++Number of component features within complex.

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
1954	Keopuka shelter (3) (Rock shelter with stone wall windbreak)	Habitation	M	L	L	+	+	+
1955	Keopuka Complex (6)	Habitation	M	M/L	M/L	+	+	+
-	Stone wall windbreaks							
-	Rock shelters							
-	Platforms							
1956	Complex (3)	Habitation	M	L	L	+	+	+
A	Low platform							
B	Boulder alignment							
C	Boulder alignment							
1957	Box C-shape	Habitation	M	L	L	+	+	+
1958	Complex (5)	Possible burial-habitation	M	M	L/H	+	+	+
A	Platform							
B	Box C-shape							
C	Box C-shape							
D	Enclosure							
E	Overhang cave							
1959	C-shape	Habitation	M	L	L	+	-	+
1960	Complex (11)	Possible burial	M	M	L/H	+	-	+
A-H	Terraces							
I-K	Mounds							
1961	Complex (3)	Habitation	M	M	M	+	+	+
A	Enclosure wall remnant							
B	Platform							
C	Platform							
1962	Complex (6)	Habitation	M/H	H	M	+	+	+
A	Platform							
B	Enclosure							
C	Platform							
D	Double enclosure							
E	Platform							
F	Platform							
7727	Trail	Transportation	M	M	H	+	-	-
7728	Trail	Transportation	M	M	H	+	-	-

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
11272	Wall	Boundary/ranching	L	L	L	+	-	-
11273	Complex (30+)	Agricultural	M	L	L	+	+	+
-	Pits (25)							
-	Mounds							
-	Terraces							
-	Retaining walls							
-	Rock alignments							
11274	Wall	Boundary	L	L	L	+	-	-
11275	Wall	Boundary/ranching	L	L	L	+	-	-
11276	Wall	Boundary/ranching	L	L	L	+	-	-
11277	Terrace	Agricultural	L	L	L	+	-	-
11278	Complex (3)	Agricultural/ habitation/ranching	M	L	L	+	-	+
-	Enclosure							
-	Terrace							
-	Terrace							
11279	Wall	Ranching	L	L	L	+	-	-
11280	Complex (50-100+)	Agricultural	L	L	L	+	-	-
-	Pits							
11281	Wall	Agricultural	L	L	L	+	-	-
11282	Wall	Ranching	L	L	L	+	-	-
11283	Terrace	Agricultural	L	L	L	+	-	-
11284	Wall	Boundary	L	L	L	+	-	-
11285	Complex (5+)	Agricultural/ habitation	L	L	L	+	-	-
-	Enclosure							
-	Terraces							
-	Walls							
-	Mounds							
11286	Complex (5+)	Agricultural/ habitation	L	L	L	+	-	-
-	Enclosures (2)							
-	Terraces (2)							
-	Road alignment							

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
11287	Terrace	Habitation (?)	M	L	L	+	-	+
11288	Enclosure	Agricultural (?)	L	L	L	+	-	-
11289	Complex (2) • Terraces	Agricultural	M	L	L	+	-	+
11290	Terrace	Agricultural/ habitation (?)	L	L	L	+	-	-
11291	Complex (15+) • Walls • Enclosure • Papamu • Embankment wall • Terrace • Platforms	Agricultural/ burial (?)/habitation	M/H	M	L/H	+	+	+
11292	Complex (6+) • Mounds (3) • Pits (3+)	Agricultural	L	L	L	+	-	-
11293	Complex (10+) • Terraces • Cobble pavement	Habitation (?)	M	L	L	+	-	+
11294	Complex (4+) • Mound • C-shape • Cleared area • Terrace	Agricultural/ temp. habitation	L	L	L	+	-	-
11295	Leveled area	Agricultural	L	L	L	+	-	-
11296	Complex (2+) • C-shape • Terrace	Agricultural/ temp. habitation	L	L	L	+	-	-
11297	Walled depression	Habitation	L	L	L	+	-	-
11298	Enclosure	Agricultural (?)	L	L	L	+	-	-

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
11299	Complex (4+) • Mound • Terrace • Pits • Platform	Agricultural	L	L	L	+	-	-
11300	Complex (4+) • Mounds (3+) • Platform • Terrace	Agricultural/ habitation (?)	L	L	L	+	-	+
11301	Complex (50-100+) • Pits	Agricultural	L	L	L	+	-	-
11302	Cave	Refuge cave/ burial	H	M	H	+	+	+
11303	Wall	Temp. habitation	L	L	L	-	-	-
11304	Modified sink	Habitation	M	L	L	+	+	+
11305	Trail	Transportation	L	M	M	+	-	-
11306	Complex (5+) • Enclosure • Terraces	Agricultural	L	L	L	+	-	-
11307	Enclosure	Habitation (?)	L	L	L	+	-	-
11308	Complex (6+) • Enclosure • Terraces • Linear allignment	Agricultural/ habitation	M	L	L	+	-	+
11309	Wall	Agricultural (?)	L	L	L	+	-	-
11310	Enclosure	Habitation	L	L	L	+	-	-
11311	Complex (24+) • Pits (15+) • Terraces (8) • Wall	Agricultural	M	L	L	+	-	-

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
11312	Complex (7+)	Habitation/ transportation	H	M	M	+	+	+
-	Sinkholes (2)							
-	Elevated causeway							
-	Ramp							
-	Platforms (2)							
-	Mound							
11313	Trail	Transportation	L	M	M	+	-	-
11314	Complex (6+)	Agricultural	L	L	L	+	-	-
-	Wall segment							
-	Modified outcrops (2)							
-	Terraces (3+)							
11315	Wall	Boundary (?)	L	L	L	+	-	-
11316	Platform	Ranching	L	L	L	+	-	-
11317	Platform	Ranching	L	L	L	+	-	-
11318	Platform	Ranching	L	L	L	+	-	-
11319	Platform	Ranching	L	L	L	+	-	-
11320	Platform	Ranching	L	L	L	+	-	-
11321	Terrace	Ranching	L	L	L	+	-	-
11322	Platform	Ranching	L	L	L	+	-	-
11323	Platform	Ranching	L	L	L	+	-	-
11324	Platform	Ranching	L	L	L	+	-	-
11325	Terrace	Agricultural	L	L	L	+	-	-
11326	Terrace	Ranching	L	L	L	+	-	-
11327	Terrace	Ranching	L	L	L	+	-	-
11328	Railroad bed	Transportation	L	M	L	+	-	-
769-7	Enclosure	Habitation	M	L	L	+	+	+
769-11	Trail	Transportation	M	M	H	+	-	-

Table 1. (cont.)

Site/ Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
769-15	Complex (2)	Habitation	M	L	L	+	+	+
A	C-shape							
B	Wall							
769-16	Enclosure wall remnant	Habitation	M	M	M	+	+	+
769-18	Complex (2)	Possible burial/ indeterminate	M	L	L/H	+	+	+
A	Platform							
B	Modified outcrop							
769-19	Complex (2)	Possible burial	M	M	L/H	+	+	+
A	Platform							
B	Platform							
769-20	Enclosure	Habitation	M	L	L	+	+	+
769-22	Enclosure remnant	Habitation	M	L	L	+	+	+
769-23	Complex (2)	Habitation	M	M	M	+	+	+
A	Enclosure remnant							
B	Enclosure							
769-24	Cart road	Transportation	M	M	H	+	-	-
769-25	Old govt. road	Transportation	M	M	H	+	-	-

Addendum to PHRI Report 394-110588, Archaeological Inventory Survey, Onouli Subdivision Project Area, Lands of Onouli and Keopuka, South Kona District, Island of Hawai'i (Rosendahl and Jensen 1989)

This addendum comprises revisions to PHRI Report 394-110588. The report was issued by Paul H. Rosendahl, Ph.D., Inc. (PHRI) in August 1989 and was submitted to the Department of Land and Natural Resources – State Historic Preservation Division (SHPD) for review in December 1990 (submittal letter dated December 28, 1990). The project was then put on hold at the instruction of the client. The report, however, was formally reviewed by the SHPD in June 1994. In the SHPD review letter (dated June 27, 1994) the SHPD noted that they had reviewed the report using 1990 standards, the year in which the report had been submitted. The letter also noted that the report was acceptable, with the following minor requested revisions:

1a. There is no title page on the report we received. We need a title page with authors listed. The authors must meet the minimum National Park Service standards.

1b. A map needs to be included showing the project location in relation to the shore, perhaps a section of the USGS quadrangle.

2. p.14. Estimated dates for the sites are made using Schilt's work in North Kona. However, the project lies in Central Kona, closer to Kealakekua. The analysis in the paragraph should consider whether there are more nearby dates, and whether the North Kona dates apply in this area.

3. p.14. A better summary of the site patterns is needed. What types of agricultural and habitation sites are present in the south part of the area? What types of agricultural site remnants are in the north – informal terraces and mounds, *kuaiwi* walls, or both?

4. p.14. What was the ranch that the walls were associated with?

5. You reference Schiltz (1984) on page 14 but it is missing from your bibliography.

In July 1994, PHRI responded to the review letter, noting that because the project was still inactive PHRI would, for the time being, address only Items 1(a,b) and 5. The other Items (2, 3, 4) would be addressed when the project was reactivated. Revised pages for Items 1(a,b) and Item 5 were enclosed with the PHRI response letter (dated July 11, 1994, to D. Hibbard from P. Rosendahl). SHPD subsequently responded (letter dated November 7, 1994), acknowledging receipt of the replacement pages and acknowledging that the remaining SHPD concerns would be met if PHRI were eventually hired for future work on the project.

Recently, the project was reactivated. PHRI is therefore now submitting to the SHPD the revisions for Items 2, 3, and 4, by way of the following revised Conclusion section. Since 1990, PHRI has changed its significance criteria to conform with the criteria used by the DLNR-SHPD; sites are now assessed for significance based on DLNR-SHPD Criteria a-e, outlined in the current draft *Hawaii Administrative Rules 13§13-275-6*, dated October 1998. The following Conclusion section, therefore, includes a revised General Significance Assessments and Recommended General Treatments table.

CONCLUSION

DISCUSSION

Of the 57 identified sites in the project area, roughly half of them are tentatively interpreted as associated with the indigenous Kona Field System. The remaining sites are tentatively interpreted as associated with historic ranching and agriculture. The Kona Field System features in the project area, as is typical of system sites elsewhere, are numerous. Besides the field system sites formally recorded during the current project, many minor unrecorded features of the system such as small mounds, terraces, and pits were present in the project area. As is also typical of the field system, the sites in the project area are somewhat repetitive in structural form – they consist primarily of agricultural features among which are interspersed occasional habitation and ceremonial or burial features.

The Kona Field System overall is characterized and discussed in Schilt (1984) in terms of four zones: the *kula* zone, the *kaluulu* zone, the *'apa'a* zone, and the *'ama'u* zone. The present project area is situated within Schilt's *kaluulu* and *'apa'a* zones. The *kaluulu* (seaward slope) zone includes the area from c. 500-1,000 ft (150-300 m) elevation and receives c. 40-55 inches (1.0-1.35 m) of annual rainfall. The *'apa'a* (upland slope) zone includes the area from c. 1,000-2,500 ft elevation and receives about 55-80 inches of rain annually. According to Schilt, crops cultivated within the *kaluulu* zone during the late prehistoric period include breadfruit (*'ulu*), mountain apple (*'ohi'a-'ai*), taro (*kalo*), sweet potatoes (*'uala*), gourd (*ipu*), and paper mulberry (*wauke*). Crops cultivated within the *'apa'a* zone include taro, sweet potatoes, ti (*ki*), and sugarcane (*ko*). Crops cultivated during the proto-historic and early historic periods (AD 1778-1850) in both zones include cabbage, melons, onions, oranges, tobacco, beans, coffee, corn, corn, cotton, pineapple, Irish potatoes, and pumpkins (Schilt 1984).

Prehistoric Agriculture

In the classic Kona Field System design field boundary walls (*kuaiwi*) are present. These are low, linear mounded rock walls oriented upslope-downslope, and low earthen rises oriented perpendicular to the *kuaiwi* (Cordy 1995; Kirch 1985; Newman 1970). In the current project area, however, historic modifications due primarily to ranching and agriculture make it difficult to ascertain how closely the original landscape conformed to the classic design. Based primarily on the extant structural evidence, it is possible that the north-northwestern portion of the project area (north of the line of sites between Sites 11280 and 11314) conformed quite closely. Supporting this are the following:

1. The terrain in the north-northwestern portion is more suitable for agriculture. Most of the project area is covered with *'a'ā*, but the north-northwestern portion is gently sloping, soil-covered ground;

2. There are a number of upslope-downslope walls in the north-northwestern portion (*Figure 1*)(Sites 11276, 11272, 11274, 11275, and 11279). During the current survey the walls, except for Site 11274, were assessed as having historic origins. It is, however, conceivable that some of the walls, or portions of them, were built over what were originally *kuaiwi*, as this would be an expedient way to build walls. Further testing would be necessary to determine this. There are also a number of walls in the project area that are oriented perpendicular to the upslope-downslope walls; these walls should also be considered possible former *kuaiwi* walls;

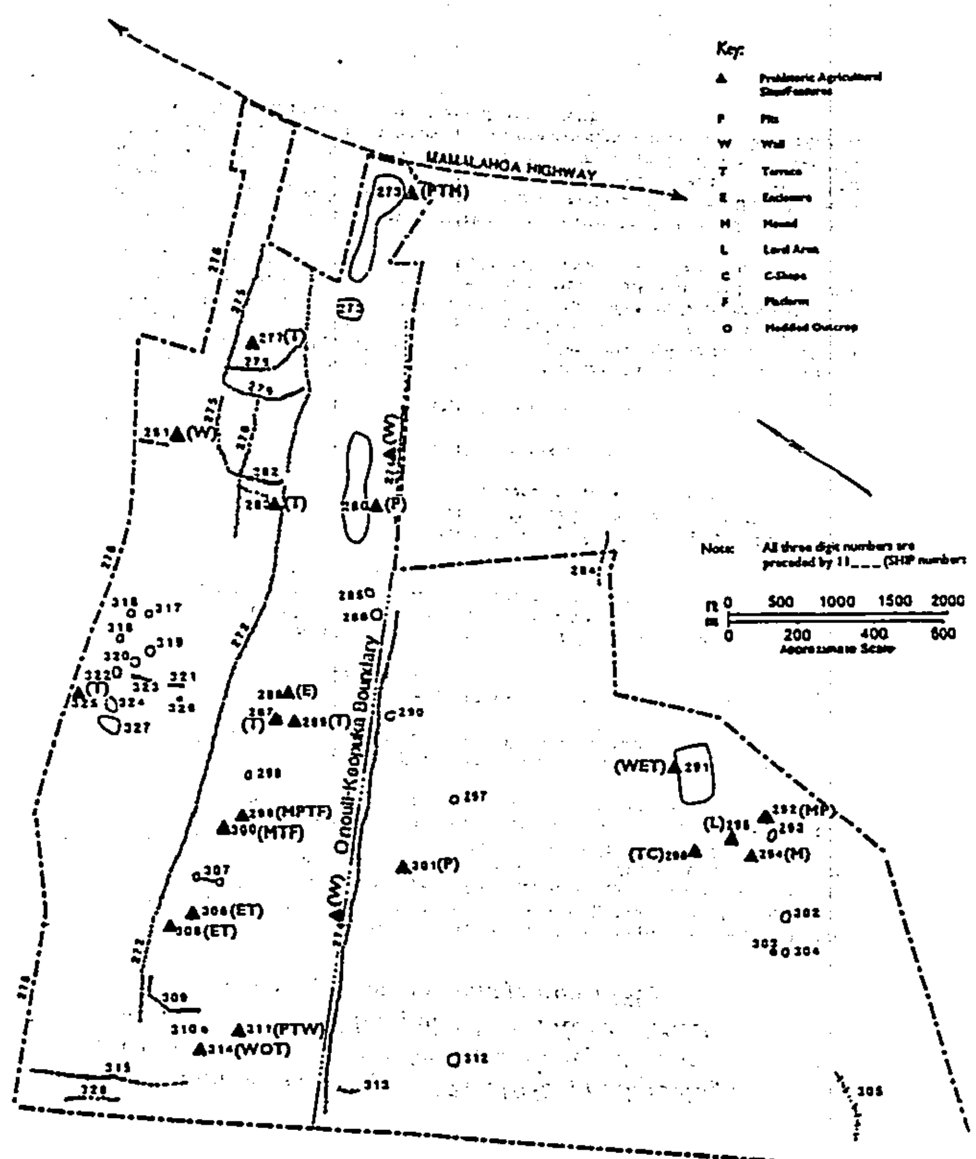

Figure 1. Locations of Prehistoric Agricultural Sites and Features

3. There are three clusters of agricultural sites typical of the Kona Field System in the northern portion. One cluster is roughly 1,500 feet from the northwest boundary of the project area. The sites are along an *'a'ā* ridge (line of sites between Sites 11288 and 11314; see *Figure 1*). The sites comprise an enclosure, terraces, platforms, a C-shape, a modified outcrop, pits, and mounds; the cluster may constitute a single large prehistoric habitation and agricultural complex. The two other clusters are pit complexes (11273 and 11280); and

4. In the central-northern portion of the project area are numerous piles of stones created as a result of historic period clearing of the area. The piles suggest that prior to historic ranching and agriculture there were numerous structures in the area. These structures probably comprised Kona Field System boundary walls and associated agricultural and habitation types similar to the ones that exist in the general area.

In the central and southern portions of the project area, below the Onouli-Keopuka boundary wall (Site 11274), Kona Field System sites are scattered and few (*see Figure 1*). The central portion contains only a single prehistoric agricultural site (11301) that consists of over fifty planting pits. In the central-southeastern portion is a number of roughly clustered agricultural sites comprising mounds, walls, terraces, and an enclosure. These, together with a few associated habitation structures (Sites 11291, 11293, and 11304), could be seen overall as a loosely spread habitation/agricultural complex. Sites are few in the central and southern portions probably due to the *'a'ā* surface. Soehren (1980) noted: "it is highly improbable that it was utilized to any extent, if at all, by the aboriginal Hawaiian farmer." The southern and central portions of the project area clearly do not conform to the standard model of the Kona Field System.

Prehistoric Habitation

During the current project, prehistoric habitation features were identified as permanent or temporary based on criteria defined by Cordy (1981:66-82). In Cordy's revised model permanent habitations: (a) have an external area greater than 16-19 sq m; (b) are substantially constructed (stone-filled and bifaced walls); (c) are associated with special-purpose structures (such as for work and storage); and (d) are located mostly on the coast, either along the shore or at the mouth of and on the sides of valley floors. Permanent habitations are also usually characterized by relatively dense concentrations of material remains and have one or more carefully constructed hearths. During the current project, however, test excavations were not conducted, so the main criteria used here for determining permanence of habitation is size, and the current designations are necessarily tentative.

Temporary habitations, according to Cordy's model, are: (a) less than 16 sq m in external area; (b) insubstantial constructions; (c) contain numerous features of internal stratification (multiple firepits); and (d) have few to no associated structures. Temporary habitations include short-term occupation structures (e.g., small enclosures, terraces, platforms, C-shaped walls), and natural overhangs and caves with evidence of modification or midden. Although temporary habitations generally contain some midden and artifacts, they often do not contain any material remains. Some temporary habitations contain substantial cultural deposits due to repeated short-term occupations.

During the current project, 12 habitation sites were identified: two terraces, four enclosures, two C-shapes, a wall, a platform, a modified sink, and a cave (*Table 1*). Based on the criteria outlined above, seven of the 12 sites are assessed as permanent habitations, and five are assessed as temporary habitations. The most substantial of the permanent habitations is Site 11291. This site comprises a large enclosure with well-stacked, core-filled walls. Associated with the enclosure are a *papamu*, a wall, short terraces, and eight low platforms that may represent burials. The other permanent habitations comprise two enclosures, a cave, a terrace, a modified sink, and a platform. Perhaps the most interesting of these is the cave, which is fairly complex and constitutes an area of 200+ square meters. Based on material remains, the cave has both historic and prehistoric components. Because of substantial constructions at the site (a causeway, ramps, a platform, mounds, and a well-built fireplace) the site was assessed as possibly evidencing permanent habitation.

The temporary habitations comprise a terrace, two C-shapes, a wall, and an enclosure. Site 11307 is a large enclosure; it, however, has no associated structures or material remains and may actually constitute a ranching feature. Site 11294 is a fairly large C-shape but is poorly constructed. The remaining temporary habitations are typical functional types.

The habitation sites in the project area are in two clusters (*Figure 2*). One is a linear cluster located along an *'a'ā* ridge overlooking the pastureland to the north. This ridge extends roughly from Site 11314 eastward to Site 11288. The other cluster is located in the south eastern portion of the project area. Both clusters are in areas in which there are numerous prehistoric agricultural features that are associated with the habitations. The linear cluster is on the border of an area defined earlier as appearing to have once exhibited the classic characteristics of the Kona Field system pattern of archaeological sites. The other cluster is in the southern portion of the project area, on *'a'ā*. As mentioned, this area does not resemble the classic field system, most likely due to the generally rougher terrain.

In summary, it appears that prehistoric habitation in the project area took place more in the north-northeast portion, where the terrain was more suitable for agriculture. It is probable that prior to modern agricultural and ranching modifications, there were a number of other habitation sites in the area. Perhaps the stone clearing piles in the north were built using stones from former habitations. The cluster of habitations in the southern portion of the project area may reflect a choice made for any number of reasons, but perhaps most likely is that the area represents a pocket of relatively suitable land for agriculture.

Chronology

Schilt has formulated settlement patterns for North Kona and the Kona Field System (Schilt (1984:276-284). Based on radiocarbon and volcanic glass dates, Schilt indicates that initial occupation of the North Kona area occurred about AD 1050-1400, with dryland agriculture flourishing by AD 1400-1600/1650. More relevant to the settlement patterns of the present project area is Cordy's summation of archaeological site patterns in Central Kona, where the project is located (Cordy 1995). According to Cordy (1995) permanent settlement began in central Kona in AD 900-1200. People settled on the shore initially and farmed in small clearings in the forested uplands nearest the coast, at about the 600-800 foot elevation level where 40-50 inches of rain fell per year. There was also some permanent settlement in intervening *kula* lands. By AD 1000-1300 settlement began expanding onto the drier *kula* slopes. Gradually, over the centuries, the agricultural fields became more rigorously defined with *kuaiwi*. Dated temporary and permanent habitations show more house structures were built after AD 1400s and 1500s, which agrees with mathematical models of when population growth should have markedly increased, so perhaps most of the formal walled fields of the system belong to this period (Cordy 1995:17).

The scope of the current project included no test excavations; no subsurface or surface datable material was recovered. The chronology for the current project area, therefore, must be estimated from chronological data derived from other archaeological work. There have been numerous archaeological investigations in the general vicinity. Hammatt et al. (1994) provides an overview and listing of over sixty studies conducted between 1930 and 1991 in the general vicinity of the current project area. Much of this work documents the Kona Field System and the associated habitation sites. However, radiocarbon ranges from the specific Central

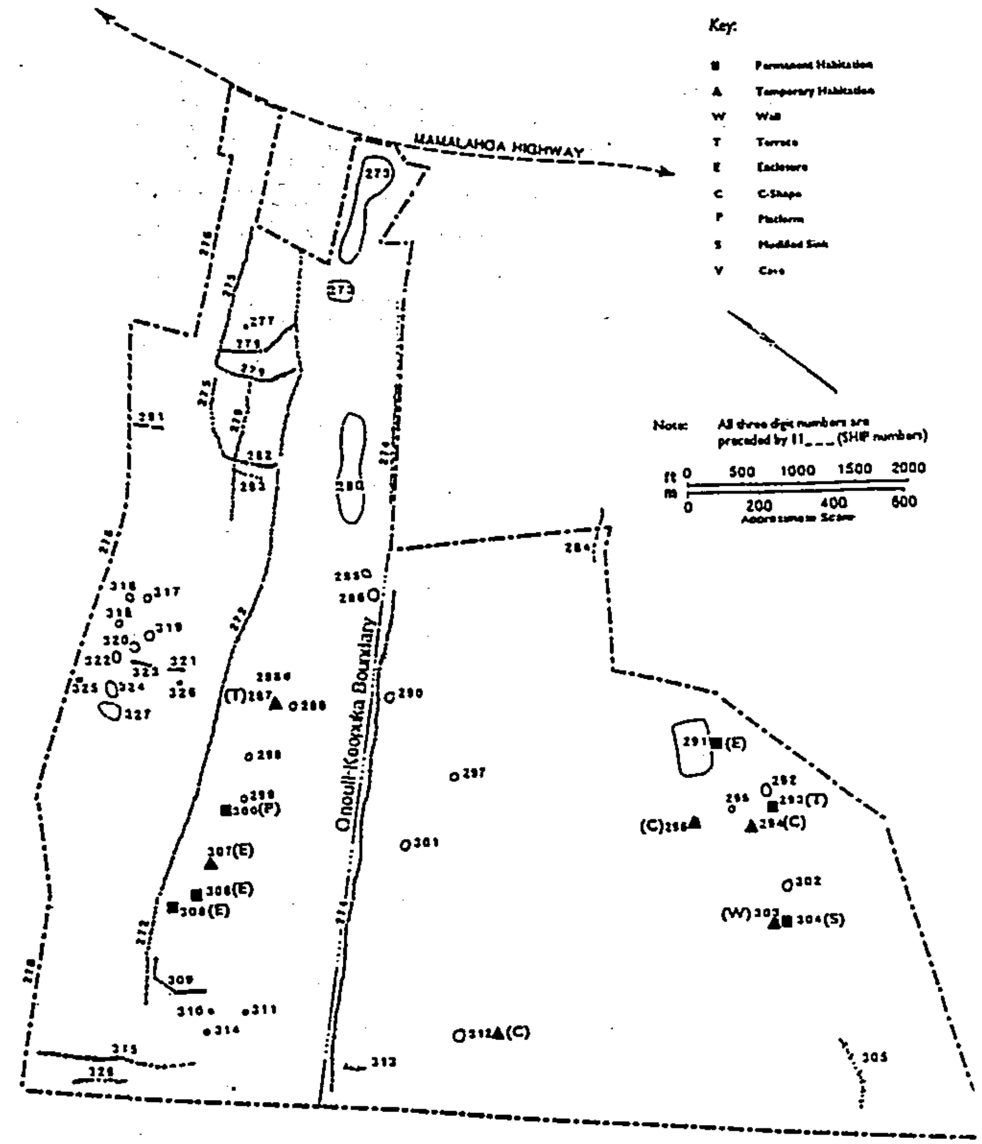

Figure 2. Locations of Prehistoric Habitation Sites and Features

Table 1. Summary of Prehistoric Habitation Features

Site/Fea. Design.	Feat. Type	Extern. Area (sq m)	Location/ Terrain*	Degree of Construction/ Condition	Associated Structures	Comments	P/T+
11287	Terrace	28	C	N and SW corners, NE wall are well-faced	None	Possible habitation. May have been used for agriculture.	T
11291	Enclosure	255	A	Well-built; core-filled walls	Papamu, walls, short terraces platforms,	Eight low platforms may represent burials.	P
11293	Terrace	64	A	Well-built, upright boulders and cobble-fill present	Terraces, walls, pavement	A series of low walls converge to form a large central terrace. Smaller terraces are probably agricultural	P
11294	C-shape	20	A	Loosely piled, poor condition	Mound, cleared area, terrace	Probably related to prehistoric agriculture	T
11296	C-shape	4	A	Loosely piled, poor condition	Terrace	Probably related to prehistoric agriculture	T
11300	Platform	25	C	Well-faced walls.	Mounds, terrace	Probably related to prehistoric agriculture	P
11303	Wall	1	A	Poorly constructed	None	Probably constructed as a windbreak.	T
11304	Modified Sink	60	A	Flat, roughly paved floor with overhang	Rock-lined fireplace	Appears to have been used prehistorically and historically. May contain a significant amount of midden	P
11306	Enclosure	120	C	Well-stacked, partially faced walls	Terraces	Probably related to prehistoric agriculture	P
11307	Enclosure	440	C	Well-built, 1-m-wide walls	None	Some soil, but no midden within structure. May have been used for ranching.	T
11308	Enclosure	450	C	Stacked 4-6 courses high; collapsed	Terraces, alignments	Inland wall served as terrace retaining wall.	P
11312	Cave	200+	A	Fairly complex system	Causeway, ramps, platforms, mound, fireplace	Prehistoric component of site may be datable. Should be investigated further.	T

+Permanent/Temporary
*A='a'ā C=Crest of 'a'ā ridge in NW

Kona vicinity at elevations similar to the project area, are few Radiocarbon data from a survey of a nearby 1,540-acre parcel is the most relevant to the current work (Hammatt et al. 1997). Hammatt's project area extended over eight *ahupua'a*, including Onouli, and the project produced two prehistoric radiocarbon ranges from sites at similar elevations to that found in the project area. One range was from the base of a terrace in a large lava tube with multiple internal features and petroglyphs (Site 10300). The other was from a blister (Site 16521) that functioned as a shelter or temporary habitation. The Site 10300 range was thought to post date construction of the terrace since the charcoal sample was thought to have filtered down through a matrix of rocks. The sample yielded a range of AD 1250-1480. The Site 16521 sample yielded a range of AD 1400-1650. It was thought that both ranges were related to agriculture in the general vicinity.

Burgett and Rosendahl's 1991 survey in Kealakekua, south of the project area (Burgett and Rosendahl 1991a), yielded one radiocarbon range that bears some relevance to the current work. The sample was from Site 14792, Feature D, a possible habitation terrace, and yielded a most probable range of AD 1390-1670. Based on the findings of previous archaeological work in the North to South Kona region, and based on the few previous radiocarbon ranges available from nearby areas, it is estimated that the current project area was under intense cultivation perhaps as early as the mid-13th century, and that cultivation extended through the mid-17th century and up into early historic times.

There are a number of historic to modern habitation sites, both permanent and temporary, in the project area, among them Sites 11278, 11285, 11286, 11290, 11297, 11310, and 11304. This indicates that some degree of habitation continued in the project area from prehistoric times up till the present. Much of the habitation was likely related to ranching and agriculture. According to Jean Greenwell (pers. comm., May 15, 2000), various members of the Greenwell family owned or leased parcels of land in Onouli and its vicinity for ranching from as early as the late 1800s to the 1980s. The locations and the sizes of the Greenwell ranchlands changed as parcels were added or subtracted over the years. Ms. Greenwell could not pinpoint the ranch headquarters but indicated the ranch extended from as far north as Keauhou 2 southward to Keopuka. A limited search of archival records by PHRI could not locate the headquarters, but records did indicate that W.H. Greenwell, H.N. Greenwell, J.B. Greenwell, and N.L. Greenwell all owned property in the near vicinity of the project area. Most of the historic walls in the project area are probably associated with the ranch and delineate pastures. As noted, some of the walls may consist of prehistoric field boundary walls that have been subsequently modified.

Two trails segments and a railroad bed in the project area have been assigned transportation functions. One trail segment, Site 11305, consists of steppingstones set across an 'a'ā flow and is oriented in an inland-seaward direction. This trail is probably a remnant of one of many prehistoric trails in the Kona area which were once used to move between coastal and inland areas. Apple (1965) classifies this trail as a Type A trail, a trail usually consisting of steppingstones of smooth waterworn *ala*; however, the steppingstones of Site 11305 consist of flat 'a'ā slabs. The other trail, Site 11313, consists of two portions. One portion consists of slabs and smooth round boulders which have been set flush in 'a'ā, and the other portion consists of an 'a'ā surface defined by alignments of round boulders. Site 11313 is also probably a prehistoric Type A trail. The railroad bed, Site 11328, is a former roadbed of the West Hawaii Railway Company. Built by the Kona Sugar Company (Conde 1973:87-89), the roadbed originally extended from Holualoa to Keopuka. Construction of the railroad began in 1901; the railroad was not in operation after 1926.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

Sites in the project area have been tentatively assessed for significance based on criteria established and promoted by the DLNR-SHPD and contained in the draft *Hawaii Administrative Rules 13§13-275-6*, dated October 1998 (*Table 2*). These significance evaluations and recommended general mitigation treatments should be considered as preliminary, subject to DLNR-SHPD concurrence. For resources to be considered significant they must possess integrity of location, design, setting, materials, workmanship, feeling, and association and meet one or more of the following criteria:

Table 2. General Significance Assessments and Recommended General Treatments

*SIHP	Significance Evaluations						Recommended Treatments			
Site No.	A	B	C	D	E	NLS	FDC	NFW	PID	PAI
11291	-	-	+	+	**	-	+	-	+	-
11302	-	-	+	+	+	-	+	-	+	-
11305	-	-	+	+	+	-	+	-	+	-
11312	-	-	+	+	+	-	+	-	+	-
11313	-	-	+	+	+	-	+	-	+	-
Subtotal	0	0	5	5	5	0	5	0	5	0
11328	-	-	+	-	-	-	+	-	+	-
Subtotal	0	0	1	0	0	0	1	0	1	0
11272	-	-	-	+	-	-	+	-	-	-
11273	-	-	-	+	-	-	+	-	-	-
11274	-	-	-	+	-	-	+	-	-	-
11275	-	-	-	+	-	-	+	-	-	-
11276	-	-	-	+	-	-	+	-	-	-
11277	-	-	-	+	-	-	+	-	-	-
11278	-	-	-	+	-	-	+	-	-	-
11279	-	-	-	+	-	-	+	-	-	-
11280	-	-	-	+	-	-	+	-	-	-
11281	-	-	-	+	-	-	+	-	-	-
11282	-	-	-	+	-	-	+	-	-	-
11283	-	-	-	+	-	-	+	-	-	-
11284	-	-	-	+	-	-	+	-	-	-

General Significance Categories:

A=Important for historical contribution to significant events and/or broad patterns of history

B=Important for association with the lives of important individuals in history

C=Excellent example of site type at local, region, island, State, or National level

D=Important for information content, further data collection necessary

E=Culturally significant

NLS=No longer significant; significant information collected; no further data collection necessary

Recommended General Treatments:

FDC=Further data collection necessary (detailed recording, surface collections, and limited excavations, possibly subsequent data recovery/mitigation excavations)

NFW=No further work of any kind necessary, sufficient data collected archaeological clearance recommended, no preservation potential

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

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

*SIHP=State Inventory of Historic Places numbers. SIHP numbers are five-digit numbers prefixed by 50-10-37 & -47 (50=State of Hawai'i; 10=Island of Hawai'i; 37&47=USGS 7.5' series quad map ["Kealakekua"&"Honaunau, Hawai'i]

**Provisional assessment; definite assessment pending further data collection (i.e., testing features for presence/absence of human skeletal remains)

Table 2. (cont.)

*SIHP	Significance Evaluations						Recommended Treatments			
Site No.	A	B	C	D	E	NLS	FDC	NFW	PID	PAI
11285	-	-	-	+	-	-	+	-	-	-
11286	-	-	-	+	-	-	+	-	-	-
11287	-	-	-	+	-	-	+	-	-	-
11288	-	-	-	+	-	-	+	-	-	-
11289	-	-	-	+	-	-	+	-	-	-
11290	-	-	-	+	-	-	+	-	-	-
11292	-	-	-	+	-	-	+	-	-	-
11293	-	-	-	+	-	-	+	-	-	-
11294	-	-	-	+	-	-	+	-	-	-
11295	-	-	-	+	-	-	+	-	-	-
11296	-	-	-	+	-	-	+	-	-	-
11297	-	-	-	+	-	-	+	-	-	-
11298	-	-	-	+	-	-	+	-	-	-
11299	-	-	-	+	-	-	+	-	-	-
11300	-	-	-	+	-	-	+	-	-	-
11301	-	-	-	+	-	-	+	-	-	-
11304	-	-	-	+	-	-	+	-	-	-
11306	-	-	-	+	-	-	+	-	-	-
11307	-	-	-	+	-	-	+	-	-	-
11308	-	-	-	+	-	-	+	-	-	-
11309	-	-	-	+	-	-	+	-	-	-
11310	-	-	-	+	-	-	+	-	-	-
11311	-	-	-	+	-	-	+	-	-	-
11314	-	-	-	+	-	-	+	-	-	-
11315	-	-	-	+	-	-	+	-	-	-
11316	-	-	-	+	-	-	+	-	-	-
11317	-	-	-	+	-	-	+	-	-	-
11318	-	-	-	+	-	-	+	-	-	-
11319	-	-	-	+	-	-	+	-	-	-
11320	-	-	-	+	-	-	+	-	-	-
11321	-	-	-	+	-	-	+	-	-	-
11322	-	-	-	+	-	-	+	-	-	-
11323	-	-	-	+	-	-	+	-	-	-
11324	-	-	-	+	-	-	+	-	-	-
11325	-	-	-	+	-	-	+	-	-	-
11326	-	-	-	+	-	-	+	-	-	-
11327	-	-	-	+	-	-	+	-	-	-
Subtotal	0	0	0	50	0	0	50	0	0	0
11303	-	-	-	-	-	+	-	+	-	-
Subtotal	0	0	0	0	0	1	0	1	0	0
Total	0	0	6	55	5	1	56	1	6	0

(1) Criterion "a". Be associated with events that have made an important contribution to the broad patterns of our history;

(2) Criterion "b". Be associated with the lives of persons important in our past;

(3) Criterion "c". Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value;

(4) Criterion "d". Have yielded, or is likely to yield, information important for research on prehistory or history;

(5) Criterion "e". Have an important traditional cultural value to the native Hawaiian people or to another ethnic group of the state due to associations with traditional cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity.

Based on the findings of the inventory survey, the archaeological remains found within the Onouli Subdivision project area appear to be, for the most part, significant for information content. Fifty of the 57 sites identified in the project area are assessed as being solely significant for information content (d). Further data collection is recommended for these 50 sites. One site is assessed as no longer significant and requires no further work (Site 11303, a wall). Of the six remaining sites, five (11291, 11302, 11305, 11312, and 11313) are assessed as being important for information content (d), as excellent examples of a site type (c), and as culturally significant (e) (provisional assessment for Site 11291 because the site may contain burials). Site 11291 includes platforms with possible burials, Site 11302 is a refuge and burial cave, Site 11312 is a fairly complex habitation cave system, and Sites 11305 and 11313 are trails. Further data collection and preservation with some level of interpretive development are recommended for these five sites. The final site (Site 11328), a historic railroad bed, is assessed as being an excellent example of a site type (c). Further data collection and preservation with some level of interpretive development is recommended for this site.

The evaluations and recommendations presented within this final report have been based on an inventory survey of the project area during which no test excavations were placed. As mentioned elsewhere in the survey report, dense vegetation over much of the project area made site identification and recording difficult. It is probable that the major features have been recorded in the project area; nevertheless, it should be noted that there is always the possibility, however remote, that potentially significant, unidentified surface structural remains, subsurface cultural deposits, or other cultural remains will be encountered in the course of future archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

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(Note: All other references in this section can be found in the reference section for PHRI Report 394-110588, for which this addendum has been prepared.)

APPENDIX I-2

Makai Area Archaeological Survey

Archaeological Inventory Survey and Limited Subsurface Testing of a 500-Acre Parcel in the *Ahupua'a* of Keopuka, District of South Kona Island of Hawai'i (TMK 3-8-1:06-11, 13-19)

by

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Cultural Surveys Hawaii
March 1995

ABSTRACT

An archaeological inventory survey with limited subsurface testing was conducted by Cultural Surveys Hawaii within the approximately 500-acre Keopuka Project Site (TMK 3-8-1:06-11, 13-19). The project area is located in the *ahupua'a* of Keopuka, district of South Kona, on the island of Hawai'i.

The survey and testing were conducted over a period of 34 days between January 22, 1992 and March 9, 1992. During the survey, 165 structural and nonstructural features were identified. The archaeological features were organized into 70 distinct sites. These sites are associated with a variety of functions, including traditional Hawaiian agriculture, habitation, burial, ritual, transportation, recreation, petroglyphs, and markers. Two historic-era transportation routes extend through the project area, across the width of Keopuka *ahupua'a*.

Limited subsurface testing was conducted at seven sites, including two permanent habitation sites, one temporary habitation site, three possible burial sites, and one lava tube utilized for habitation and burial placement. One human burial was identified at Site 50-10-47-1960 as a result of the testing.

Results of the inventory survey indicate a traditional Hawaiian settlement pattern typifying *ahupua'a* landuse on the leeward coast of Hawai'i, with the main permanent settlement centered on the coast - specifically on the south end. Intensive agriculture was practiced in the Upland Zone of Keopuka, but because of the dominant a'a flow that encompasses much of the land division, agricultural yield was likely low which is probably reflected in the apparently small population that occupied the coast.

Of the 70 sites recorded, 26 sites are recommended for preservation and 31 sites are recommended for data recovery. It is recommended that no further work is necessary for 13 sites that are deemed to be no longer significant.

ACKNOWLEDGMENTS

Field work for the Keopuka project required many days of intensive labor. The authors would like to thank Brian Colin, Ingrid Carlson, Edward Duncan, Matthew McDermott, and Stephen Whitworth for their hard work throughout the survey. We would also like to thank 1250 Oceanside Partners for their assistance and support throughout the entire project. Report figures were prepared by Brian Colin, Daria Creed and Bryce Myers.

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I. INTRODUCTION

A. Project Background

An archaeological inventory survey with limited subsurface testing was conducted by Cultural Surveys Hawai'i for 1250 Oceanside Partners within the approximately 660-acre Keopuka project area (Figures 1-4). The survey area is within the *ahupua'a* of Keopuka in South Kona District, Hawai'i Island.

The field work was conducted between January 22, 1992 and March 12, 1992 and was under the direct supervision of Mark Stride and the overall guidance of Dr. Hallett H. Hammatt.

The project area is located between the prominent bays of Kealakekua Bay to the south and Keauhou Bay to the north. The property surveyed by Cultural Surveys Hawai'i extends from sea level to approximately 800 ft. (244 m.) a.m.s.l. (above mean sea level). The actual boundaries of the project area are delineated by the coastline to the west, the *ahupua'a* of Onouli 2 to the north, the *ahupua'a* of Ka'awaloa to the south and the 800-foot contour to the east.

B. Scope of Work

The primary goal of the inventory survey was the identification of any and all cultural resources within the project area. The survey was designed to meet the requirements of the State Historic Preservation Division-Department of Land and Natural Resources (SHPD-DLNR). The Scope of Work included:

(1) A complete (100%) ground survey of the project area (as shown in Figure 4). All archaeological sites were located, described and mapped. Field documentation included photographs and scale drawings of most, if not all, of the sites. All sites were assigned state site numbers. Interpretive evaluations including the archaeological significance and recommended treatment of each site was evaluated.

(2) Limited subsurface testing was conducted to ascertain the presence or absence of human remains and intact cultural deposits, and to obtain datable samples for chronological information.

(3) Research on historic and archaeological background was done, including investigation of historic maps, written records, and Land Commission Award documents.

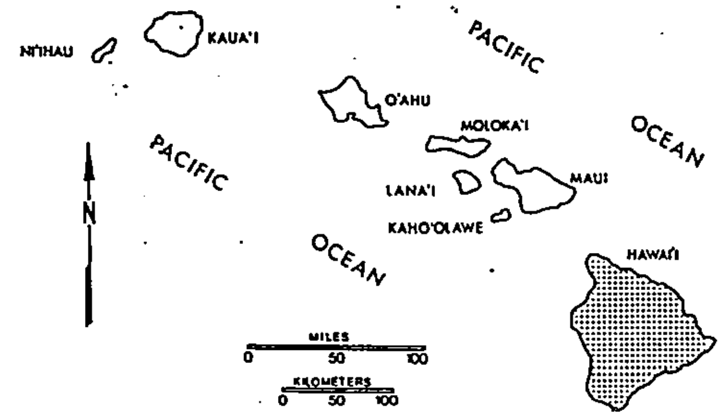


Figure 1 State of Hawai'i

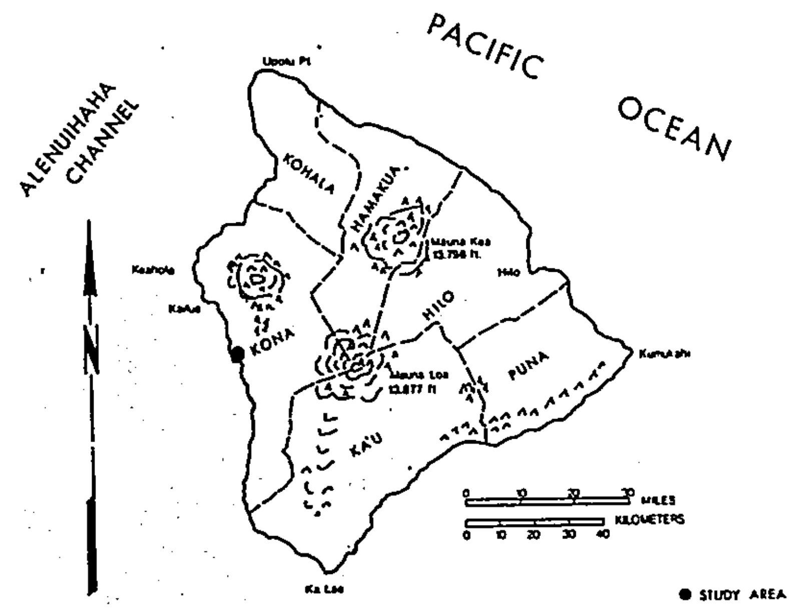


Figure 2 Hawaii Island Location Map

Figure 3 Portions of USGS 7.5 Minute Series Topographic Maps (Kealakekua and Honaunau Quads) Showing Project Area Location

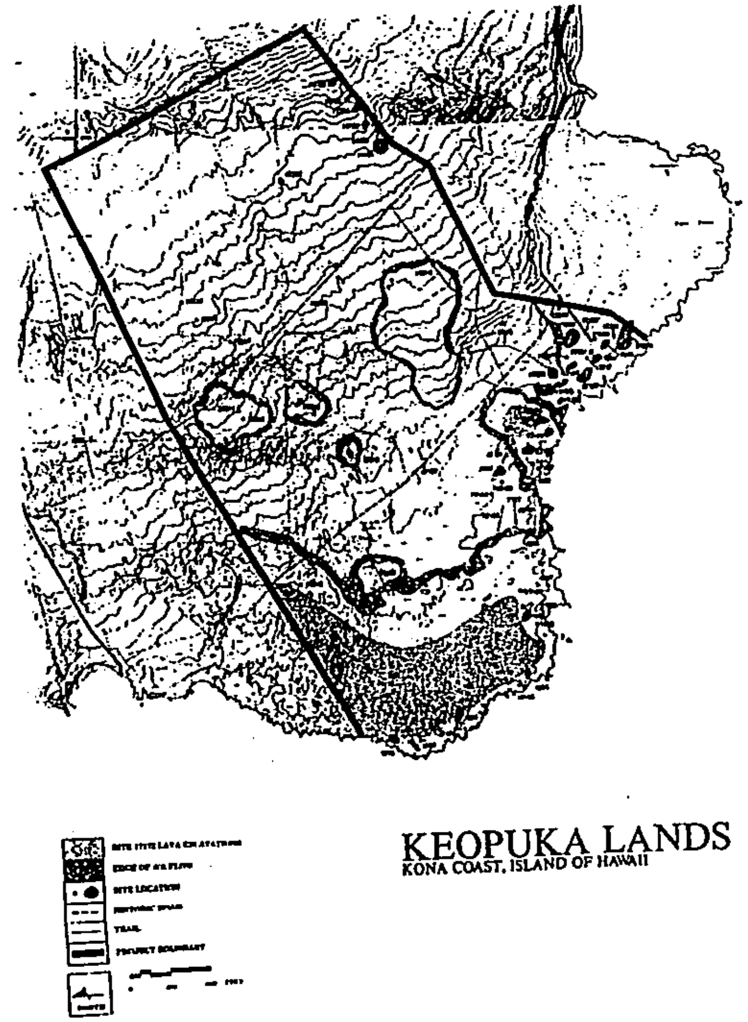


Figure 4 Project Area Map Showing Locations of Archaeological Sites

(4) Preparation of this survey report including the following:

a. A topographic map of the survey area showing all archaeological sites and site areas;
b. Description of all archaeological sites with selected photographs, scale drawings, and discussions of function;

c. Historical and archaeological background sections summarizing prehistoric and historic land use as they relate to the archaeological features;

d. A summary of site categories, their significance in an archaeological and historic context;

e. Recommendations based on all information generated which will specify what steps should be taken to mitigate impact of development on archaeological resources - such as data recovery (excavation) and preservation of specific areas. These recommendations will be developed in consultation with the landowner and the State and County agencies.

C. Methods

The field work was conducted by crews of between three to seven archaeologists and required a total of 136 person-days. Complete ground coverage of the project area was achieved by pedestrian sweeps which were spaced at equal intervals ranging from 10.0 m. to 30.0 m. (33.0 to 100.0 ft.) - depending on ground visibility which was generally excellent. The survey sweeps were oriented both *mauka/makai* (east/west) and cross-slope (north/south), depending upon the land form, nearby landmarks that would assist in plotting the sites on the topographic map, and available access roads. To ensure complete survey coverage of the project area, the outer sweep lines, which were not delineated by visible means (*i.e.*, historic walls), followed specific compass bearings which were marked with flagging tape so as to be clearly visible for adjoining sweeps.

All of the accessible lava tubes were examined throughout their full extent. However, access to one lava tube (Site 50-10-47-17235) was gained only via a 15 to 20 m. (49.2 to 65.6 ft.) drop from the ground surface to the tube floor. An effort was made to repel into the lava tube but there was no surface feature nearby to which a climbing rope could be secured. This cave was thus considered inaccessible to us and therefore only surface observations are reported. The main activity areas of all tubes except Site 50-10-47-17235, were mapped and described.

All of the archaeological sites were plotted on a 1 inch = 400 ft. (5 to 10 ft. contour) project area map. Sites were located on the contour map by using (in combination) a black-and-white aerial photograph, distinct topographical contours, and tape and compass measurements to known points.

Each site was described in detail and mapped to scale. Maps of all habitation sites appear in this report in either drafted form or as field copies. The majority of the sites were

photographed. Temporary site numbers (prefixed by CSH) and feature designations, if necessary, were assigned to each site or site complex. Yellow flagging tape labelled with the temporary site number and other pertinent information was tied above the site and/or a flag was placed directly onto the structure. Each site or individual feature was recorded by formal site type using descriptive categories (*i.e.*, mounds, platforms, enclosures, etc.) presented in the SURVEY RESULTS section of this report. Functional interpretation of sites were established on the basis of structural characteristics, spatial associations with other sites, and in some cases, associated artifacts as well as external correlations with other archaeological studies and interpretations in the general region. Significance and recommended treatment of each site was determined on the basis of type, complexity, configuration, apparent function, probable age, and comparable characteristics to other sites in the region.

During the field work, an effort was made to consolidate related features into complexes. Feature associations were typically based on the following considerations; proximity, similarity in construction technique, similarity in states of preservation, functional interrelationships, and inclusion within a larger, enclosing wall. In areas where a high site density was observed (specifically along the coast), feature associations were less obvious and proximity became the main factor for determining such associations.

Limited subsurface testing was conducted at seven sites. The testing was carried out at a selection of possible burials (Sites 50-10-47-1960, 50-10-47-17194, 50-10-47-17214), a lava tube (Site 50-10-47-17225), a rock shelter (Site 50-10-47-17199), and two habitation sites (Sites 50-10-47-1948 and 50-10-47-17197). The structures were tested using controlled excavation to the base of construction and/or cultural layer. Where soil was present, controlled excavation was extended to bedrock or culturally sterile soil layers with contents sifted through 1/8-inch mesh screens. Where soil and/or rock construction were excavated, profiles of excavation units were prepared, at least one profile per excavation unit. Where the human burial was encountered (at Site 50-10-47-17190), excavation was halted, the unit was back-filled, after appropriate notes and the profile were taken. Results of the subsurface testing are presented in the *Excavation Results* section of this report. All excavations units were back-filled and structures reconstructed.

Subsequent to the field work all sites were given SHPO (State Historic Preservation Office) site numbers. As a result of the inventory survey, 70 archaeological sites were identified on the property (Table 1).

Table 1 (continued)

State Site #	CSH Site #/Feature	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-1958	24/A	Irregular enclosure	Habitation (R)		
50-10-47-1958	24/B	Platform	Burial (possible)		
50-10-47-1958	24/C	C-shaped enclosure	Habitation (R)		
50-10-47-1959	29	C-shaped enc./pavement	Habitation (R)	D	Data recovery
50-10-47-1960	32	Complex	Burial; burials (possible)	C,E	Preservation
50-10-47-1960	32/A	Terrace	Burial (possible)		
50-10-47-1960	32/B	Platform	Burial (possible)		
50-10-47-1960	32/C	Terrace	Burial (possible)		
50-10-47-1960	32/D	Platform	Burial (possible)		
50-10-47-1960	32/E	Terrace	Burial		
50-10-47-1960	32/F	Terrace	Burial (possible)		
50-10-47-1960	32/G	Terrace	Burial (possible)		
50-10-47-1961	31	Complex	Habitation (R); modern hearth	D	Data recovery
50-10-47-1961	31/A	Irregular enclosure	Habitation (R)		
50-10-47-1961	31/B	Alignment	Modern hearth		
50-10-47-7727	26	Trail	Transportation	A,D	Data recovery
50-10-47-7728	38,42	Trail	Transportation	C,D,E	Preservation
50-10-47-10290	90	Trail	Transportation-"Old Govt. Rd."	A,C,D	Preservation
50-10-47-14185	87	Lava tube	Burial	E	Preservation
50-10-47-14186	none	Trail	Transportation	C,D,E	Preservation
50-10-47-14188	83	Complex	Habitation (P)	D	Data recovery
50-10-47-14188	83/A	Terrace	Habitation (P)		
50-10-47-14188	83/B	Lava tube	Habitation (P)		
50-10-47-14188	83/C	Lava tube	Habitation (P)		
50-10-47-14188	83/D	Terrace	Habitation (P)		
50-10-47-14188	83/E	Pavement	Habitation (P)		
50-10-47-14188	83/F	Terrace	Habitation (P)		
50-10-47-14190	84	Complex	Habitation (P); burial	D,E	Preservation
50-10-47-14190	84/A	Terrace	Habitation (P)		
50-10-47-14190	84/B	Pavement	Habitation (P)		
50-10-47-14190	84/C	Lava tube	Habitation (P); burial		

Table 1 - Keopuka Archaeological Inventory Survey: Summary of Sites

State Site #	CSH Site #/Feature	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-1948	5	Complex	Habitation (P)	C,D	Preservation
50-10-47-1948	5/A	Irregular enclosure	Habitation (P)		
50-10-47-1948	5/B	Terrace	Habitation (P)		
50-10-47-1948	5/C	Platform	Habitation (P)		
50-10-47-1948	5/D	Platform	Habitation (P)		
50-10-47-1948	5/E	Rectangular enclosure	Habitation (P)		
50-10-47-1948	5/F	Terrace	Habitation (P)		
50-10-47-1949	6	Complex	Heiau	D,E	Preservation
50-10-47-1949	6/A	Platform	Heiau		
50-10-47-1949	6/B	Pavement	Heiau (possible)		
50-10-47-1950	11	Complex	Habitation (R)	D	Data recovery
50-10-47-1950	11/A	Rockshelter	Habitation (R)		
50-10-47-1950	11/B	C-shaped enclosures	Habitation (R)		
50-10-47-1950	11/C	C-shaped enclosure	Habitation (R)		
50-10-47-1951	12	Platform	Habitation (T)	D	No further work
50-10-47-1952	16	Complex	Habitation (P); burial (possible)	D,E*	Data recovery/Poss. Preserve
50-10-47-1952	16/A	Platform	Burial (possible)		
50-10-47-1952	16/B	Platform	Habitation (P)		
50-10-47-1952	16/C	Pavement	Habitation (P)		
50-10-47-1952	16/D	Lava blister	Habitation (P)		
50-10-47-1952	16/E	Enclosure remnant	Habitation (P)		
50-10-47-1952	16/F	Pavement	Habitation (P)		
50-10-47-1952	16/G	Lava blister	Habitation (P)		
50-10-47-1953	19	Lava blister	Habitation (T)	D	Data recovery
50-10-47-1955	20	Complex	Habitation (R)	D	Data recovery
50-10-47-1955	20/A	Rectangular enclosure	Habitation (R)		
50-10-47-1955	20/B	Lava blister	Habitation (R)		
50-10-47-1955	20/C	Lava blister	Habitation (R)		
50-10-47-1956	22	Platform	Habitation (R)	D	Data recovery
50-10-47-1957	23	U-shaped enclosure	Habitation (R)	D	Data recovery
50-10-47-1958	24	Complex	Habitation (R); burial (possible)	D	Data recovery/Poss. Preserve

Table 1 (continued)

State Site #	CSH Site #/ Feature	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-17195	37	Complex	Habitation (P)	D	Preservation
50-10-47-17195	37/A	Rectangular enclosure	Habitation (P)		
50-10-47-17195	37/B	Pavement	Habitation (P)		
50-10-47-17195	37/C	Modified depression	Habitation (P)		
50-10-47-17917	39	Complex	Habitation (P)	C,D	Preservation
50-10-47-17197	39/A	Platform	Habitation (P)		
50-10-47-17197	39/B	Platform	Habitation (P)		
50-10-47-17197	39/C	Circular enclosure	Habitation (P)		
50-10-47-17197	39/D	Rectangular enclosures	Habitation (P)		
50-10-47-17197	39/E	Platform	Habitation (P)		
50-10-47-17197	39/F	Platform	Habitation (P)		
50-10-47-17198	40	Complex	Hab. (R); burial (possible); marker	D, E*	Data recovery/Poss. Preserve
50-10-47-17198	40/A	Platform	Burial (possible)		
50-10-47-17198	40/B	Pavement	Habitation (R)		
50-10-47-17198	40/C	Platform	Burial (possible)		
50-10-47-17198	40/D	Platform	Marker		
50-10-47-17199	41	Complex	Habitation (R)	D	Data recovery
50-10-47-17199	41/A	Terrace	Habitation (R)		
50-10-47-17199	41/B	Lava tube	Habitation (R)		
50-10-47-17201	43	Complex	Habitation (P)	D	Preservation
50-10-47-17201	43/A	Platform	Habitation (P)		
50-10-47-17201	43/B	Lava blister	Habitation (P)		
50-10-47-17201	43/C	Wall	Habitation (P)		
50-10-47-17201	43/D	Wall segment	Habitation (P)		
50-10-47-17201	43/E	Pavement	Habitation (P)		
50-10-47-17202	44	Complex	Habitation (P); burial (possible)	D,E*	Data recovery/Poss. Preserve
50-10-47-17202	44/A	Rectangular enclosure	Habitation (P)		
50-10-47-17202	44/B	C-shaped enclosure	Habitation (P)		
50-10-47-17202	44/C	Platform	Habitation (P)		
50-10-47-17202	44/D	Terrace	Habitation (P)		
50-10-47-17202	44/E	Mounds	Burial (possible)		

Table 1 (continued)

State Site #	CSH Site #/ Feature	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-14190	84/D	Wall segment	Habitation (P)		
50-10-47-14192	86	Lava tube	Burial	E	Preservation
50-10-47-17172	1	Lava excavations	Agriculture	D	Data recovery
50-10-47-17173	2	Ahu	Marker	D	No further work
50-10-47-17174	3	Trail	Transportation	D	Data recovery
50-10-47-17175	4	C-shaped enclosure	Habitation (T)	D	No further work
50-10-47-17178	10	Lava blister	Habitation (T)	D	No further work
50-10-47-17179	14	Petroglyph	Special	A,D	Preservation
50-10-47-17181	21	Lava blister	Habitation (T)	D	No further work
50-10-47-17182	15	Rectangular enclosure	Habitation (T)	D	No further work
50-10-47-17183	25	Trail	Transportation	D	Data recovery
50-10-47-17185	27	Trail	Transportation	D	Data recovery
50-10-47-17186	28	Lava blister	Habitation (T)	D	No further work
50-10-47-17188	30	Lava blister	Habitation (T)	D	Data recovery
50-10-47-17189	none	Trail	Transportation-"Old Cart Rd."	A,D	Data recovery
50-10-47-17191	33	Lava tube	Habitation (T)	D	Data recovery
50-10-47-17192	34	Complex	Habitation (P)	C,D	Preservation
50-10-47-17192	34/A	Terrace	Habitation (P)		
50-10-47-17192	34/B	Platform	Habitation (P)		
50-10-47-17192	34/C	Rectangular enclosure	Habitation (P)		
50-10-47-17192	34/D	Lava blister	Habitation (P)		
50-10-47-17193	35	Complex	Habitation (P)	C,D	Preservation
50-10-47-17193	35/A	Platform	Habitation (P)		
50-10-47-17193	35/B	Feature remnant	Habitation (P)		
50-10-47-17194	36	Complex	Habitation (R); burial (possible)	D,E*	Data recovery/Poss. Preserve
50-10-47-17194	36/A	Platform	Habitation (R)		
50-10-47-17194	36/B	Terrace	Habitation (R)		
50-10-47-17194	36/C	Modified outcrop	Habitation (R)		
50-10-47-17194	36/D	Platform	Burial (possible)		
50-10-47-17194	36/E	Rockshelter	Habitation (R)		
50-10-47-17194	36/F	Lava tube	Burial (possible)		

Table 1 (continued)

HI State Site #	CSH Site #/ Feature #	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-17209	57/B	Ahu	Marker		
50-10-47-17209	57/C	Alignment	Marker		
50-10-47-17209	57/D	Ahu	Marker		
50-10-47-17209	57/E	Ahu	Marker		
50-10-47-17210	59	Wall segment	Indeterminate	D	No further work
50-10-47-17211	60	Lava tube	Habitation (T)	D	No further work
50-10-47-17212	61	Lava tube	Habitation (T)	D	No further work
50-10-47-17213	63	Lava tube	Habitation (T)	D	Data recovery
50-10-47-17214	65	Platform	Marker	D	No further work
50-10-47-17215	66	Ahu	Marker	D	No further work
50-10-47-17216	67	Complex	Habitation (R); Transportation	D,E	Preservation
50-10-47-17216	67/A	Irregular enclosure	Habitation (R)		
50-10-47-17216	67/B	Trail	Transportation		
50-10-47-17217	68	Lava tube	Habitation (R); burial	D,E	Preservation
50-10-47-17218	72	Lava tube	Habitation (T)	D	Data recovery
50-10-47-17219	73	Complex	Habitation (R)	D	Data recovery
50-10-47-17219	73/A	Lava tube	Habitation (R)		
50-10-47-17219	73/B	Terrace	Habitation (R)		
50-10-47-17220	74	Lava blister	Habitation (R)	D	Data recovery
50-10-47-17221	75	Complex	Habitation (P)	D	Data recovery
50-10-47-17221	75/A	Pavement	Habitation (P)		
50-10-47-17221	75/B	Enclosure remnant	Habitation (P)		
50-10-47-17221	75/C	Wall	Habitation (P)		
50-10-47-17222	76	Rectangular enclosure	Habitation (P)	D	Data recovery
50-10-47-17224	80	Complex	Habitation (R); burial	D,E	Preservation
50-10-47-17224	80/A	Modified sink	Habitation (R)		
50-10-47-17224	80/B	Lava tube	Burial		
50-10-47-17225	81	Complex	Habitation (P); burial	D	Preservation
50-10-47-17225	81/A	Lava tube	Habitation (P); burial		
50-10-47-17225	81/B	Terrace	Habitation (P)		
50-10-47-17225	81/C	Platform	Habitation (P)		

Table 1 (continued)

HI State Site #	CSH Site #/ Feature #	Formal Site or Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-17202	44/F	C-shaped enclosure	Habitation (P)		
50-10-47-17202	44/G	Terrace	Burial (possible)		
50-10-47-17202	44/H	Pavement	Habitation (P)		
50-10-47-17202	44/I	L-shaped enclosure	Habitation (P)		
50-10-47-17203	45	Complex	Habitation (P)	C,D	Preservation
50-10-47-17203	45/A	Wall	Habitation (P)		
50-10-47-17203	45/B	Platform	Habitation (P)		
50-10-47-17203	45/C	Enclosure remnant	Habitation (P)		
50-10-47-17203	45/D	Pavement	Habitation (P)		
50-10-47-17203	45/E	Rectangular enclosure	Habitation (P)		
50-10-47-17204	46	Platform	Burial (possible)	E*	Poss. Preserve
50-10-47-17205	48	Complex	Burial (possible); Special	C,D,E*	Preservation
50-10-47-17205	48/A	Platform	Burial (possible)		
50-10-47-17205	48/B	Platform	Burial (possible)		
50-10-47-17205	48/C	Terrace	Burial (possible)		
50-10-47-17205	48/D	Platform	Burial (possible)		
50-10-47-17205	48/E	Platform	Burial (possible)		
50-10-47-17205	48/F	Wall	Boundary		
50-10-47-17205	48/G	Petroglyph	Special		
50-10-47-17205	48/H	Platform	Burial (possible)		
50-10-47-17205	48/I	Platform	Burial (possible)		
50-10-47-17206	50	Pavement	Habitation (P)	D	Data recovery
50-10-47-17207	52	Holua slide	Recreation	B,C,D,E	Preservation
50-10-47-17208	54	Complex	Habitation (P)	D	Preservation
50-10-47-17208	54/A	Platform	Habitation (P)		
50-10-47-17208	54/B	Wall	Habitation (P)		
50-10-47-17208	54/C	Platform	Habitation (P)		
50-10-47-17208	54/D	Platform	Habitation (P)		
50-10-47-17208	54/E	Pavement	Habitation (P)		
50-10-47-17209	57	Complex	Transportation; Marker	D	Data recovery
50-10-47-17209	57/A	Trail	Transportation		

Table 1 (continued)

Site/SIHP #	CSH Site #/Feature	Formal Site/Feature Type	Interpreted Function	Preliminary Significance	Recommended Treatment
50-10-47-17225	81/D	Terrace	Habitation (P)		
50-10-47-17228	88	Complex	Agriculture	D	Data recovery
50-10-47-17228	88/A	Terrace	Agriculture		
50-10-47-17228	88/B	Terrace	Agriculture		
50-10-47-17228	88/C	Terrace	Agriculture		
50-10-47-17228	88/D	Terrace	Agriculture		
50-10-47-17229	89	Lava tube	Burial	E	Preservation
50-10-47-17234	85	Modified outcrop	Habitation (T)	D	No further work
50-10-47-17235	64	Complex	Habitation (R); burial	D,E	Preservation
50-10-47-17235	64/A	Lava tube	Habitation (R); burial		
50-10-47-17235	64/B	Lava tube	Indeterminate		

*KEY:

(P) Permanent
(R) Recurrent
(T) Temporary

A Site reflects major trends or events in the history of the state or nation
B Site is associated with the lives of persons significant in the past
C Site is an excellent site type
D Site is likely to yield information important to prehistory and history
E Site has cultural or religious significance - including burials (E* = possible burials)

II. NATURAL SETTING

The project area consists of approximately 500 acres in the traditional land division, or *ahupua'a*, of Keopuka, in the district of South Kona on the island of Hawai'i. It is situated on the lower western flank of Mauna Loa, between sea level and 800 feet above mean sea level (a.m.s.l.). The project area terrain is predominately exposed lava flows, relatively flat along the coast and gently to moderately sloping elsewhere. The coastal portion of the project area includes the landform identified as Keawekaheka Point on the northern end and a portion of the landform known as Kaawaloa Flat on the southern end.

The climate in Keopuka is typical for the leeward Kona region where rain showers develop generally in the afternoons brought on by warm air moving inland by light sea breezes. The humid air gradually condenses over higher altitudes throughout the day. At night the land cools creating breezes which send warm air back out to sea. Rainfall averages in the project area range between 40 and 50 inches a year, with generally lighter rainfall at the coast and heavier rainfall in the uplands of the *ahupua'a* (Armstrong, 1973:57). No natural springs or perennial streams are present within the project area.

The project area consists of three different land types. According to the *Soil Survey of Island of Hawai'i, State of Hawai'i* (Sato *et al.* 1973:Sheets 111 and 121), these three land types are; Pahoehoe Lava Flows along the coast, a'a Lava Flows throughout the central portion, and a'a lava overlain by a thin layer of soil within the upper elevations. The Pahoehoe lava forms the flatland on the northern end of the coast, at Keawekaheka Point, and forms smaller pockets (*kipuka*) within the a'a flows of the southern end of the coast. The Pahoehoe lava extends inland from the coast a maximum of 2800 feet. A'a lava forms the majority of the project area land surface, extending from the coast at several points to the inland (or eastern) boundary of the project area, at approximately 7900 feet from the shoreline at Keawekaheka Point. At several points along the inland boundary of the project area, the a'a lava is overlain by a thin layer of soils characterized as *Kaimu Extremely Stony Peat* (*ibid.*:22), which continues inland to roughly 12,000 feet from the coast. There are also small, scattered, shallow soil deposits located in depressions among the undulations of the lava flows throughout the project area.

The majority of the project area, as exposed lava flows, contains very little vegetation. That which is present is within the upper elevations where soil is more prevalent, isolated along the shoreline and in small intermittent soil deposits within the lava flows. Within the lower elevations, exotic vegetation includes *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena glauca*), and guinea grass (*Panicum maximum*). Indigenous or Polynesian-introduced species include coconut (*Cocos nucifera*) and some *noni* (*Morinda citrifolia*). Within the upper elevations, exotic species of vegetation dominate, and include; Christmas-berry (*Schinus terebinthifolius*), *koa haole* (*Leucaena glauca*) and guinea grass (*Panicum maximum*). Other less prevalent exotic species include guava (*Psidium guajava*) and lantana (*Lantana camara*). Indigenous or Polynesian-introduced species - observed in considerably fewer numbers - include *'Ohi'a* (*Metrosideros polymorpha*), *noni* (*Morinda citrifolia*), *kukui* (*Aleurites moluccana*), *ti* (*Cordyline terminalis*), and scattered stands of *'ilima* (*Sida fallax*).

III. BACKGROUND STUDIES

A. Historic Background

Direct evidence of the historic background of Keopuka *ahupua'a* is scant. The sources that provide the clues necessary for understanding late prehistoric and early historic land use and settlement patterns in the *ahupua'a* of Kona contain virtually no specific references to Keopuka.

As a result, the historic background of Keopuka can only be inferred from that of nearby lands. The *ahupua'a* of Ka'awaloa, for example, which borders Keopuka to the south is frequently mentioned in historic sources. Ka'awaloa forms the northern border of Kealakekua Bay and, as such, figures prominently in the historical developments that occurred there. Scattered among the many references to Ka'awaloa, are clues to the late prehistoric and early historic land use of these and surrounding lands including, by inference, Keopuka.

The following historical background is presented through a discussion of four time periods: (1) The Late Prehistoric/Contact Period; (2) The Early Historic Period; (3) The Mid to Late Nineteenth Century; and (4) The Twentieth Century.

Late Prehistoric/Contact Period

In late prehistoric times, the Kealakekua Bay area was a populous and politically important one; it was the home of several Hawai'ian *ali'i*, and it was a traditional Hawai'ian religious center containing religious complexes and several large *heiau*.

Many of the historical references to Ka'awaloa reflect its proximity to Kealakekua Bay. Ka'awaloa is identified as having been the residence of specific Hawai'ian royalty, such as Kalaniopu'u, one of the ruling chiefs of Hawai'i Island at the time of European contact, his son Naihe, and Naihe's wife, Kapiolani. Kapiolani, who became the dominant chiefess of this region after the death of Naihe in 1831, was one of the early royal converts to Christianity and was known as a great supporter of missionary activities in the Kealakekua region and throughout the North and South Kona Districts. Her support of missionary activities contributed to the establishment of a mission station and missionary residences in Ka'awaloa beginning in the 1820s (Kamakau 1992:381-2).

The Hawai'ian scholar and historian, Samuel Kamakau, also identified Ka'awaloa as the burial place of Keoua, the father of Kamehameha I, and the resting place of other chiefs. Kamakau related that the remains of some of these chiefs were deposited in the cliffs of Ka'awaloa (the *pali*) by Kuhina-nui (Elizabeth) Kaahumanu. Kaahumanu, like Kapiolani, was also an early royal convert to Christianity and, in an effort to prevent the deification of the bones of deceased chiefs by chiefs and commoners still loyal to traditional Hawai'ian religious practices, had them removed from their original burial places and redeposited in the less accessible cliffs of Ka'awaloa (Kamakau 1992:322).

Ka'awaloa also figures prominently in the tale of Captain Cook's visit to Kealakekua Bay and his untimely demise there. It was off the coast of Ka'awaloa that Cook landed his ship in 1779, it was on the shore of Ka'awaloa where Cook's men fought with the local

inhabitants, and it was among the cliffs of Ka'awaloa to which Cook's body was secreted away after he was killed. Since that time, the shoreline at Ka'awaloa has been associated with Cook's death, and the monuments erected there to his memory has drawn visitors since early in the nineteenth century.

<u>Accounts of Foreign Visitors</u>

Descriptive accounts written by early foreign visitors to the Kealakekua region provide some important clues to the late prehistoric and early historic settlement of the region, for although none could be found that mention Keopuka specifically, there are several that provide some descriptions of the landscape nearby Keopuka and hints to the traditional settlement pattern imposed upon it. Two of the early historic accounts that name Ka'awaloa specifically include one written by Archibald Menzies, a surgeon and naturalist who served on the H.M.S. Discovery from 1792-94; and another by William Ellis, a missionary and explorer who toured the Island of Hawai'i in 1823.

While his ship was in port at Kealakekua Bay, Menzies arranged an escorted tour of the uplands above Kealakekua Bay. He mentioned the village of Ka'awaloa, and directly in back of it he and his company travelled up the *pali* "over a dry, barren, rocky country up a steep ascent" (Menzies 1920:74). Once on the top of the *pali*, he described the country and the villages to the south.

> The tract which extended along shore, if we might judge from its appearance and our knowledge of that which we had already travelled over, we were ready to pronounce a dreary naked barren waste; if we accept a few groves of cocoa palms here and there near the villages. But that which stretched higher up along the verge of the woods from the manner in which it was industriously laid out in little fields, exhibited a more pleasing and fertile appearance (*ibid*:74).

Continuing further upland, Menzies encountered plantations of breadfruit trees with sweet potatoes and rows of cloth plants (*wauke*) planted between them. Beyond these plantations, he found that,

> the country became more and more fertile, being in a high state of cultivation. For several miles around us there was not a spot that would admit of it but what was with great labor and industry cleared of the loose stones and planted with esculent roots or some useful vegetables or other (*ibid*:75).

Menzies group continued up the slope "to the verge of the woods", where they found two or three huts which were inhabited (*ibid*:76).

Ellis' tour of Hawai'i passed through the Kealakekua region about thirty years after Menzies' tour of the uplands, mostly following along the coast through the more heavily populated villages. Ellis did not provide much in the way of description of Ka'awaloa or the surrounding landscape, but he did provide some evidence indicating that the area was a productive and populous one. In one day Ellis and his company travelled from the village of Keauhou to the village of Ka'awaloa. On that day he recorded having seen 443 houses and eight heiau. At Ka'awaloa, Ellis discussed the tale of Captain Cook's visit and demise, and hiked up to the cliff northeast of the village to visit the site where Cook's bones were presumed to have been taken. On the following day, he continued southward toward Kealakekua, which he described as consisting of a number of villages along the southern shore of Kealakekua Bay with a considerable population (Ellis 1969:121-140).

Late Prehistoric/Contact Period Land Use

The traditional settlement pattern of the Kona region, as observed by Menzies and other early visitors, consisted essentially of coastal residents who exploited both marine resources, primarily through fishing and gathering; and terrestrial resources, primarily through intensive agriculture, within specific traditional land divisions, or *ahupua'a*. Each *ahupua'a* was governed by either a chief, chiefess or their agent, a *konohiki*. The commoners who lived within the *ahupua'a*, the *maka'ainana*, secured their own livelihoods there and produced the surplus that maintained the traditional Hawai'ian hierarchical political system.

> An *ahupua'a* contained all the elements necessary to sustain life in ancient Hawai'i. Most of the population lived in the coastal areas, where the sea provided food, transportation, and recreation; inland areas were farmed for additional food sources, and clothing and housing materials were secured there. (Alvarez 1990:1.1)

Since *ahupua'a* are generally comprised of a strip or wedge of land extending from the coast to the upland forests, a variety of ecological conditions are present within each, with varying elevations, rainfall and soil conditions. Traditional agricultural productivity was maximized through the adaptation of specific crops and specific agricultural practices to the varying ecological and topographical conditions present within each *ahupua'a* between the coast and the upland forests. Recent research has identified four distinct ecological subzones in the Kona region which follow rainfall gradients generally predicted by elevation. The landscape modifications attributed to the traditional agricultural exploitation of these subzones is sometimes labelled as the Kona Field System, and designated site 50-10-37-6601.

Kona Field System

The classification of the four subzones of the Kona Field System was initially introduced by T. Stell Newman (1970) with subsequent contributions by Marion Kelly (1983). Newman defined the subzones using aerial photography in correlation with historic accounts of early visitors to Hawai'i. Kelly's subsequent research of the Native Claims Registers (from 1846 to 1848) provided Hawai'ian names of the subzones and, based on reported claims, what types of traditional or historic crops were cultivated in each. In *Subsistence and Conflict in Kona Hawai'i*, Rose Schilt presents a comprehensive summary of the subzones correlating Newman's and Kelly's studies with rainfall data compiled during her research (Schilt 1984:6). The classifications on the following page are based on Schilt's compiled data:

Kula Subzone/Coastal Area
Elevation: Sea level to 500 ft. (0 to 150 m.)
Annual Rainfall: c. 30-50 in. (0.8-1.2 mm.)
Late Prehistoric crops: Sweet potatoes, gourd, and *wauke*.

Kaluulu Subzone/Seaward Slope
Elevation: 500-1000 ft. (c. 150-300 m.)
Annual Rainfall: c. 40-55 in. (1.00-1.35 mm.)
Late Prehistoric Crop: Breadfruit, with sweet potatoes and *wauke* interspersed; mountain apple and some taro.

'Apa'a Subzone/Upland Slope
Elevation: 1000-2500 ft. (300-750 m.)
Annual Rainfall: c. 55-80 in. (1.35-2.00 mm.)
Prehistoric Crop: Taro, sweet potatoes, *ti*, and sugarcane.

'Ama'u Subzone/Upland Jungle
Elevation: 2500-4000 ft. (750-1200 m.)
Annual Rainfall: c. 80 in. (2.0 mm.)
Prehistoric Crops: Bananas and plantains

Note: Historic period crops were also cultivated in the *kaluulu* and *'apa'a* subzones and to a lesser degree in the *kula* subzone. These crops included cabbage, melons, onions, oranges, tobacco, beans, coffee, corn, cotton, pineapple, Irish potatoes, and pumpkin.

The area of the Kona Field System was estimated by Newman to have been eighteen miles long between Kailua and Kealakekua Bay and extending three miles inland from the coast. Although there is some interesting debate over whether this entire area should be regarded as belonging to one "system", and if so, whether the limits of the system should be expanded or reduced, historical and archaeological evidence indicates that the range of agricultural features commonly associated with the Kona Field System can be found within the *ahupua'a* that comprise the Kealakekua Bay region.

Land Use in Keopuka

As mentioned at the beginning of this section, evidence of traditional subsistence and settlement within Keopuka *ahupua'a* is virtually nonexistent within the historic sources consulted. These sources include the oral traditions and histories recorded by Fornander, I'i, and Kamakau; the accounts of early foreign visitors and residents; missionary records; and records associated with the Mahele which, although from the 1850s, reflect remnants of traditional land use. It is assumed, however, that the native residents of Keopuka in late prehistoric times followed similar settlement patterns and engaged in the same range of activities that was documented for the inhabitants of nearby lands, although the lack of specific references to Keopuka might imply that very few native Hawai'ians made Keopuka their home.

The Early Historic Period

In the 1820s, when William Ellis was touring the Island of Hawai'i, Kealakekua Bay was a populous area with clusters of houses along the coast and extensively cultivated uplands. Nevertheless, Ellis and other visitors noticed that the Kona region was at one time even more populous. Ellis commented that "the number of heiaus and depositories of the dead, which we passed, convinced us that this part of the island must formerly have been populous" (Ellis 1969:116). Captain Charles Wilkes made a similar observation in 1845, referring to the Kailua area he wrote that "the ground has the appearance of having once been more extensively cultivated than it is at present" (Quoted in Schilt 1984:8).

These observations reflect one of the most significant changes which occurred in the Hawai'ian Islands in the decades following European contact; a drastic decline in the population of the native inhabitants, primarily due to deaths from introduced diseases.

In 1823, William Ellis estimated the population of the Hawai'ian islands to have been 130,000 to 150,000, with 85,000 living on Hawai'i. A missionary estimate from the same year reported the population of all islands at 140,000, also with 85,000 on the island of Hawai'i. More formalized census figures were reported by missionaries for the years 1832, 1836 and 1850. Although these figures are not considered to be strictly accurate, they clearly show an overall and dramatic reduction of the Hawai'ian population over the years reported. The census totals for all islands are 130,000 in 1832, 108,000 in 1836 and 84,000 in 1850 (Schmitt 1973:8). Between 1831 and 1835 in North Kona, this trend was apparent to one missionary who wrote:

> In these past four years, the people of North Kona have diminished 692 less than those previously counted. 692 more persons died than were born. A tenth of the adults have died in the four years. If perhaps the people who come after are diminished at the same rate, the people of Hawai'i will be finished and the land will be empty!! (Quoted in Schmitt 1973:31)

Missionary census data from 1835 indicate a combined total population of Keopuka and Ka'awaloa at 462 persons (Schmitt 1973:29). This represents slightly less than 10% of the population of South Kona, estimated to have totalled 4997 men, women and children in 1835. By 1860, the population total of the South Kona District was estimated to have been reduced to 2683 persons (Schmitt 1977:12-13), a reduction of 46% over a 25 year period. Applied to the 1835 population estimate for Ka'awaloa and Keopuka, it is likely that by 1860, the combined population of Keopuka and Ka'awaloa was somewhere around 214 persons.

Another change associated with the new foreign visitors and residents in early historic times was the introduction of non-traditional crops. Introduced crops were observed to include cabbage, onions, oranges, melons and tobacco. Between 1825 and 1850 local subsistence farming began to shift to a market economy with the further introduction of beans, coffee, corn, cotton, pineapple, Irish potatoes and pumpkin (Schilt 1984:6,24). In many places, these new crops were simply cultivated within the pre-existing field system.

Exotic vegetation, such as Mesquite or *kiawe*, introduced by Father Bachelot about 1828 (Merlin, 1977:13), and *koa haole* introduced before 1837 (Cuddihy and Stone, 1990:85), also began to alter the Kona landscape in early historical times by contributing to the development of coastal forests, leading to increased ground cover, dew and probably rain.

Other important shifts within the field system were effected with the spread of feral ungulates throughout the island, including goats, sheep and cattle. Brought to Hawai'i in 1794, cattle foraged wild in the uplands, and their population increased to such an extent that they soon became a nuisance to farmers, spurring the construction of walls to keep cattle out of agricultural fields and house lots. The Kuakini Wall, State site 50-10-37-6302, was constructed early in the 19th century, in part, to keep feral cattle, goats and pigs *mauka* of Kona's coastal settlements.

Early Historic Land Use

These early historic changes only gradually came to alter land use and settlement patterns in the Kealakekua Bay region, for despite the ever-increasing political and economic influence foreigners were acquiring in the Kealakekua Bay region, and throughout all of Hawai'i in early historic times, the use of the land seems to have remained essentially the same from late prehistoric times until after the land divisions of the Great Mahele in the 1850s. Although diminishing in numbers, most of the native Hawai'ians continued to live along the coast and participate in the same kinds of traditional subsistence activities as they had in late prehistoric times. In her study of land use in Ka'awaloa, Alvarez wrote,

> at the time of the Great Mahele [1848], Ka'awaloa was a Hawai'ian village, and the land was being used in a traditional manner. While maintaining its ethnicity, however, it retained little else. Its political role was eclipsed, its population and economic significance were on the decline... (Alvarez 1990:4.2)

The presence of new foreign residents at Kealakekua Bay in early historic times, particularly the missionaries associated with the mission station established there in 1824, created new forces that would eventually alter settlement patterns in the region, but in early historic times, traditional settlement patterns persisted. After 1831, for example, the mission station at Kealakekua Bay was moved from the coast to an area called Kuapehu, located above the *pali* at Ka'awaloa. Eventually, "a village had developed... out of the temporary lodgings of the missionaries there. Kapiolani and Naihe followed them [the missionaries] there, which induced the maka'aina to do the same" (Alvarez 1990:4.10). By 1838 though, a new church was built near the coast at Kepulu, near Napo'opo'o, and the village at Kuapehu was abandoned soon after. Church officials recognized that at that time the village of Kuapehu on the *pali* was not going to last, citing one of the reasons as "the majority of them [the natives] prefer the shore" (quoted in Alvarez 1990:3.7).

Trails and Roads

One of the more visible changes in land use related to the increase of foreign residents and visitors was the development of new roads and trails and/or the improvement of pre-existing ones. As Alvarez noted, "the presence of the Protestant missionaries in the 1820s and 1830s had resulted in significant overland transportation development" (Alvarez 1990:4.5).

Some of the improved trails or roads that radiated out from the Kealakekua Bay area crossed into or passed through Keopuka.

One of these was a trail identified by Russell Apple (1973:15) on his *circa* 1750 map (Figure 5) as an "AB" trail (a foot and horse trail) that followed close to the coast and connected the village at Ka'awaloa to Keawekaheka. This trail was originally a footpath and later upgraded for horses, but subsequently fell into disuse (Alvarez 1993:3.33) and does not appear on Apple's *circa* 1850 map (Figure 5). This trail has not been correlated to any known archaeological sites.

A second improved trail that passes through Keopuka is the "horse trail" connecting Ka'awaloa village to Kailua which traverses the *ahupua'a* between 75 feet and 100 feet a.m.s.l. This is the same road identified as a "C" trail (a refined horse trail) on Apple's *circa* 1875 map (Figure 5); and corresponds to the "old cart road" on the current tax map (Figure 6) and the "4WD" road on the current USGS map (see Figure 3). Alvarez, in her research of trails and roads in Ka'awaloa, identified this as the road built by Governor John Adams Kuakini in 1836, and described as "bordered by the smooth steppingstones of a still older trail" (Alvarez 1993:3.34). During the course of the present inventory survey, site number 17189 was assigned to this road.

Another historic road traverses Keopuka roughly parallel with, but further inland from the "old cart road" mentioned above. This road lies at approximately 500 feet a.m.s.l. along the southern boundary of the present project area, and at 350 feet a.m.s.l. along the northern boundary. This road was not included on any of Apple's maps (probably because those maps focused on the immediate vicinity of Kealakekua Bay), but is identified on the current tax map as the "old government road from Kealakekua pali to Kainaliu." This road is considered to be the same as site 10290, the road that runs through the *ahupua'a* of Honuaino, Hokukano, Kanaueue, Haleki'i, and Ke'eke'e, located to the north (sometimes referred to as the "King's Trail"). Site 10290 was identified as an historic site in 1984 during a PHRI reconnaissance survey of those lands for the Pu'u Ehu Estates Project Area (Kaschko 1984), and subsequently assigned state site number 10290. Site 10290 also appears to be the same as site 14754 identified during the 1991 PHRI inventory survey in Ka'awaloa (Walker *et al.* 1991).

The latter two roads discussed above (sites 17189 and 10290) originate from the "cart road" that ran from the coast, up the pali, and into to the uplands of Ka'awaloa. Alvarez describes this as "the cart road built up the side of the pali to Kuapehu," and noted that,

> this road, built in the late 1820s by those who violated the Christian marriage laws, was maintained until the end of the century, and became south Kona's most important road. It probably contributed more than any other facility to Ka'awaloa's significance at mid-century. The cart path was an improvement of an ancient footpath up and along the pali... (Alvarez 1990:4.5)

This road is identified on Apples' *circa* 1850 map as a "D" trail (a "C" trail improved for carts, carriages or cars) and on Apples *circa* 1875 map as "Cart Road" (see Figure 5). This road is referred to as the "Ka'awaloa Road" on the tax map, and as simply a "4WD" road on the USGS map. This road corresponds to site 14176, identified during the PHRI inventory survey in Ka'awaloa (Walker *et al.* 1991).

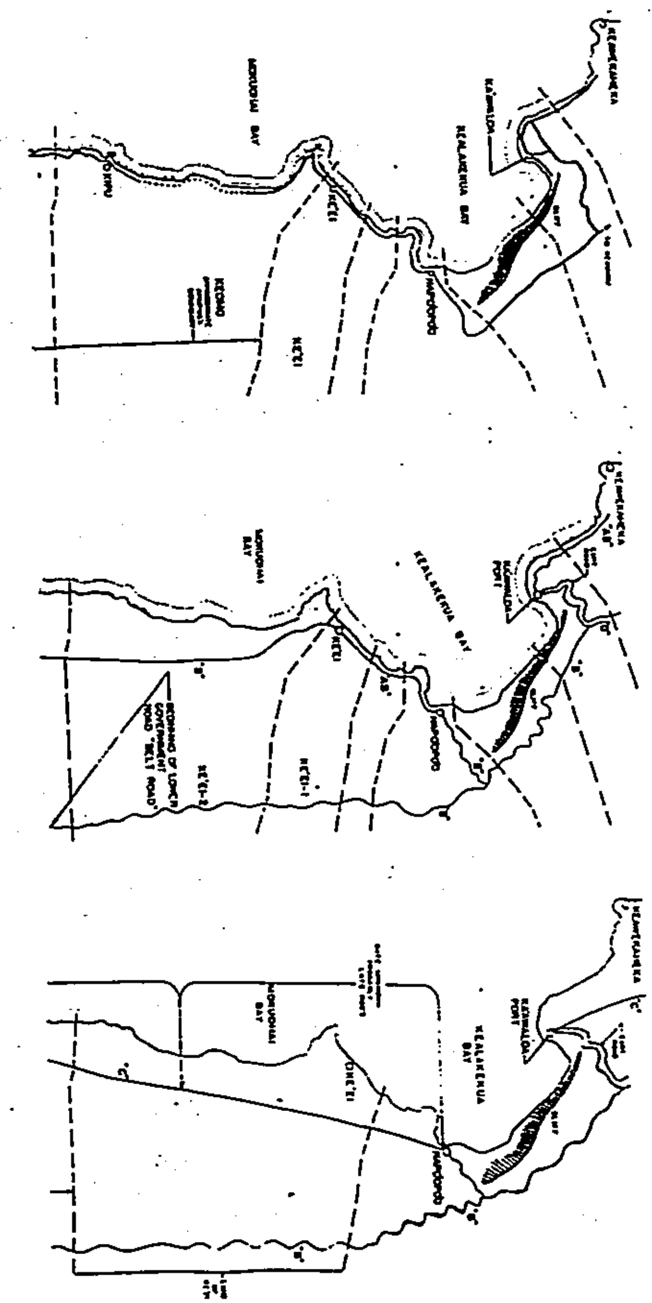


Figure 5 Maps Showing the Evolution of Trails and Roads in the Vicinity of Kealakekua Bay; *circa* 1750, *circa* 1850 and *circa* 1875 (From Apple 1973:14,15,16 - Portions of Figures 7, 8 & 9)

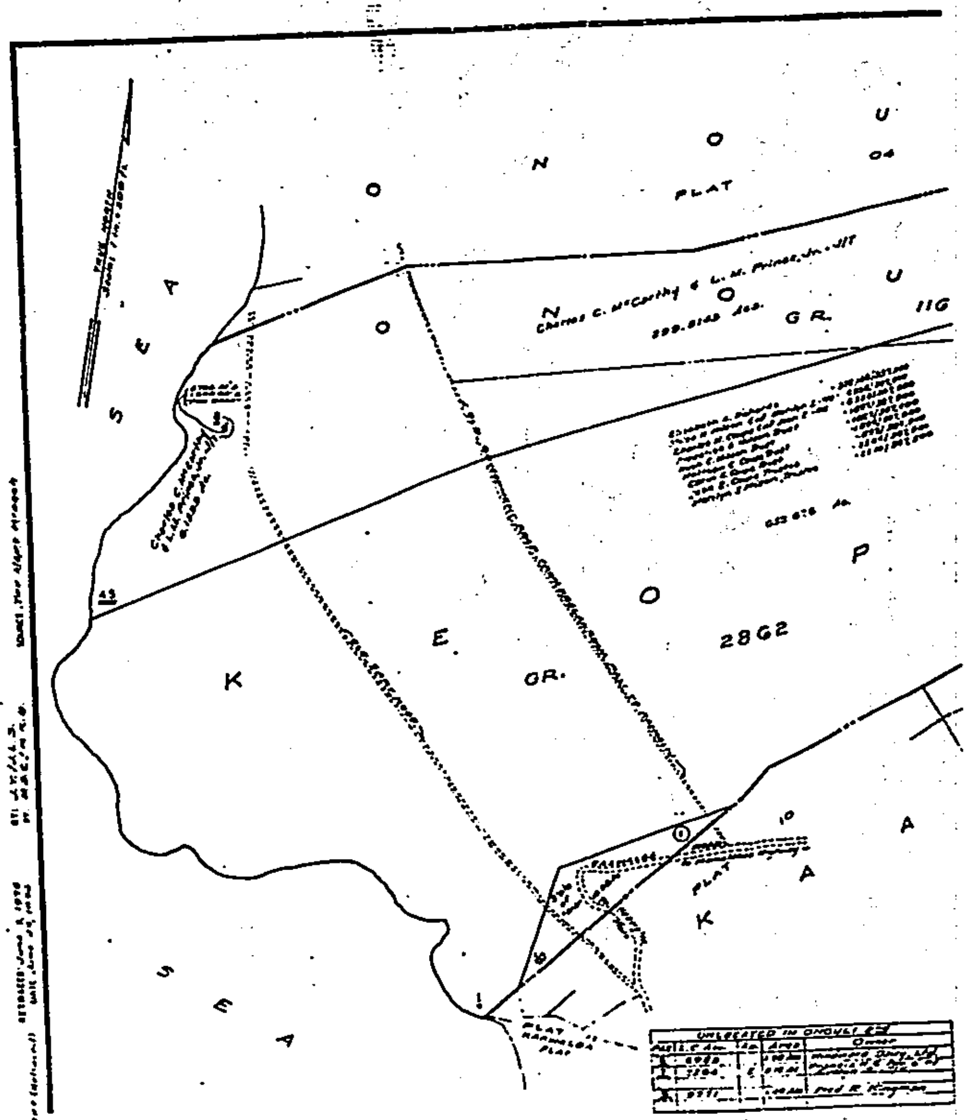


Figure 6 Portion of Tax Map Key 8-1-07 Showing Lcation of Roads in Keopuka and Vicinity

Land Use in Keopuka

The presence of those roads that lie within Keopuka provides the only direct evidence of early historic land use within the *ahupua'a*. Other changes can only be inferred from the evidence available for nearby lands. The depopulation that was occurring throughout the islands was recorded in the Kealakekua region, and clearly could not have avoided the native population of Keopuka. Other early historic changes, especially the economic and political changes associated with the new foreign residents, would have affected the entire region, Keopuka included.

The Mid to Late Nineteenth Century

Usually a valuable source of information on mid-nineteenth century land use in the Hawai'ian Islands, the Mahele records of the 1850s contain very little information on the native Hawai'ian population of Keopuka, or the kinds of activities that population was engaged in. This is primarily because there were no Land Commission Awards (LCA's) granted in the *ahupua'a* of Keopuka and, consequently, no Land Commission records of persons claiming to have lived there or claiming to have used Keopuka lands for agricultural or other pursuits.

At the time of the Mahele, the entire *ahupua'a* of Keopuka became "Government Land," and soon afterwards was sold off by the government. Acting on the advice and under the pressure of foreign advisors, the Hawai'ian government replaced the traditional land distribution system with one based on private ownership. As a result, foreigners were then allowed to purchase Hawai'ian lands, and were thus free to engage in land-based commercial enterprises. The majority of those who purchased Keopuka lands at this time were the foreign residents and visitors who had begun to settle in the Kealakekua Bay region in early historic times.

Although the absence of LCA's does not necessarily reflect an absence of native inhabitants, all subsequent historical references to Keopuka involve the residences and the commercial pursuits of those who, subsequent to the Great Mahele, began to buy and sell Keopuka lands. The Mahele records consulted contained no historical references to the presence of native inhabitants at Keopuka, nor the use of Keopuka lands for traditional subsistence-related activities.

Keopuka was distributed in the form of five grants: Grant 2862 to Awahua; Grant 148 and 1584 to Daniel Barrett; Grant 1171 to Preston Cummings; and Grant 1161 to J.D. Paris (Figure 7). All of these men, except Awahua, were first-generation foreign residents of the Kealakekua region. Following is a brief history of the ownership of Keopuka lands, with some biographical information about these and subsequent Keopuka land owners. The activities that these people were known to have engaged in provide the only available clues, albeit indirect, to the historic use of Keopuka lands in the latter half of the nineteenth century.

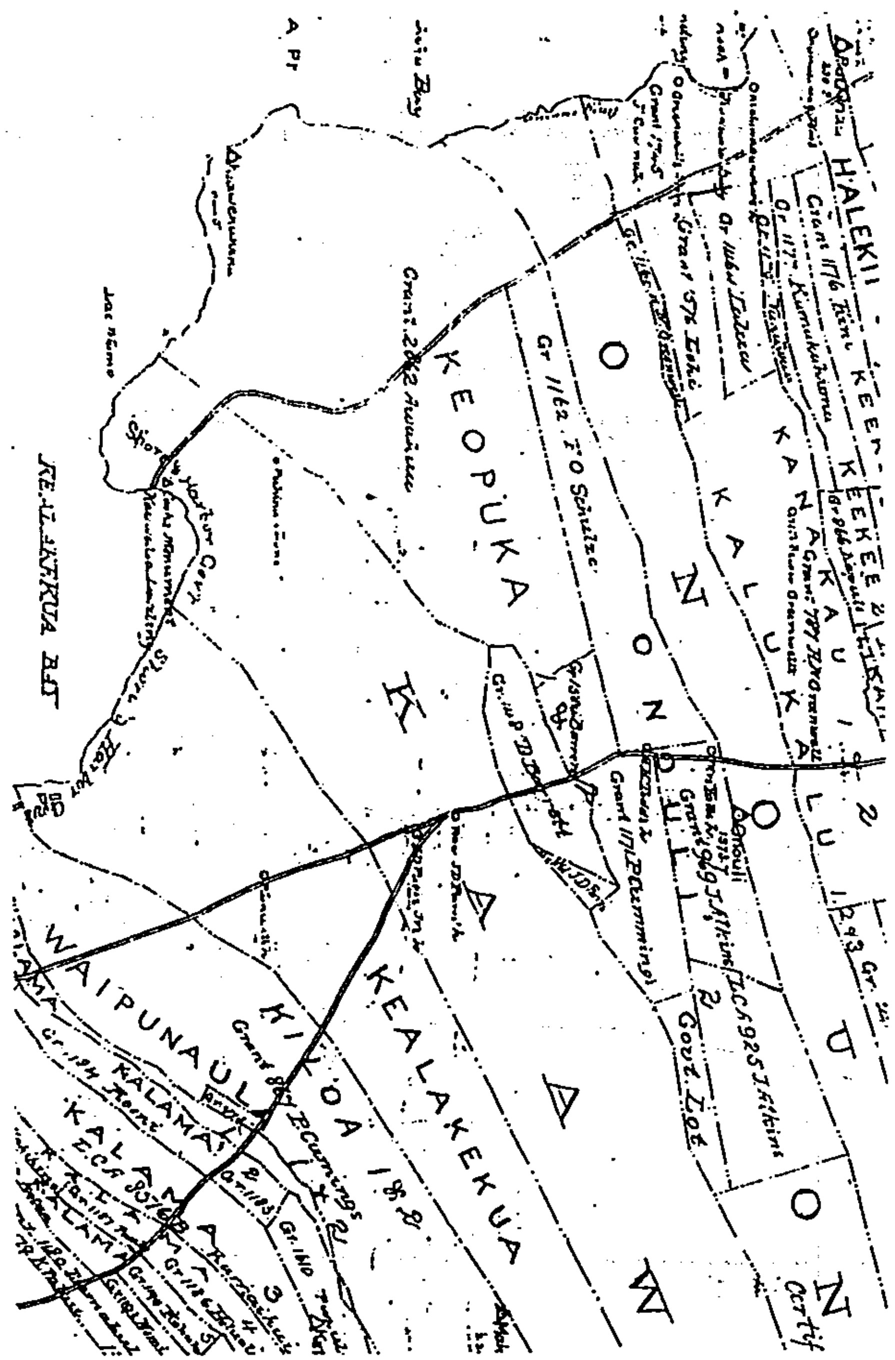


Figure 7 1891 Map of Keopuka and Vicinity Showing Location of Grants, Roads and House Sites (J.S. Emerson, RM 1280, Scale 1:24000)

Grant 2862

In 1862, Awahua, identified in the Mahele records (*i.e.* the Mahele records associated with LCA 6750 in Ka'awaloa) as the *konohiki* for Ane Keohokalole - the Chiefess of Ka'awaloa - received the largest of the five Keopuka parcels, totalling almost 740 acres. He reportedly lived near the chiefess at the village on the flat at Ka'awaloa, and maintained order there under the direction of Keohokalole's husband (Alvarez 1990:4.3). In addition to Grant 2862 in Keopuka, Awahua also received two parcels of land along the coast in Ka'awaloa, presumably including his house lot there.

Awahua did not retain his land in Keopuka for long, however, and within one year, Grant 2862 was deeded to Charles Kana'ina (Bureau of Conveyances [BoC]: Book 17 Page 141). Kana'ina was Lunalilo's father and a member of the Hawai'ian royal family. He was known to have bought and sold many properties from the 1850s until his death in 1877. Ownership of the land was then transferred to Princess Meriam Likelike (Meriam Likelike Cleghorn) in 1871 (BoC: Book 32 Page 284), one of Awahua's heirs. Land ownership documents did not specify the kind of uses, if any, to which Grant 2862 lands were put by these owners.

By 1875, Grant 2862 came under the ownership of A.A. Todd (BoC: Book 42 Page 77), and much of this land remained in the Todd family well into the twentieth century. The location of A.A. Todd's house, as depicted on the 1891 map (see Figure 7), was located adjacent to the *mauka* road (the present day Mamalahoa Highway closely follows this road), very close to Keopuka, within the neighboring *ahupua'a* of Onouli 2.

A.A. Todd and other members of the Todd family were active in local political and economic affairs in the Kealakekua region. Todd, for example, was appointed Commissioner of Agriculture for Port and Collection, District of Kealakekua in 1890 (the Board of Commissioners of which also included H.N. Greenwell and Moses Barrett); and his son, John Todd, was an appointed member of the Fence Commission of South Kona District in 1895 (Minister of the Interior Documents, Hawai'i State Archives - Name Catalog). Mr. Todd (whether A.A. or John Todd is unclear) is also identified as having built the Hala Canning Company pineapple cannery in Napo'opo'o, which was in operation from at least 1905 until the 1920s (Alvarez 1990:4.25).

Portions of Grant 2862 remained in the Sarah Todd Estate until 1940. After 1940, all of Grant 2862 and portions of Grant 1162 in Ka'awaloa, totalling 900-plus acres, were acquired by the Greenwell Estate (BoC: Land History of TMK 8-1-6 and TMK 8-1-7, on Microfilm).

Grants 1584 and 148

Grant 1584 and Grant 148, both located adjacent to Grant 2862 to the east, were originally owned by Daniel Barrett. Although the 1891 map (see Figure 7) which shows the location of Todd's house in Onouli and the two Paris houses in Ka'awaloa (to be discussed later) does not show a Barrett house, land ownership documents from the mid-twentieth century refer to Grant 1584 as the "Barrett House Lot" (BoC: Land History of TMK 8-1-7:04, on Microfilm).

Members of the Barrett family, like the Todd family, were also active members of the South Kona District community. Daniel Barrett was identified in Minister of the Interior correspondence documents as the person who supplied fire wood to the steamboat *Kilauea* that made weekly stops at Ka'awaloa in the 1860s (Apple 1973:50). In 1880, he was listed in Bowser's Directory as a "coffee planter" (p.181, cited in Alvarez 1990:2.22).

Daniel's son, Moses Barrett, mentioned previously as one of the Commissioners of Agriculture for Port and Collection, District of Kealakekua, was also the Keeper of the Royal Burying Grounds at Ka'awaloa in 1887 and the Road Supervisor of South Kona throughout the 1890s (Minister of the Interior documents, Hawai'i State Archives, Name Catalog). Moses Barrett was identified in the 1880 Bowser Directory as having lived above Ka'awaloa Flat at Keopuka, where he tended cattle (p.181 quoted in Alvarez 1990:3.16). Moses Barrett also owned several parcels of land on the coast at Ka'awaloa, including one that contained a hotel, the "Barrett Hotel," which seems to have been in operation from 1875 until his death in 1894 (Alvarez 1990:3.16).

One of the Barrett's (presumably Daniel) was also a Deputy Sheriff in South Kona and worked with Sheriff R.B. Neville in the 1860s. Both of these men were involved in an event which came to be known as the Kaona Rebellion in 1868 (Neville was killed and Barrett was seriously wounded, for an account see: Paris 1926:87; and *The Pacific Commercial Advertiser* October 24 and October 31, 1868). Barrett and R.B. Neville also appear to have been business partners, sharing ownership of several parcels of land in South Kona (BoC: Grantor and Grantee Records for the Island of Hawai'i 1845 to 1900).

In 1865, R.B. Neville acquired ownership of Grant 1584 (BoC: Book 21 Page 72) and another Neville, S.M. Neville, was deeded that land and a portion of Grant 148 in 1893 (BoC: Book 121 Page 237). These properties were then acquired by H.A. Lindley in 1900 and 1901 (BoC: Book 203 Page 363 and Book 217 Page 468), and in that same year, sold to H.N. Greenwell (BoC: Book 223 Page 21).

Grant 1171

Grant 1171 was originally owned by Preston Cummings. Cummings was considered to have been an agriculturalist and was associated with the commercial cultivation of pineapple and coffee. It is likely that this is also the same person referred to by Reverend J.D. Paris as "Captain Cummings," whose home in 1851 was along Kealakekua Bay, "near the little *heiau* where Henry Opukahaia was trained for priesthood and hard by the great heathen temple where Captain Cook erected his tent and placed his big guns... " (Paris 1926:114).

Cummings, like the other Keopuka land owners, was also an active member of the South Kona community in the latter half of the nineteenth century. He was Police Captain at Napo'opo'o in 1847 and, like Moses Barrett, was involved in Road Works; having been active in getting a road to Napo'opo'o and a road to "the steamboat landing" at Ka'awaloa in 1852 (Minister of Interior Documents, Hawai'i State Archives, Name Catalog). Captain Cummings also reportedly had a prison built at Napo'opo'o in the 1850s that was used until 1875, the prisoners at which reportedly "planted gardens in the area, growing cane and pineapples," (Yent 1985:14).

Interest in Grant 1171 was acquired by R.B. Neville in 1868 (BoC: Book 26 Page 366) and was sold to H.N. Greenwell in 1884 (BoC: Book 89 Page 180). A portion of Grant 1171 has, in recent times, been sold by the Greenwell Trust and developed into the "Keopuka Coffee Farms Subdivision" (e.g TMK 8-1-06:84).

Grant 1161

Grant 1161, a sliver of land adjacent to Grant 148, was originally owned by Reverend J.D. Paris. Paris was an influential missionary stationed at the Kealakekua region from 1852 until his death in 1892. Paris established the Kahikolu Church near Kealakekua Bay in 1852, and after 1863 formed branch churches throughout the South Kona District.

According to Paris' personal manuscripts, he had a house built at higher ground above the Pali because "the mission dwellings in Kepulu [on the south side of Kealakekua Bay] near the great church were in ruins, and also that the climate there had been exceedingly trying to the health of the missionaries" (Paris 1926:114). Paris identified his house as being located at Kuapehu, near where Kapiolani and others lived for the brief period between 1831 and 1838. This house is identified as the Paris Jr. house on the 1891 map (because the Rev. sold this parcel to his son, then returned some years later and built himself a new house nearby). The two Paris houses were, like the Todd's house and, presumably, the Barrett's house, located adjacent to the *mauka* road (see Figure 7). Paris is said to have walked from his home to the churches located near the coast, "walking up and down the steep, hot rocky trail" (*ibid*:115).

J.D. Paris was not only the dominant missionary in the Kealakekua area throughout the latter half of the nineteenth century, but soon after the Mahele, he also became one of the dominant landowners in the Kealakekua region as well, investing in land as a livelihood. By 1863, Paris owned virtually all of the lands in the ahupua'a of Ka'awaloa and Kealakekua. After his death in 1892, his son, John Paris Jr. "retained much of his father's interest... followed by a succession of Paris descendants who continue to be a presence in Ka'awaloa" (Alvarez 1990:2.12). Members of the Paris family are associated with certain commercial endeavors in the region as well, particularly the raising of cattle and goats, including Angora goats. Paris was reported to have kept livestock "at Ka'awaloa and other nearby lands" (*ibid*:4.12).

It is unknown what J.D. Paris or his heirs did specifically with the small parcel of land they owned in Keopuka. Since the only references to Paris family houses are in Ka'awaloa, it seems likely the Keopuka land was purchased not for a house site but for cattle pasturage or simply as investment property.

Mid to Late Nineteenth Century Land use

The second half of the nineteenth century saw the end of traditional settlement and subsistence in the Kealakekua region. Within several years after the land divisions of the Great Mahele, the new foreign residents and their heirs came to own and control the vast majority of lands throughout the Kealakekua region including the entire ahupua'a of Keopuka.

It can be assumed from the small number of native inhabitants who remained at Ka'awaloa by the middle of the nineteenth century, that the area continued to experience the depopulation that began soon after contact, as well as a variety of other forces associated with the changing political and economic conditions taking place in the region. The net effect of these changes was the virtual abandonment of the traditional coastal settlements.

> Regardless of ownership, or perhaps in part because of it, the Hawai'ian people had left Ka'awaloa. As early as 1866, Clemens had called the village "still" and "lonesome." Ka'awaloa itself he described as "a little flat plain, on which stands a coconut grove and some ruined houses." Chaney in 1879 described it as "forsaken" and Barnfield reiterated the theme: "Ka'awaloa is the quietest place I was ever in." (quoted in Alvarez 1990:4.16)

The new land owners in the region typically built their homes adjacent to the prime agricultural lands along the *mauka* road and used the surrounding lands for a variety of commercial endeavors. Land use in the Kealakekua area in the final decades of the nineteenth century was dominated by the raising of livestock and the cultivation of commercial crops, including pineapple, sugar and coffee. With new and improved roads, the new landowners linked themselves to each other and to the areas that were becoming important to the new market-based economy, such as the harbors and the newly emerging urban centers.

> Ostensibly, Ka'awaloa loomed large in the Hawai'ian Kingdom in 1890. The government had built and maintained for the prior thirty years a wharf and navigational buoy. The community was served by a subsidized inter-island shipping service. The government had maintained the cart road built by the missionaries and had linked upper Ka'awaloa with both Kailua and Ka'u through government roads. (Alvarez 1990:4.18)

Land Use in Keopuka

Specific references to late nineteenth century land use in Keopuka are limited to the one reference to Daniel Barrett living in Keopuka and tending cattle, however the activities associated with all of the owners of Keopuka lands suggest that it may have been used for many of the other commercial activities that were engaged in throughout the Kealakekua region, such as the raising of goats and the cultivation of commercial crops. Eventually, the majority of lands within the *ahupua'a* came under the ownership of the Greenwell family, suggesting that at least some portions of Keopuka were incorporated into one of the three Greenwell ranches that were established in Kona. The *makai* portion of Keopuka was probably not put to such use though, since it consists of barren lava and could never have been very productive for grazing.

The Twentieth Century

The early part of the twentieth century saw an intensification of many of the commercial enterprises that began after the Mahele; namely, an expansion of cattle ranching in the more marginal agricultural lands and an expansion of commercial crop cultivation in the prime agricultural lands.

Within the more agriculturally productive lands of the uplands above Kealakekua Bay, a variety of crops were grown in the early twentieth century, including pineapple, sugar, tobacco and coffee. Pineapple became an important crop between roughly 1905 and the early 1920s, and a pineapple cannery was built in Napo'opo'o, which was in operation until the 1920s (Alvarez 1990:4.25). After 1920, coffee had emerged as the dominant commercial crop, culminating in the establishment of the Captain Cook Coffee Company (the CCCC). The CCCC, headquartered in Ka'awaloa along the main government road in the village that eventually took its name after the company, "Captain Cook," dominated the economy of the region and "easily dominated the financial lives of its tenants" (*ibid*:4.28).

Although coffee continued to be the economic mainstay of the entire Kona region through the 1940s, coffee prices had plummeted during the Great Depression and the large coffee companies were gradually replaced by independent coffee farmers. The CCCC had subleased much of its lands to individual farmers early in the twentieth century, including Chinese, Portuguese and later, Japanese laborers leaving the sugar plantations. Many of these farmers stayed in the region and eventually purchased the lands they farmed and continued to grow coffee.

> The ethnic composition of Kona's population continued in its earlier direction. By 1940, Japanese formed a majority of the population while Filipinos were close to 10%. Native Hawai'ians and part-Hawai'ians made up only a quarter of the population. (Alvarez 1990:4.38)

The other dominant economic activity in the Kealakekua region was cattle ranching. Two of the twelve principal stock and sheep ranchers on the island of Hawai'i listed in Thrum's 1902 Annual Index were two of the landowners previously mentioned; the Greenwells and John Paris, Jr. (Quoted in Alvarez 1990:4.29). The Greenwells and the John Paris are said to have exported their cattle through the port at Napo'opo'o until 1931 when a new method of loading cattle was introduced at Ka'awaloa, and used until 1941.

> The method consisted of administering a shock to a cow as it stood at the top of a chute. The shock sent it sliding into the water, from whence it was pulled by the neck to a nearby lifeboat. (Alvarez 1990:4.36)

After 1941, the coast of Ka'awaloa was all but abandoned, having been essentially closed down by the military after the Japanese invasion of Pearl Harbor. In the 1970s, the state acquired lands along the coast of Ka'awaloa for the Kealakekua Bay State Historical Park. The uplands of Ka'awaloa had become the village of Captain Cook, and much of the lands that had been cultivated in coffee have been, and continue to be, developed into house lots and business properties.

Land Use in Keopuka

Specific references to twentieth century land use in Keopuka are limited to the recent sale, subdivision and development of some Keopuka lands, particularly along the Mamalohoa Highway on the mauka end of the *ahupua'a*. One such subdivision is called the "Keopuka Coffee Farms Subdivision" (which includes TMK 8-1-06:84) suggesting previous use of the area as coffee farm land. Otherwise, as with previous time periods, the history of Keopuka lands must be inferred from the known history of its neighboring lands.

B. Previous Archaeological Research

Studies in Keopuka *Ahupua'a*

A total of eight archaeological studies have been conducted within portions of the *ahupua'a* of Keopuka (Figure 8). These include:

(1) The coastal survey by John F. G. Stokes (Stokes 1991). A cursory reconnaissance survey conducted before the advent of modern archaeology; assumed to have at least partially surveyed the coastal portion of Keopuka.

(2) The coastal survey of John E. Reinecke in 1929 (Reinecke 1930). Also a cursory coastal reconnaissance conducted before the advent of modern archaeology; known to have surveyed the coast of Keopuka within several hundred feet of the shore.

(3) The coastal survey conducted as part of the State Inventory of Historic Places in the 1970s (State Historic Preservation Office [SHPO] 1971). Assumed to have covered essentially the same area as the survey of Reinecke in 1929.

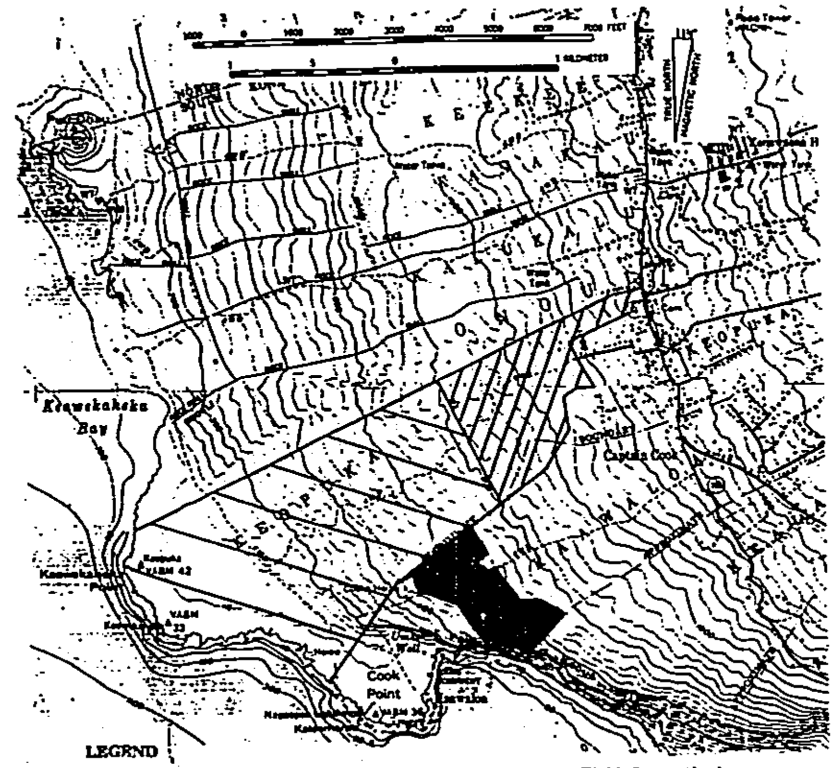
(4) The reconnaissance survey conducted by Lloyd J. Soehren (Soehren 1980). Reported to have surveyed a large portion of Keopuka between 850 feet and 1400 feet a.m.s.l.

(5) The reconnaissance survey of the remaining half of Keopuka conducted by Lloyd Soehren (Soehren 1981). Reported to have surveyed the area between the coast and 850 feet a.m.s.l.

(6) The inventory survey of Paul H. Rosendahl, Inc. (PHRI) (Rosendahl and Jensen 1989). A survey of an 248 acre project area that lies within both Keopuka and Onouli *ahupua'a* between the elevations of 800 feet and 1350 feet a.m.s.l.

(7) The field inspection survey conducted by PHRI (Walker and Rosendahl 1990). A reconnaissance survey of a 660 acre project area in Keopuka and Onouli (which also included that portion of Keopuka covered by their 1989 inventory survey).

(8)The inventory survey by PHRI of the Kealakekua Ranch Development - Kaawaloa Parcel (Walker *et al.* 1991). This survey was conducted on a 70 acre parcel that lies primarily within Kaawaloa, but also partially extended across the southern boundary of Keopuka between the elevations of 570 feet and 800 feet a.m.s.l.



LEGEND

Area surveyed by Rosendahl & Walker 1990 (Field Inspection); Rosendahl & Jensen 1989 (Inventory Survey); Soehren 1980 (Reconnaissance)

Area of the present inventory survey, previously surveyed by Rosendahl & Walker 1990 (Field Inspection); Soehren 1981 (Reconnaissance)

Area Surveyed by Walker et al. 1991 (Inventory Survey)

Other surveys within Keopuka include coastal surveys with unspecified project areas - Stokes 1991 (early reconnaissance); Reinecke 1930 (early reconnaissance); SHPO 1971 (reconnaissance)

Figure 8 Map Showing Approximate Locations of Previous Archaeological Studies Within Keopuka *Ahupua'a*

The present project area is a 500-acre portion of Keopuka *ahupua'a* situated between the coast and about 800 feet a.m.s.l. It has been wholly surveyed by two of the eight previous archaeological studies conducted in Keopuka, and partially surveyed by four. The entire project area was included in Soehren's 1981 reconnaissance (#5 above) and PHRI's 1990 field inspection (#7). The coastal portion of the present project area was included in the surveys of Stokes (#1), Reinecke (#2), and the SHPO (#3); and a small portion of the southern edge of the project area was included in PHRI's inventory survey of 1991 (#8).

The Early Coastal Surveys of Stokes and Reinecke

The main objective of Stokes' survey was to locate and record *heiau* on the island of Hawai'i. Although Stokes did not describe any *heiau* in Keopuka, it is presumed that he investigated at least some portions of the coast of Keopuka, since his surveys brought him to Kaawaloa flat which extends across the southern boundary of Keopuka.

Reinecke's survey was not limited to recording *heiau*, but included locating and briefly recording all of the archaeological sites he encountered. In Keopuka, Reinecke identified thirty sites (Reinecke's sites 132-161), all of which were located within several hundred feet of the coast, the area upon which Reinecke's survey was focused. These sites include: permanent habitation complexes with house platforms, animal pens and large surrounding pens (*i.e.*, enclosures); temporary habitation sites including low-walled windbreaks, cave shelters and various modified outcrops; possible burial mounds; and a possible *heiau*. Although the recorded locations of these sites are difficult to correlate with the findings of more recent surveys and the site descriptions are brief, many of these sites were re-identified during the SHPO survey of 1971 and are considered to be represented in the sites identified in that survey and assigned state site numbers at that time (Table 2).

The State Inventory of Historic Places Survey

SHPO researchers (including B.P. Bishop Museum staff) surveyed the coast of Keopuka in 1971 as part of the State Inventory of Historic Places. Many of the sites along the coast of Keopuka described by Reinecke forty years earlier, were re-identified and, together with previously unrecorded sites, were regrouped into fifteen sites or site complexes (Sites 1948 through 1962). These include camp sites and rock shelters consisting of low stone walls, platforms and midden scatters; burial platforms and terraces; house sites consisting of platforms, pavements, enclosures and stone wall fences; and a small possible *heiau*. Although the records for these sites are not published in manuscript form, the site files are available at the Department of Land and Natural Resources-Historic Preservation Program/State Historic Preservation Division (DLNR/SHPD).

The present survey included re-identifying these fifteen sites and incorporating them into the inventory survey so that they would be included in any subsequent significance and recommended treatment evaluations. In the process of re-evaluating these sites for current inventory-level survey standards, two of the sites identified in the SHPO survey and assigned state site numbers at that time have been changed during the present study; Site 1962 has been distinguished into two sites (Site 17192 and 17193), and Site 1954 has been incorporated into site 1955 as an affiliated feature (see Table 2 and the SITE DESCRIPTIONS section of this report).

Table 2 - Correlation of Previously Identified Sites Within the Project Area

Current Site # (50-10-47-)	CSH Site # (Present Study)	Previous Study in Which Site was identified/Site Number(s) Assigned
1948	5	SHPO 1971/1948; Reinecke 1930/161-165
1949	6	SHPO 1971/1949; Reinecke 1930/160
1950	11	SHPO 1971/1950; Reinecke 1930/159
1951	12	SHPO 1971/1951; Reinecke 1930/157
1952	16	SHPO 1971/1952; Reinecke 1930/149-155
1953	19	SHPO 1971/1953; Reinecke 1930/148
1955	20 A-C	SHPO 1971/1954-1955; Reinecke 1930/146-147
1956	22	SHPO 1971/1956; Reinecke 1930/145
1957	23	SHPO 1971/1957
1958	24	SHPO 1971/1958; Reinecke 1930/144
1959	29	SHPO 1971/1959
1960	32	SHPO 1971/1960; Reinecke 1930/142
1961	31	SHPO 1971/1961
7727	26	Soehren 1981/7727
7728	38 & 42	Soehren 1981/7728
10290	90	PHRI 1991/14754; (a.k.a. The Old Govt. Road)
14185	87	PHRI 1991/14185
14188	83	PHRI 1991/14188
14190	84	PHRI 1991/14190
14192	86	PHRI 1991/14192
14186	---	PHRI 1991/14186
17192	34	SHPO 1971/1962; Reinecke 1930/133-134
17193	35	SHPO 1971/1962; Reinecke 1930/132
7000	---	(a.k.a. The Kealakekua Bay Historic District)
50-10-37-6601	---	(a.k.a. The Kona Field System)

The Reconnaissance Surveys Conducted by Soehren

In 1980, Lloyd J. Soehren conducted a reconnaissance-level survey of a large portion (acreage unspecified) of the *mauka* half of Keopuka *ahupua'a*, between about 850 feet and 1400 feet a.m.s.l. Soehren acknowledged that the project area was within the boundaries of the Kona Field System (site 50-10-37-6601), but found that,

> the ground is generally so rough and stony that it is highly improbable that it was utilized to any extent, if at all, by the aboriginal Hawai'ian farmer. Better suited land was available immediately to the north and also farther south in Kaawaloa. Remnants of the Field System are clearly visible on aerial photographs of those areas but no such features can be seen in the project area. (Soehren 1980)

Soehren also acknowledged that a small portion of the southwest corner of the project area was included in the Kealakekua Bay Archaeological and Historic District (State Site 50-10-47-7000), but found that this inclusion was "due more to the requirement that such districts be defined as quadrilaterals than to any intrinsic archaeological or historic values." He concluded that "examination of the parcel... revealed no features attributable to the aboriginal Hawai'ian culture, nor any reasonable prospect of there being any such features" (*ibid.*).

In 1981, Soehren conducted another reconnaissance-level survey in Keopuka. This survey was of an approximately 500 acre parcel situated in the *makai* end of the *ahupua'a*. The project area of this survey covered the width of the *ahupua'a* from the shoreline to about 850 feet a.m.s.l. Soehren once again acknowledged that Keopuka was within the boundaries of the Kona Field System, but found that "there is no evidence of systematic cultivation by the aboriginal Hawai'ian on the parcel examined, nor is there any reason to expect any, of the kind defined in the nomination forms" (Soehren 1981). He also reiterated his belief that, although a portion of the project area was within the Kealakekua Bay Archaeological and Historic District, "such districts were defined arbitrarily...and the boundary here would more appropriately conform to the *ahupua'a* or current property boundary" (*ibid*).

Although Soehren found no evidence of traditional agriculture within the project area, he did identify three steppingstone trails (only two of which were assigned site numbers at that time, sites 7727 and 7728) and three historic period cart paths or roads (none of which were assigned state site numbers at that time). Soehren noted that two of the steppingstone trails were near the south side of Keopuka leading from the shore inland (Site 7727 and 7728), and the third was abandoned at the base of the pali.

Soehren described one of the historic roads as "the old government road from Kealakekua pali to Kainaliu beach which probably dates from about 1840." This road was discovered at 400 feet elevation and correlates to Site 10290, identified during a subsequent survey of nearby lands (see Historic Background Section of this report).

Another of the historic roads described by Soehren correlates to Site 17189, which was assigned during the present survey. This road he describes as,

> nearer the shore... connecting the landing at Kaawaloa with the coastal villages to the north, including Kainaliu, Keauhou and Kailua. Although now used as a jeep road, and labelled "old cart road" on the tax map, it has evolved from an earlier steppingstone foot path as attested by the smooth, flat waterworn boulders which have been taken up and now rest on either side of the track.

The third historic road identified by Soehren was "one that intruded only briefly into Keopuka." This was the cart road from Kaawaloa Landing up the pali to Kuapehu, the home of Rev. John D. Paris "to whom its construction is attributed" (Soehren 1981). This road was assigned site number 14176 during the course of a subsequent PHRI inventory survey in Kaawaloa (Walker *et al.* 1991).

In the letter report for this survey, Soehren also listed the archaeological sites identified by Reinecke (referred to as "the Bishop Museum Survey of 1929") and re-identified by the State of Hawai'i (Site 1948 through 1962), commenting that, "the majority of the sites are typical of temporary camp sites used by fisherman" (*ibid*).

PHRI 1989 Inventory Survey and 1990 Field Inspection

In 1989, PHRI conducted an inventory survey of the Onouli Subdivision Project Area, a 248 acre parcel located in Onouli and Keopuka *ahupua'a* between the elevations of 800 feet and 1,350 feet a.m.s.l. (Rosendahl and Jensen 1989). This project area included the land surveyed by Soehren in 1980, in which he identified no archaeological sites. A total of 57 sites were identified during this survey, roughly half of which were tentatively associated with the Kona Field System, and the remaining sites were tentatively interpreted as associated with historic ranching and agriculture (*ibid*:14). These sites, based upon functional interpretations, include: boundary and/or ranching walls; agricultural complexes which include enclosures, terraces, and level areas; habitation complexes which include terraces and enclosures; a modified sink and a walled depression, both used for habitation; a habitation cave; a refuge cave; a burial cave; and transportation features which include trails and a railroad bed.

This 248-acre project area was also included in a subsequent study by PHRI, a field inspection survey (Walker and Rosendahl 1990). The field inspection was conducted on a 660 acre study area in Keopuka and Onouli *ahupua'a* between sea level and 1350 ft. a.m.s.l., and included virtually all of the areas covered by the previous archaeological surveys of Keopuka. The area covered by the 1989 PHRI inventory survey was included in the field inspection report because, at the time of the field inspection in 1990, the 1989 inventory survey report (Rosendahl and Jensen 1989) was regarded by PHRI as a draft with tentative findings and had not been submitted to the State for review.

A total of eleven sites were newly identified during the field inspection survey. Because it was a field inspection, or reconnaissance-level study however, these sites were not assigned state site numbers, but retained the temporary site numbers assigned to them by PHRI (PHRI sites 769-7, 11, 15, 16 through 20, and 22 through 25). These sites include habitation complexes consisting of enclosures, enclosure remnants and walls, possible burial complexes consisting of platforms and modified outcrop, and transportation features consisting of a trail, a cart road and the old Government Road. These sites have not been correlated sites identified in previous or subsequent studies, but are assumed to be included in the site inventory of the present survey.

PHRI 1991 Inventory Survey

The PHRI inventory survey of the Kealakekua Ranch Development - Kaawaloa Parcel (Walker *et al.* 1991), was conducted primarily within Kaawaloa *ahupua'a*, but also partially extended into the southern boundary of Keopuka. The project area was an approximately 70 acre parcel between the elevations of 570 feet and 800 feet a.m.s.l. During the survey, 44 sites containing over 85 component features were identified and included both prehistoric and historic sites. Functional feature types include habitation (33.0%); agriculture (22.4%); temporary habitation (10.6%); agriculture/habitation (9.4%); boundary (7.1%); transportation (4.7%); and burial (3.5%).

Of the 44 sites identified during this survey, six are recognized as being within the boundaries of the present project area (Site 14165, 14186, 14188, 14190, 14192 and 14754). Two of these are transportation sites, consisting of a steppingstone trail remnant and an historic road (previously identified as Site 10290); two are habitation complexes consisting of terraces, pavements, modified outcrops and caves; and two are burial sites, both of which are within lava caves. A charcoal sample was collected from the interior surface of one of these burial caves, Site 14192, and, according to the authors of that report, the most likely age range for that sample is 1470-1680 AD (Walker *et al.* 1991:22).

The Distribution of Previously Identified Sites

Analyses of archaeological findings and historical research of the *ahupua'a* of the Kona coast have revealed that, within each *ahupua'a*, there are basically three land use zones; a coastal zone, an intermediate zone, and an upland zone.

The coastal zone is identified as the lands along the immediate shoreline and is recognized as having been where traditional settlement was concentrated. Archaeological sites within the coastal zone typically include features associated with permanent and temporary habitation, features associated with traditional Hawai'ian political and religious practices, and features associated with limited agricultural activities.

The intermediate zone is identified as the land between the coastal zone and the agriculturally productive uplands, and is recognized as having been where limited intensive agriculture was practiced (wherever conditions were adequate), and through which people and goods moved between the coast and the uplands. Archaeological sites within the intermediate zone typically include features associated with intensive, though dispersed, agriculture; features associated with traditional, predominately temporary, habitation; and features associated with cross-*ahupua'a* and intra-*ahupua'a* transportation.

The upland zone is identified as containing the most productive agricultural lands within the *ahupua'a*, with rainfall levels and soil conditions highly conducive to intensive agriculture. Archaeological sites within the upland zone typically include features associated with intensive agriculture (densely distributed), and features associated with permanent and temporary habitation.

The present project area is an approximately 500 acre parcel situated within Keopuka between the coast and approximately 800 feet a.m.s.l., and encompasses virtually all of the coastal and intermediate zones of Keopuka.

The Coastal Zone of Keopuka

The coastal zone of Keopuka is here defined as the area between sea level and roughly 50 feet a.m.s.l. Previous archaeological studies have identified a total of 26 sites within the coastal zone of Keopuka; these include the fifteen sites identified during the SHPO survey of 1971 (Site 1948 through 1962, which also include the sites previously identified by Reinecke); the two sites identified by Soehren in 1981 (Site 7727 and 7728); and nine of the eleven newly identified sites from the PHRI field inspection survey of 1990 (PHRI temporary sites 769-7,11,15,16,18,19,20,22,23).

Based on the site descriptions and the interpreted functions (where provided), the majority of these coastal zone sites of Keopuka are habitation complexes. Of the fifteen sites identified during the SHPO survey, twelve were interpreted as possible habitation complexes consisting of such feature types as enclosures, terraces, platforms, and rock shelters (Site 1948, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1959, 1961 and, 1962). Two of these sites were interpreted as historic, based on the presence of historic artifacts, and one was interpreted as modern. Of the nine coastal zone sites identified during the 1990 PHRI field inspection, six were tentatively interpreted as habitation-related, consisting of enclosures, enclosure remnants and walls (PHRI temporary sites 769-7, 769-15, 769-16, 769-20, 769-22, 769-23). No age determinations of these sites were made.

In the previous archaeological studies, sites interpreted (or tentatively interpreted) as habitation sites were not distinguished into temporary, recurrent, or permanent habitation categories. Nevertheless, a cursory examination of the site descriptions suggests that at least four contain features generally associated with permanent habitation sites, such as well-constructed platforms, terraces and enclosures (Sites 1948, 1952, 1961, and 1962). The remaining habitation sites contain features more commonly associated with temporary or recurrent use, such as small C-shaped enclosures and rock shelters. Several of the latter also showed evidence of modern use, implying continued use as temporary camp sites.

The next most common functional site type found in the coastal zone of Keopuka is burial or possible burial, accounting for four of the 26 coastal zone sites (Sites 1958, 1960, and PHRI Sites 769-18, 769-19). Feature types include platforms, modified outcrop, terraces and mounds. There were also three transportation-related sites consisting of steppingstone trails (Sites 7727, 7728 and PHRI temporary site 769-11), and one platform interpreted as a small *heiau* (Site 1949).

The Intermediate Zone of Keopuka

The intermediate zone of Keopuka is defined here as the land between roughly 50 feet and 950 feet a.m.s.l. In Keopuka, this land is predominately exposed *a'a* lava, and the *mauka* boundary of the intermediate zone is the rather distinct line where the exposed lava ends and vegetation begins to dominate. Previous archaeological studies have identified thirteen sites within the intermediate zone. Two of these sites were identified during the 1990 PHRI field inspection, six were identified during the 1989 PHRI inventory survey, and five were newly identified during the 1991 PHRI inventory survey. Six of these sites were interpreted as habitation sites, five were interpreted as transportation sites, and two were burial sites.

The habitation sites appear to be primarily temporary or recurrent use sites consisting of a refuge cave (Site 11302), a wall section (Site 11303), a modified sink (Site 11304), and three complexes; one within a cave system (Site 11312), and two that include cave features, terraces, pavements or modified outcrops (Site 14188 and 14190).

Two of the transportation-related sites are historic roads (previous studies have assigned a variety of site numbers to these two roads, but in the present study these are referred to as Site 10290 and Site 17189 - see Table 2); and three are trail segments (Site 11305, 11313 and 14186).

Both of the burial sites identified within the intermediate zone were natural lava tubes. Site 14185 contained the remains of four individuals and Site 14192 contains some seventeen burials, all of which, except one, appear to have been disturbed possibly by pot hunters (Walker *et al.* 1991:A-31).

The Upland Zone of Keopuka and Portion of Onouli

The upland zone of Keopuka consists of the land between roughly 950 feet a.m.s.l. and the *mauka* boundary of the *ahupua'a*, which is at approximately 1800 feet a.m.s.l. Previous archaeological surveys in Keopuka have not extended beyond 1350 feet a.m.s.l. at the Mamalahoa Highway. Sixteen sites or site complexes have been identified within the upland zone of Keopuka, all of which were identified during the 1989 PHRI inventory survey. The primary function of fifteen of the sixteen sites was interpreted as agricultural (Site 11273, 11280, 11285-11292, 11294-11296, and 11301). The remaining site (Site 11293) was interpreted as an habitation complex.

Most of the agricultural sites were considered to be prehistoric in origin, although several were recognized as having been altered by historic ranching or agricultural activities. Features associated with traditional agriculture include; pits, mounds, terraces, retaining walls, and alignments (considered by PHRI to represent elements of the prehistoric Kona Field System [Rosendahl and Jensen 1939:A1]). Features associated with historic and modern activities include enclosures, road alignments, bulldozer berms and modern trash.

The one site interpreted as a habitation complex (Site 11293) contained several low terraces and "a series of low walls which converge to form a large centrally located terrace" (*ibid*:A14) Several of the site complexes that were interpreted as primarily agricultural also contained other functional feature types, including possible burials (*e.g.*, Site 11291), possible habitation features (*e.g.*, Site 11296) and a *papamu* (Site 11291).

C. Background Summary and Predictive Model

The background research undertaken for this project provided very little direct evidence of late prehistoric and historic land use in Keopuka, specifically. Instead, the background research looked to the adjoining *ahupua'a* of Kaawaloa, and the Kealakekua Bay region in general, as an indirect source of background information about Keopuka. The compilation of previous archaeological research conducted within keopuka *ahupua'a* provided a good indication of the kinds of prehistoric and historic land use activities that have occurred specifically within Keopuka, and the general distribution of archaeological sites within the *ahupua'a*. This section will combine these two sources of background information and present a brief outline of prehistoric and historic land use within Keopuka, and suggest how further archaeological research could contribute to this model.

Coastal Zone

Traditional Land Use

Historical evidence of late prehistoric and early historic land use at Kaawaloa *ahupua'a* indicates that, at the time of western contact, the coast contained a moderately dense native Hawai'ian population including the residences of several Hawai'ian *ali'i*. This native population was supported through the exploitation of nearby marine resources and the agricultural exploitation of the upland slopes of the *ahupua'a*. Evidence of traditional land use along the coast includes permanent habitation complexes, chiefly residences, agricultural plots, several large *heiau*, and a network of steppingstone trails leading into the agriculturally rich uplands and into adjoining *ahupua'a*.

Although it is likely that the coastal residents of Keopuka engaged in the same kinds of traditional subsistence activities and used the resources of the *ahupua'a* in a similar way as the coastal residents of Kaawaloa, archaeological evidence indicates that there were far fewer coastal residents at Keopuka. Evidence of traditional coastal habitation includes only several sites interpreted as permanent habitation complexes. The majority of sites are more indicative of temporary or recurrent habitation. As Soehren noted "the majority of [coastal] sites are typical of temporary camp sites used by fisherman" (Soehren 1981). Unlike Kaawaloa, there were no sites found along the coast of Keopuka that suggested chiefly residences or religious complexes, and only one site interpreted as a "small possible *heiau*".

Further archaeological study of the coastal zone of Keopuka would likely identify more evidence of traditional land use, especially evidence of activities represented by less prominent archaeological features, such coastal zone agriculture. A full accounting of permanent habitation sites on the coast of Keopuka would also help clarify the extent to which the coast of Keopuka was inhabited in prehistoric and early historic times.

Historic Land Use

As foreign contact and foreign settlement increased throughout historic times, the native Hawai'ian population and their traditional way of life rapidly declined throughout the Hawai'ian islands. Historic records indicate that this decline began in the Kealakekua region within a few decades after contact and, by the 1860s, the once populated coast of Kaawaloa was almost completely devoid of native inhabitants.

The entire *ahupua'a* of Keopuka became Government Land during the Mahele, and within a short time, it was divided into five parcels and sold to private landowners. The coastal zone was included in the largest of these parcels which, by 1875, came under the ownership of a known "agriculturalist," A.A. Todd. Although it is known that Todd was involved in the commercial pineapple business in the Kealakekua Bay region, and that he lived in Onouli, which adjoins Keopuka, no reference was found indicating to what use, if any, Todd put his Keopuka lands. It is possible that he cultivated pineapples or other commercial crops within Keopuka, but this would have been more likely within the portion of his Keopuka lands that extend into the intermediate or upland zones, for conditions in the coastal zone would not have been favorable for agriculture. It is more likely that Todd used the *makai* portion of his Keopuka lands for cattle ranching, the economic activity that eventually came to dominate the surrounding landscape in late historic times.

Little evidence of historic land use of the coastal zone of Keopuka was found by the previous archaeological studies. Several of the coastal habitation sites identified during the SHPO survey were interpreted as historic in construction and one exhibited signs of modern usage, but all of these sites suggest intermittent, temporary use. Evidence of other historic use is limited to historic roads or cart paths, some of which were built for the transportation of commercial crops and other goods to and from the boat landings and the burgeoning urban centers such as Kailua to the north and Ka'u to the south.

Further archaeological study of the coastal zone of Keopuka would probably identify more archaeological sites associated with the historic use of the land, but such sites would likely be relatively few. The coastal zone was not well-suited to agricultural use, and sites associated with cattle ranching are generally limited to enclosures, boundary walls and, perhaps, wells. There is a possibility of finding more evidence of historic habitation within the coastal zone, and such evidence could be used to determine what kinds of historic period activities were being engaged in there, and when habitation in the coastal zone ceased.

Intermediate Zone

Traditional Land Use

Traditional land use in the intermediate zone of the *ahupua'a* of the Kona coast is generally understood to have included limited agriculture and scattered, predominantly temporary habitation. In Kaawaloa, the intermediate zone was described at the time of western contact as "a barren, rocky country...a dreary, naked barren waste" (Menzies 1920:74), but it has been recognized that even these areas were used in the cultivation of traditional crops. Research on the Kona Field system has determined that along the Kona coast between the elevations of sea level and approximately 500 feet a.m.s.l., such traditional crops as sweet potatoes, gourds and *wauke* were planted, even within the exposed rocky areas, such as those found in Kaawaloa. Between the approximate elevations of 500 feet and 1000 feet a.m.s.l., as agricultural conditions improve, traditional crops also included breadfruit trees. This probably

correlates to the portion of Kaawaloa that Menzies described as "along the verge of the woods...and in a high state of cultivation" (*ibid*:75).

Evidence of traditional land use in the intermediate zone of Keopuka was limited to six habitation sites, five transportation sites and two burial sites. These sites were sparsely distributed within the areas subjected to inventory-level survey, and most of these were identified within the *mauka* end of the intermediate zone, at around 850 feet a.m.s.l. Very few sites were identified within the bulk of the intermediate zone of Keopuka. This lack of sites within the intermediate zone of Keopuka probably at least partially reflects the fact that this zone is even more barren and rocky than most of the other *ahupua'a* of the Kona coast, for it is dominated by a relatively recent *a'a* lava flow. The intermediate zone of Keopuka would have thus provided even fewer opportunities for traditional agricultural use. As a result, there would have been less need for associated habitation structures. The identified habitation sites within the intermediate zone of Keopuka were not associated with any agricultural sites, but appear to have been isolated recurrent or temporary use sites, including several "refuge" caves.

Further archaeological study of the intermediate zone of Keopuka would likely find more evidence of traditional land use activities, including agricultural sites and additional scattered habitation sites. Because the intermediate zone of Keopuka is predominantly exposed *a'a*, traditional agricultural and habitation sites are probably few and widely dispersed, but may include unique adaptations to the difficult conditions imposed by the landscape.

Historic Land Use

The distinction between the coastal zone and the intermediate zone has little meaning for historic land use in Keopuka, for these two zones were combined as part of one parcel, and were most likely subjected to the same historic usage. Based on the known activities of the owner of this parcel, A.A. Todd, and the known use of surrounding lands, historic use of this parcel consisted of either the cultivation of commercial crops, or for cattle ranching. Cattle ranching was the most likely land use activity for both the coastal and intermediate zones of Keopuka, for the same natural constraints which limited traditional agriculture in the intermediate zone of Keopuka, would also have limited historic agriculture as well.

Archaeological evidence of historic land use in the intermediate zone of Keopuka is limited to the historic cart paths or roads noted in several of the earlier surveys, and several other features which exhibited evidence of historic or modern modification. No sites directly attributable to historic habitation, agriculture or ranching were identified during the previous archaeological studies of Keopuka.

More intensive archaeological survey of the intermediate zone would probably find evidence of cattle ranching and perhaps limited historic agriculture. The previous surveys of the majority of the intermediate zone have been limited to reconnaissance surveys, and many of the earlier surveys did not consider such sites historically significant (the surveys of Stokes and Reinecke would have even predated sites considered significant today).

The Upland Zone

Traditional Land Use

Throughout the *ahupua'a* of the Kona coast, the uplands are recognized as having been highly suitable for intensive agriculture, and were extensively utilized for the cultivation of traditional crops in both prehistoric and historic times. In Kaawaloa, Menzies described the uplands as "industriously laid out in little fields... not a spot that would admit of it but was with great labor and industry cleared of the loose stones and planted with esculent roots or some useful vegetables or other" (Menzies 1920:74-75). Research on the Kona Field System has identified the area between approximately 1000 feet and 2500 feet a.m.s.l., as having been cultivated in such traditional crops as Taro, sweet potatoes, *ti*, and sugarcane.

Evidence of traditional land use within the upland zone of Keopuka was obtained during the 1989 PHRI inventory survey, which provided 100% coverage of a 248 acre parcel in Onouli and Keopuka (the exact boundary between the two *ahupua'a* is not clear), part of which included portions of the upland zone of Keopuka. Roughly half of the 57 sites identified during this project were interpreted as associated with the Kona Field System and, "consisted primarily of agricultural features among which are interspersed occasional and ceremonial or burial features" (Rosendahl and Jensen 1989:14). Agricultural features include walls (some of which perhaps delineated prehistoric fields), pits, terraces, mounds, and enclosures. Habitation sites consist of possible permanent habitation features such as platforms and large terraces, and possible temporary habitation features including a wall segment, a modified sink, and a C-shaped enclosure. Evidence of other traditional land use activities include possible burial features, including platforms and cave sites, and steppingstone trail segments.

Further archaeological work within the unsurveyed portions of the upland zone of Keopuka would likely find a similar range of site types associated with traditional land use, and further testing could be used to clarify the tentatively interpreted site functions and provide dates to establish the chronology of traditional land use in the upland zone of Keopuka. Further evaluation could also be done of the habitation sites to determine the percentage of permanent and temporary habitation features, and their affiliation with nearby agricultural or other sites.

Historic Land Use

The upland zone of Keopuka was divided into four parcels during the Mahele, each considerably smaller than the fifth parcel which, as previously mentioned, included most of the coastal and intermediate zones of Keopuka. Each of these four parcels was sold to one of the foreigners who, by the middle of the nineteenth century, had come to settle in the Kealakekua Bay area. At least one of these new owners lived on his parcel, D. Barrett, who also reportedly raised cattle nearby. Two other owners of Keopuka lands lived close by, One in Onouli and one in Kaawaloa.

Although no information was found indicating the specific uses to which these owners put their Keopuka lands to, these and subsequent Keopuka land owners have been associated with a wide range of historic land use activities in nearby lands, including the commercial cultivation of sugar, coffee and pineapples; the raising of cattle, sheep and goats; and the harvesting of forest products. Unlike the coastal and intermediate zones of Keopuka, the upland zone afforded conditions favorable for the cultivation of both traditional and historic crops, so it is likely that the cultivation of commercial crops occurred in some portions of the

upland zone. By the late nineteenth and early twentieth centuries, virtually all of these lands came under the ownership of H.N. Greenwell or his heirs, and it is probable that under their control, some of these lands were used for cattle ranching, which was their primary business throughout the Kona Districts.

Archaeological evidence of historic land use in the upland zone of Keopuka includes sites associated with ranching, such as boundary and other walls, enclosures, platforms and terraces (interpreted as ranch clearing features), and water troughs. Historic habitation sites were also identified and included enclosures and a wall-lined depression. Other historic sites include cart path, or road segments and a railroad bed.

Further archaeological study of the upland zone of Keopuka would likely find a similar range of sites associated with ranching, and dating samples of agricultural sites could determine the extent to which the upland zone was used for historic agriculture. In the unsurveyed portions of the upland zone that have not already been altered by historic and modern development, evidence of historic house sites may also be found, perhaps attributable to specific persons or families.

SURVEY RESULTS

A total of 165 features were identified in the project area and subsequently grouped into 70 sites. Each site and individual component feature was documented during the inventory survey, including descriptions of the following: geological landscape, surrounding vegetation, formal site/feature type, metric dimensions, quantity and description of component features, tentative function, presence of cultural material, state of preservation and estimated excavation potential. In addition to the descriptive record, almost all of the identified sites and features were drawn to scale on either individual site maps or on the overall project map (see Figure 4). This information is included below within each site description.

A. Site Descriptions

State Site #: 50-10-47-1948 **CSH Site #:** 5

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	6
Dimension:	969.0 m.^{2} (10,465.2 ft.^{2})
Elevation:	10-17 ft. a.m.s.l.

Description: Site 1948 (Figure 9) is a complex located near the coast on terrain composed of beach sand and pahoehoe outcrops. The vegetation includes coconut trees, scrub *kiawe*, various grasses, lantana and *noni*. The complex consists of six features, designated Features A to F. The entire area of the complex measures 34.0 m. (111.5 ft.) N/S by 28.5 m. (93.5 ft.) E/W.

The site is interpreted as a permanent habitation complex based on the substantial architecture of the features in combination with the site's multiple-feature design. This interpretation was also supported by the testing results of Test Unit 8, which was excavated in Feature A of this site (see the *Excavations Results* section of this report).

Feature A is an irregular enclosure comprising two contiguous C-shaped enclosures. The entire feature measures 8.0 m. (26.2 ft.) NW/SE by 3.6 m. (11.8 ft.) NE/SW. Vertical facing occurs in sections of the enclosure walls, ranging in height from 0.9 m. to 1.0 m. (3.0 ft. to 3.3 ft.). The C-shapes are constructed of small to medium sized pahoehoe boulders and cobbles. Exposed sections of outcrop are integrated into the C-shape structures. Each C-shape encloses a circular area measuring roughly 3.0 m. (9.8 ft.) in diameter and both open to the southwest (*makai*). The interior of Feature A is level beach sand.

A scattering of marine midden, boulders, and small to medium-sized pieces of coral were observed. A single glass jug was observed in the northeast wall of the feature and several glass fragments were observed on the ground surface, some of which were collected as surface artifacts of Test Unit 8. Approximately 20.0 m. (65.6 ft.) northwest of Feature A, there is a small salt pan or bait cup pecked into a large pahoehoe boulder.

Feature A is considered to be in fair to poor condition with fair excavation potential. Limited subsurface testing was conducted at this feature (see *Excavation Results* section of this report).

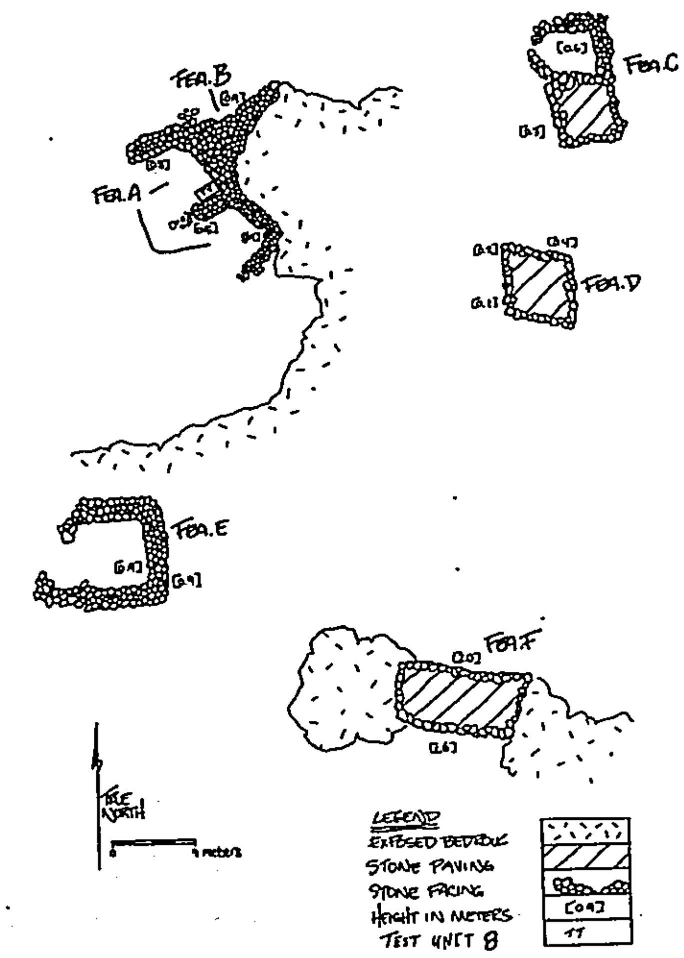


Figure 9 Site 50-10-47-1948 Complex, Features A through F; Plan View

Feature B is a terrace which abuts Feature A to the northeast and pahoehoe outcrop to the southeast. The terrace measures 4.0 m. (13.2 ft.) NE/SW by 2.0 m. (6.6 ft.) NW/SE. The northwest edge of the terrace is vertically faced to a measured height of 0.95 m. (3.1 ft.). The perimeter is constructed of boulders and the surface is paved with cobbles. Coral and historic glass were observed on the surface of the terrace.

Feature B is considered to be in fair condition with fair excavation potential.

Feature C consists of a small, roughly square platform and a contiguous enclosure. It is located approximately 20.0 m. (65.5 ft.) east of Features A and B. The platform measures 4.0 m. (13.1 ft.) by 3.0 m. (9.8 ft.). The platform edges measure 0.3 m. (1.0 ft.) high, maximum, and are tumbled in some sections. The platform perimeter is constructed of larger boulders. The surface is paved with cobbles.

The enclosure abuts the north edge of the platform and measures 3.8 m. (12.5 ft.) N/S by 3.8 m. (12.5 ft.) E/W. The enclosure walls measure 0.6 m. (1.0 ft.) high and 0.8 m. (2.6 ft.) thick. It is constructed of pahoehoe boulders and cobbles. The walls of the enclosure have tumbled and the interior consists of exposed outcrop mixed with shallow soil deposits. Shell midden was observed.

Feature C is in fair to poor condition with poor excavation potential.

Feature D is a low, square platform located 5.0 m. (16.4 ft.) south of Feature C and approximately 10.0 m. (32.8 ft.) southeast of Feature A. The platform measures 3.5 m. (11.5 ft.) N/S by 3.5 m. (11.5 ft.) E/W, and rises a maximum height of 0.4 m. (1.3 ft.). The feature is constructed of small pahoehoe boulders and cobbles with larger boulders along the perimeter. The platform is one to two courses above the outcrop surface.

Small amounts of shell midden were observed, but no artifacts were observed.

Feature D is in fair to poor condition with fair to poor excavation potential.

Feature E is a rectangular enclosure located 11.0 m. (36.1 ft.) south of Feature A. The feature measures 6.0 m. (19.7 ft.) E/W by 5.0 m. (16.4 ft.) N/S. The enclosure walls average 0.7 m. (2.3 ft.) in thickness and measure 0.9 m. (3.0 ft.) high, maximum. The enclosure walls are core-filled. Coral, cowrie and *opihi* were observed. Historic glass was also observed and the enclosure may have been used as a glass bottle dump.

Feature E is in good condition and excavation potential is good.

Feature F is a rectangular terrace located 11.5 m. (37.7 ft.) southeast of Feature E. The terrace measures 6.0 m. (19.7 ft.) E/W by 3.0 m. (9.8 ft.) N/S, to a maximum height of 2.0 m. (6.6 ft.). The terrace is flush with pahoehoe outcrop to the east. The north and south edges of the terrace are constructed of boulders and the surface is cobble-filled.

Shell midden was observed.

Feature F is in good condition with good excavation potential.

State Site #: 50-10-47-1949	
Site Type:	Complex
Age:	Prehistoric
Function:	*Heiau*
Features (#):	2
Dimension:	106.4 m.² (1,149.1 ft.²)
Elevation:	23-24 ft. a.m.s.l.

Description: Site 1949 (Figures 10 and 11) is a complex located approximately 50 m. (165 ft.) from the coast, in undulating terrain of pahoehoe bluffs and ridges. Scattered pockets of soil support *noni*, low coastal shrubs and grasses. The complex consists of two features, designated Features A and B.

Feature A is a platform measuring 7.0 m. (23.0 ft.) N/S by 5.0 m. (16.4 ft.) E/W. Along the south edge, the platform measures 1.7 m. (5.6 ft.) high above the outcrop surface. The edges of the platform are constructed of large boulders with small boulders filling the spaces. The north, east, and south faces are well-faced with the west side being collapsed. Two enclosure sub-features abut the west edge of the platform, in the northwest and southwest corners. The condition of these two enclosures is poor and may be the result of wall collapse, possibly due to wave action. The northwest enclosure measures almost 1.0 m. (3.3 ft.) in diameter and is filled with rubble. The southwest enclosure is rectangular-shaped and measures 1.5 (4.9 ft.) N/S by 1.0 m. (3.3 ft.) E/W and is also filled with rubble.

Located in the center of the platform surface is an upper tier sub-feature. The tier is square-shaped and measures approximately 0.6 m. (2.0 ft.) above the surface of the platform (2 to 3 courses high).

A circular depression was observed in the southeast corner of the tier and measures 0.5 m. (1.6 ft.) in diameter. The tier may have functioned as an altar and the depression in the upper tier may have held an idol.

The substantial construction of the platform and internal features (including a probable altar) strongly suggests that the feature is a *heiau*. Its close location to the coast may indicate that it as a *koa* or fishing shrine.

Some marine midden was observed, but no artifacts.

Feature A is in good condition and excavation potential is fair.

Feature B is a rectangular pavement located approximately 15.2 m. (49.9 ft.) west of Feature A. It measures 2.6 m. (8.5 ft.) N/S by 1.6 m. (5.2 ft.) E/W. The feature is a level ʻaʻā cobble and pebble pavement. A few cobbles are utilized to outline the perimeter of the pavement along the north and west sides. The feature was constructed directly on a rough pahoehoe bluff.

A modern surveyor's *ahu* lies at the northeast corner of Feature B with a survey pole standing upright. A USGS benchmark is located 4.6 m. (15.1 ft.) to the north. Pahoehoe excavations and broken pahoehoe rubble surround the feature on all sides, but with greater frequency to the east. Given that Feature B is located in close proximity to Feature A, it is also interpreted as a *heiau*.

No midden or artifacts were observed.

Feature B is in poor condition and excavation potential is poor.

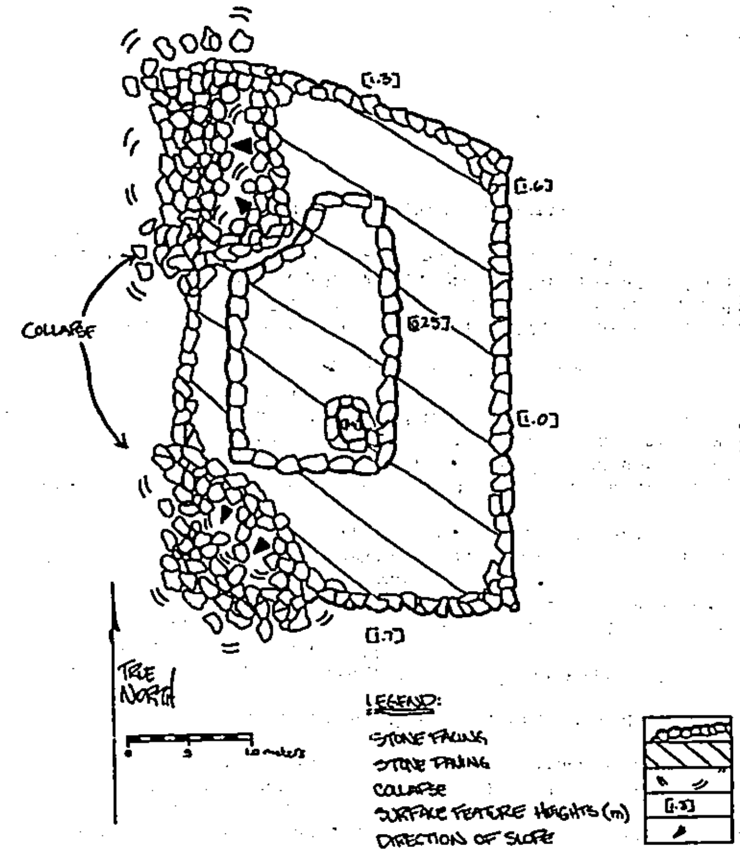


Figure 10 Site 50-10-47-1949, Feature A Platform; Plan View

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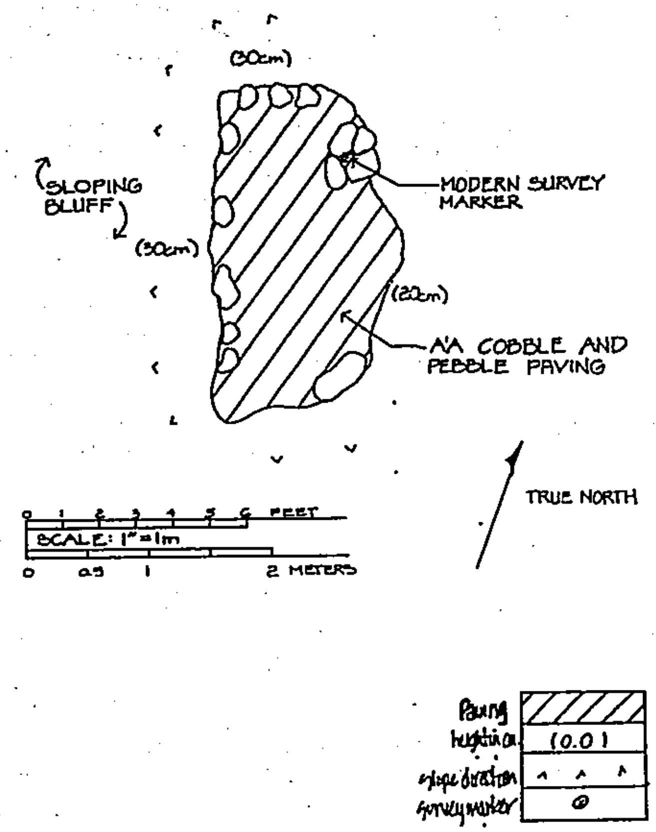

Figure 11 Site 50-10-47-1949, Feature B Pavement; Plan View

50

State Site #: 50-10-47-1950 **CSH Site #:** 11

Site Type: Complex
Age: Prehistoric
Function: Recurrent habitation
Features (#): 3
Dimension: 536.0 m.^{2} (5,788.8 ft.^{2})
Elevation: 35 ft. a.m.s.l.

Description: Site 1950 (Figure 12) is a complex located in undulating pahoehoe terrain. Spots of lantana and grass occur near the complex. The complex consists of three features, designated Features A to C. All three features are interpreted as individual shelters that were utilized on a recurrent basis. This interpretation is based on the individual feature's small size, minimal degree of construction and primarily C-shape design. The complex is in an isolated location in a barren lava landscape inland from the coastal edge. Its location may indicate that it was once associated with a trail that traversed the coast or that it was associated with fishing activities.

Feature A is a rockshelter located on the northwest side of a high pahoehoe outcrop. The shelter measures 2.5 m. (8.2 ft.) NE/SW by 1.1 m. (3.6 ft.) NW/SE with a maximum ceiling height of 0.8 m. (2.6 ft.). A rough wall is constructed directly in front of, and enclosing, the rockshelter entrance. The wall measures 2.0 m. (6.6 ft.) NW/SE by 2.75m. (9.0 ft.) NE/SW and 0.7 m. (2.3 ft.) high. It is constructed of a rough piling of pahoehoe boulders and cobbles. Midden was observed on the floor of the shelter.

At 2.5 m. (8.2 ft.) to the northwest, an associated sink was observed. It measures 1.5 m. (4.9 ft.) in diameter and has an encircling, constructed wall which measures 0.8 m (2.6 ft.) high and 0.6 m. (2.0 ft.) thick. No cultural material was observed.
Feature A is in fair condition and excavation potential is poor.

Feature B is two contiguous C-shaped enclosures located 9.5 m. (31.2 ft.) south of Feature A. The north C-shape is partially collapsed and measures 2.7 m. (8.9 ft.) N/S by 2.5 m. (8.2 ft.) E/W. (2.0 ft.), and to a maximum height of 0.5 m. (1.6 ft.). Construction is of pahoehoe boulders and the interior is exposed pahoehoe and scattered cobbles. Midden was observed in and around Feature B. A water-rounded boulder was incorporated into the *makai* opening of this north C-shape.

The contiguous C-shape to the south is similar in construction and is well-preserved. This C-shape measures 3.0 m. (9.8 ft.) E/W by 2.9 m. (9.5 ft.) N/S. The walls have a maximum thickness of 0.75 m. (2.5 ft.) and reach a maximum height of 0.6 m. (2.0 ft.). The C-shape is constructed of pahoehoe boulders and cobbles and appears to be core-filled. The south C-shape opens to the west and the interior is rough boulder/cobble fill.
Scattered midden was observed, but no artifacts were observed.
Feature B is in poor condition excavation potential is poor.

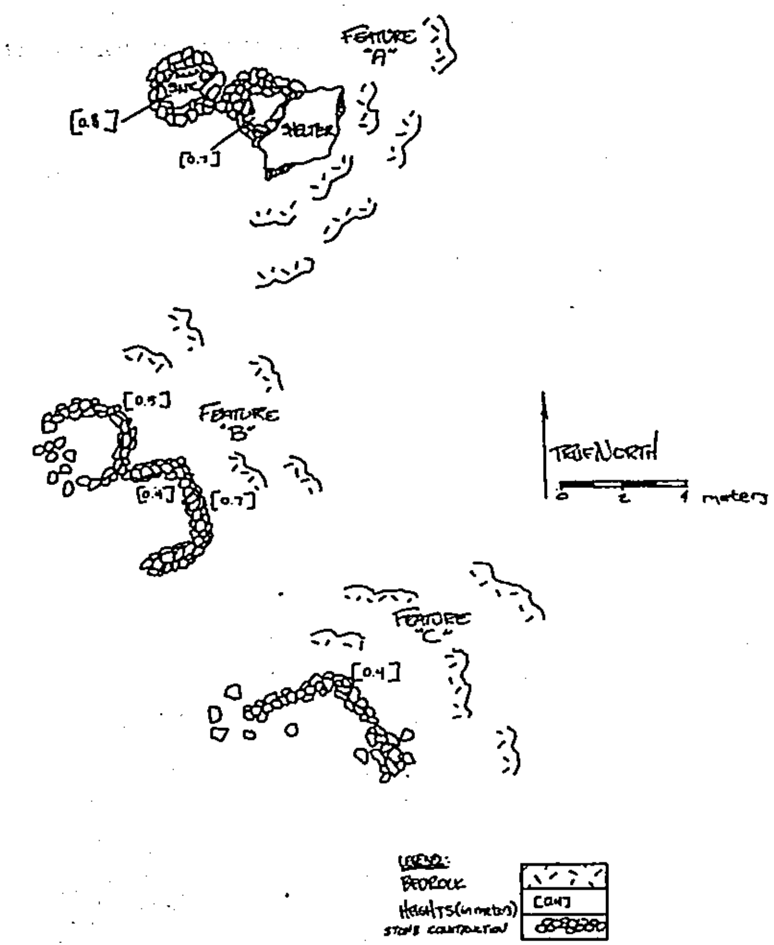

Figure 12 Site 50-10-47-1950 Complex, Features A through C; Plan View

Feature C is a C-shaped enclosure located 5.0 m. (16.4 ft.) southeast of Feature B. The feature measures 4.0 m. (13.1 ft.) N/S by 3.5 m. (11.5 ft.) E/W. The walls have an average thickness of 0.6 m. (2.0 ft.) and reach a maximum height of 0.6 m. (2.0 ft.). The walls are of core-filled, pahoehoe cobble and boulder construction. The C-shape is open to the southwest. The interior surface consists of outcrop and loose, small boulders. Some midden was observed.

A short core-filled wall abuts the C-shape to the north. This wall measures 3.3 m. (10.8 ft.) long, 0.6 m. (2.0 ft.) thick, and 0.7 m. (2.3 ft.) high. It is constructed of pahoehoe boulders and cobbles and water-rounded boulders. Sections of the wall are collapsed.

Feature C is in poor condition and excavation potential is poor.

State Site #: 50-10-47-1951 **CSH Site #:** 12

Site Type: Platform
Age: Prehistoric
Function: Temporary habitation
Features (#): 1
Dimension: 8.4 m^2 (90.7 ft^2)
Elevation: 20 ft. a.m.s.l.

Description: Site 1951 is a roughly rectangular platform located 15.2 m. (49.9 ft.) from the edge of a sea cliff atop a pahoehoe bluff (Figure 13). The surrounding vegetation consists of three to four *noni* trees. The platform measures 3.5 m. (11.5 ft.) N/S by 2.4 m. (7.9 ft.) E/W and is constructed of pahoehoe cobbles and boulders. The north edge is well-preserved and measures to a height of 0.8 m. (2.6 ft.). The west side of the site has probably been damaged by wave action. The perimeter of the platform is raised on the north, east, and south sides giving the platform a U-shaped appearance.

One water-rounded hammerstone was observed in the northwest corner of the platform, but no midden was present.

Site 1951 is in fair condition and excavation potential is fair.

State Site #: 50-10-47-1952 **CSH Site #:** 16

Site Type: Complex
Age: Prehistoric
Function: Permanent habitation; possible Burial
Features (#): 7
Dimension: 1,152.2 m^2 (12,443.8 ft^2)
Elevation: 20-30 ft. a.m.s.l.

Description: Site 1952 is a complex located on varying terrain of undulating pahoehoe ridges, bluffs, and level areas. The complex consists of seven features, designated Features A to G (Figure 14).

The complex is interpreted as a permanent habitation site, with the smaller and less substantial features being auxiliary structures, such as a storage shed or food processing area (*e.g.*, Feature E and G) and a lithic workshop (*e.g.*, Feature F). The primary habitation

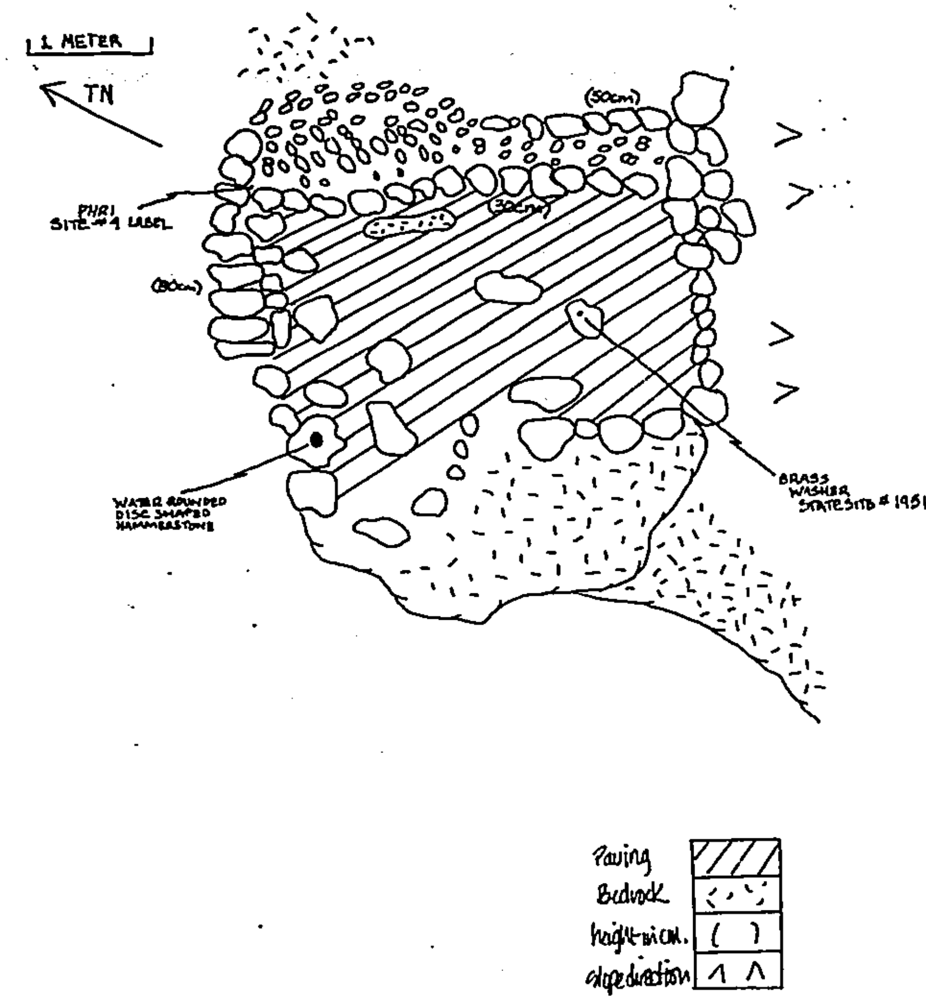

Figure 13 Site 50-10-47-1951 Platform; Plan View

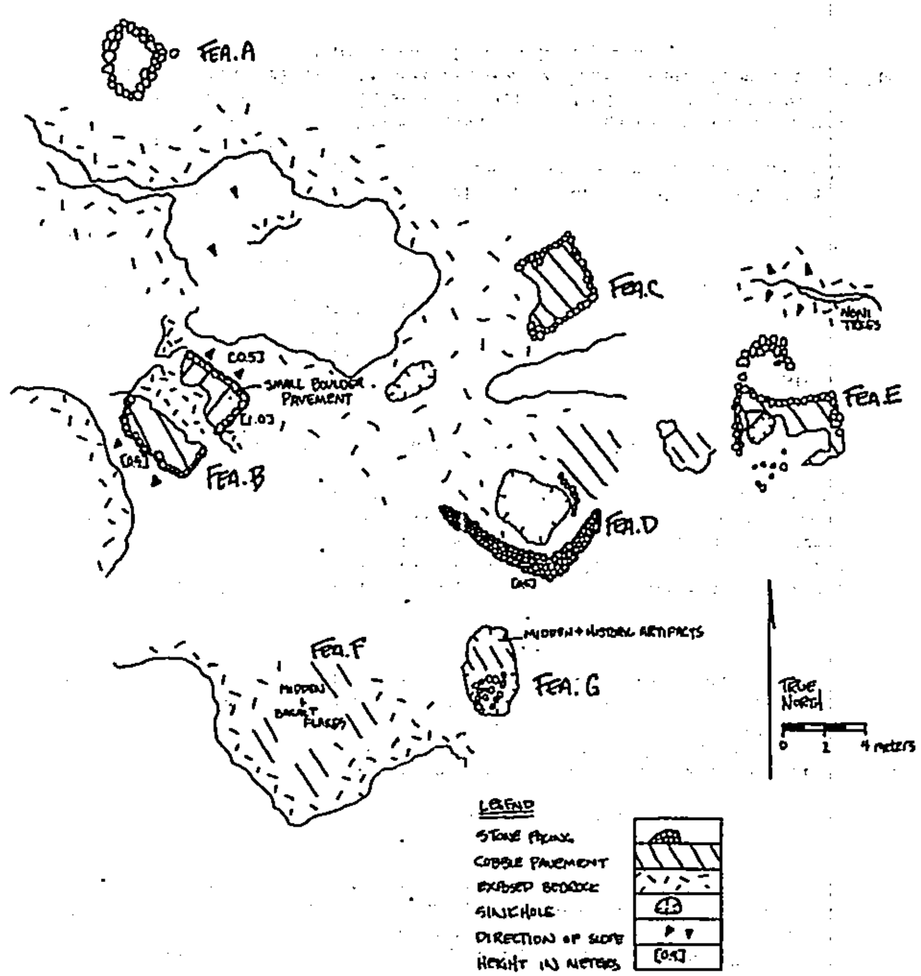

Figure 14 Site 50-10-47-1952 Complex, Features A through G; Plan View

features of the complex probably include the more substantial constructions with larger floor areas, such as Features B, C, and D. Feature A is interpreted as a possible burial because of its small size, elevated height and its location over a crevasse in the pahoehoe outcrop (*i.e.*, possibly covering a burial placed in an underlying crack, lava tube or blister).

Feature A is a small triangular platform located on top of a pahoehoe bluff. The feature measures 3.5 m. (11.5 ft.) NW/SE by 3.0 m. (9.8 ft.) NE/SW. The northwest corner measures 0.8 m. (2.6 ft.) high. The perimeter of the feature is constructed of pahoehoe boulders and the interior is small boulders and cobbles. Feature A appears to cover a crack in the pahoehoe, indicating the possibility of a burial.

No midden or artifacts were observed. Feature A is in fair to poor condition.

Feature B is a platform located approximately 12.0 m. (39.4 ft.) south of Feature A. The platform is rectangular and measures 5.7 m. (18.7 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE. The construction of this platform is interesting as it utilizes a level pahoehoe bluff with two terrace-like extensions abutting opposite sides of the bluff. The resulting platform surface consists of two cobble pavements constructed on either side of a naturally level, pahoehoe bluff.

In general, the platform edges are faced pahoehoe boulders and the platform surface is small boulder and cobble pavement. A maximum height of 1.0 m. (3.3 ft.) is measured on the southeast side. The central section of exposed outcrop surface measures 2.5 m. (8.2 ft.) long and the constructed parts of the platform extend approximately 1.6 m. (5.2 ft.) to either side of the outcrop.

No midden or artifacts were observed.
Feature B is in fair condition and excavation potential is poor.

Feature C is a pavement located 13.0 m. (42.6 ft.) northeast of Feature B. The pavement is roughly square-shaped and measures 3.75 m. (12.3 ft.) E/W by 3.5 m. (11.5 ft.) N/S. The perimeter of the pavement is constructed of small pahoehoe boulders. The pavement consists of pahoehoe cobbles and pebbles and it contains both cinder and coral fragments.
No midden or artifacts were observed.
Feature C is in fair to poor condition and excavation potential is poor.

Feature D is a lava blister accessed through a collapsed portion of the blister that has created a depression in the ground surface, or sink. The sink measures 3.2 m. (10.5 ft.) E/W by 2.0 m.(6.6 ft.) N/S. An alignment of small pahoehoe boulders bisects the sink into northeast and southwest halves. The alignment measures 3.0 m. (9.8 ft.) long NW/SE, and 1.0 m. (3.3 ft.) thick. The alignment is poorly preserved and no facing was observed. Within the blister is a small area possibly used as a shelter. The height of the sheltered area ranges between 0.75 m. to 1.0 m. (2.5 ft. to 3.3 ft.). The soil layer within the floor of the lava blister is thin. Abundant shell midden was observed.

An L-shaped, core-filled wall is located on the surface along the southwest and southeast edges of the sink. The wall measures 6.5 m. (21.3 ft.) in length with an average thickness of 0.8 m. (2.6 ft.) and a maximum height of 0.6 m. (2.0 ft.) in the south corner. The walls are core-filled.

A level area of pahoehoe north of the sink was observed. It measures 4.0 m. (13.1 ft.) N/S by 2.5 m. (8.2 ft.) E/W. It is square in shape and cobble paved. Midden was observed in this area.

Feature D is in fair to poor condition and excavation potential is fair.

Feature E is an enclosure remnant located approximately 10.0 m. (32.8 ft.) east of Feature D. The feature measures 6.0 m. (19.7 ft.) E/W by 4.5 m. (14.8 ft.) N/S to a maximum height of 0.4 m. (1.3 ft.). It is constructed of pahoehoe cobbles and boulders. To the south lies a remnant wall which may have been part of this feature. A boulder-filled sink was observed in the northwest corner of the feature and may have functioned as storage space. A pavement was observed in the northeast corner of the feature.

No midden or artifacts were observed.
Feature E is in fair to poor condition and excavation potential is poor.

Feature F consists of a level pavement located 8.5 m. (27.9 ft.) southwest of Feature D. The paving is intermittently scattered over the rougher portions of the outcrop. The feature measures approximately 5.0 m. (16.4 ft.) N/S by 4.0 m. (13.1 ft.) E/W. An abundance of shell midden and some coral fragments and basalt flakes were observed on the surface of the feature. The south end of the feature commands an impressive view of the coast.

Feature F is in fair condition and excavation potential is fair.

Feature G is a lava blister containing a rock shelter. It is located 4.0 m. (13.1 ft.) northeast of Feature F. The feature measures 4.0 m. (ft.) N/S by 2.3 m. E/W with a maximum ceiling height of 1.2 m. (3.9 ft.). The blister is accessed through a sink, and the shelter entrance is to the west (*makai*). The interior floor of the shelter is outcrop and scattered cobbles. Modern glass bottle fragments and rusted metal were observed on the interior floor.

Feature G is in fair to poor condition and excavation potential is poor.

State Site #: 50-10-47-1953 **CSH Site #:** 19

Site Type:	Lava blister
Age:	Prehistoric
Function:	Temporary habitation
Features (#):	1
Dimension:	6.3 m.^{2} (68.0 ft.^{2})
Elevation:	26 ft. a.m.s.l.

Description: Site 1953 (Figure 15) is a modified lava blister located in pahoehoe lava, approximately 20.0 m. (65.6 ft.) from the coast. A *noni* tree is growing in the center of the collapsed sink of the blister.

The sheltered area of the lava blister is accessed through a collapsed sink measuring an roughly 3.0 m. in diameter. The shelter is an overhang of the blister ceiling situated in the northeast side of the sink. The interior of the blister overhang measures 2.8 m. (9.2 ft.) E/W by 2.5 m. (8.2 ft.) N/S with a maximum ceiling height of 1.2 m. (3.9 ft.).

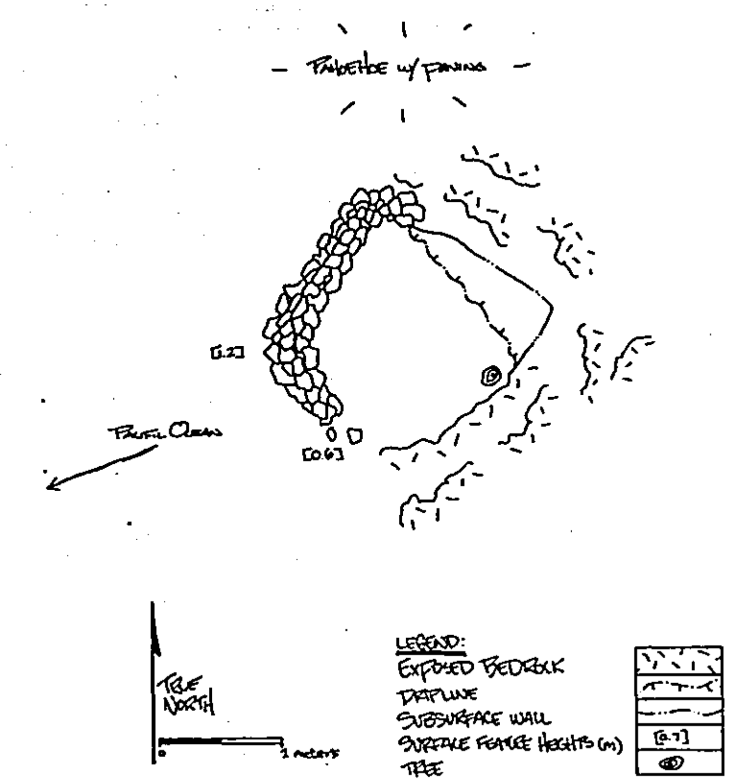

Figure 15 Site 50-10-47-1953 Lava Blister; Plan View

An L-shaped wall has been constructed around the ground surface perimeter of the collapsed sink, on its west side. The wall creates an effective weather break for the interior of the blister. The wall is constructed of boulders and cobbles, measuring 2.5 m. (8.2 ft.) long, 0.9 m. (3.0 ft.) thick, and 1.2 m. (3.9 ft.) high. Midden and historic glass bottle fragments were observed in both the interior of the blister and the surrounding area. To the north of this site are two well-defined pahoehoe excavation sites.

Site 1953 is in fair condition and excavation potential is poor.

State Site #: 50-10-47-1955 **CSH Site #:** 20

Site Type:	Complex
Age:	Prehistoric
Function:	Recurrent habitation
Features (#):	3
Dimension:	553.5 m.^{2} (5,977.8 ft.^{2})
Elevation:	30-39 ft. a.m.s.l.

Description: Site 1955 (Figure 16) is a complex located on a level area of pahoehoe outcrop. The vegetation consists of grass, fern and *noni* trees. The complex consists of an enclosure, designated Feature A, and two lava blisters, designated Features B and C.

The complex is interpreted as a recurrent habitation site because the sizes of the features are small (indicating short-term use) and the site is located in close proximity to other temporary and recurrent shelter sites (Site 1953 and 1956). Feature A and C have relatively substantial architecture and Feature A has a constructed entryway. Both of these characteristics would suggest that the site was utilized on a recurrent basis, rather than temporary.

Site 1955 was previously identified by Reinecke (1930) and it was subsequently recorded in the statewide survey conducted under the state-wide inventory of historic places in the early 1970s (SHPO 1971). Originally Feature C of the present complex was considered to be a separate site and designated as Site 1954. During the present survey, Site 1954 was combined with Site 1955 complex because the three features are spatially associated and appear to be functionally related.

Feature A (see Figure 95) is a square enclosure which measures 3.75 (12.3 ft.) NE/SW by 3.7 m. (12.1 ft.) NW/SE. The walls of the enclosure measure to a maximum height of 0.6 m. (2.0 ft.) and to an average thickness of 0.5 m. (1.6 ft.). The enclosure is constructed of small to medium boulders and cobbles. The interior of the enclosure is rough pahoehoe and a small piece of coral was observed. No other midden or artifacts were observed.

Feature A is in fair condition and the excavation potential is poor.

Feature B is a lava blister located approximately 25.0 m. (82.0 ft.) northwest of Feature A. The entrance into the blister is constricted by two wall segments, one to the north, the other to the south. The walls are constructed of small to medium-sized boulders. A large Christmas-berry tree obstructs the entrance to the shelter area of the blister.

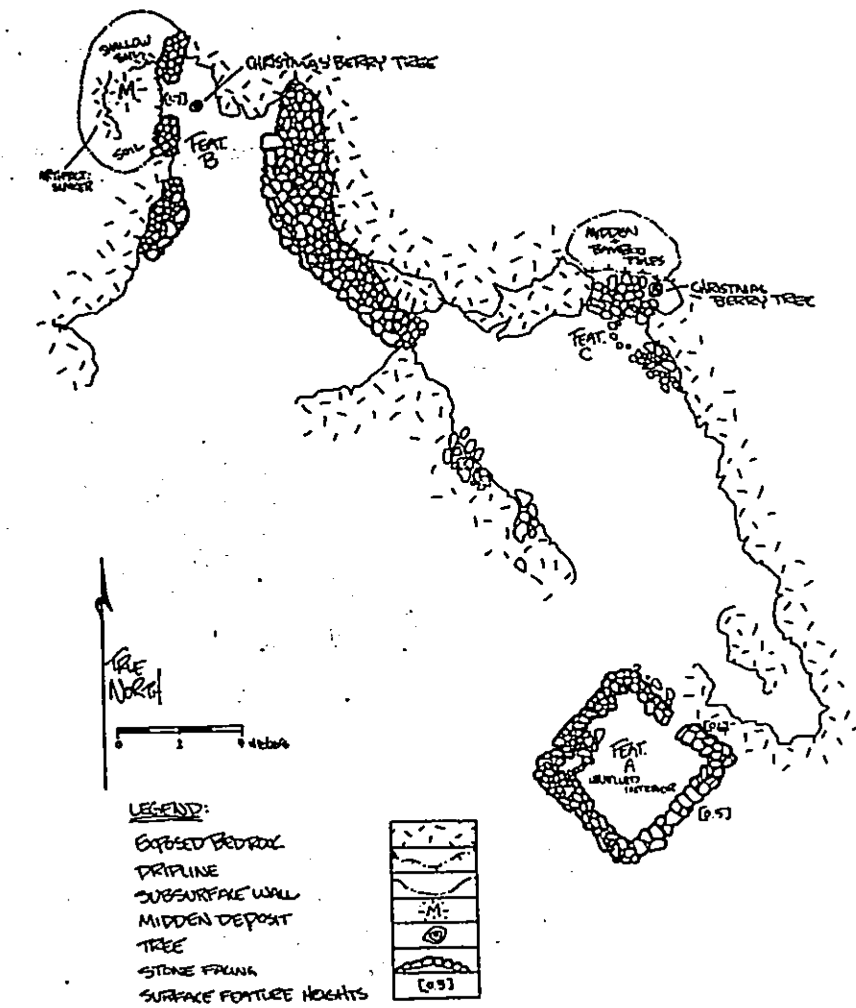

Figure 16 Site 50-10-47-1955 Complex, Features A through C; Plan View

The shelter itself is spacious with several shelves and two, small, lower chambers. The blister measures 5.0 m. (16.4 ft.) N/S by 2.2 m. (7.2 ft.) and the maximum ceiling height measures 2.0 m. (6.6 ft.).

The main floor of the blister is shallow soil on a lava surface. Scattered midden was observed including *opihi*, *pipipi* and sea urchin. Four indigenous artifacts were collected from Feature B (Accs. 5 through 8) and include: two wooden spear fragments, one coconut cup, and one basalt sinker. Historic artifacts observed include: bottles, rusted cans, and a bamboo pole.
Feature B is in good condition and excavation potential is good to fair.

A wall extends between Feature B and C, measuring 9.0 m. (29.5 ft.) long N/S and 2.0 m. (6.6 ft.) thick, maximum. A portion of the wall terraces the edge of the pahoehoe outcrop.

Feature C is a lava blister located approximately 15.0 m. (49.2 ft.) north of Feature A. The entrance to the blister is horizontal measuring 2.5 m. (8.2 ft.) wide by 2.3 m. (7.5 ft.) high. Outside of the entrance the ground surface is paved and measures 3.5 m. (11.5 ft.) N/S by 2.0 m. (6.6 ft.) E/W; it is constructed of small to medium boulders and cobbles. The entrance is currently blocked by Christmas-berry and *noni* trees. The shelter area of the blister measures 3.5 m. (11.5 ft.) E/W by 2.0 m. (6.6 ft.) N/S. The ceiling height ranges from 2.0 m. (6.6 ft.) to 2.3 m. (7.5 ft.). Scattered midden and bamboo poles were observed inside the blister.

Feature C is in fair condition and excavation potential is fair to poor.

State Site #: 50-10-47-1956 **CSH Site #:** 22
Site Type: Platform
Age: Prehistoric
Function: Recurrent habitation
Features (#): 1
Dimension: 22.0 m.^{2} (237.6 ft.^{2})
Elevation: 25 ft. a.m.s.l.

Description: Site 1956 (Figure 17) is a platform located in an undulating mix of pahoehoe and 'a'ā lava terrain. The vegetation consists of grass, shrubs, and small *noni* trees. The site is interpreted as a recurrent habitation shelter because of its proximity to and structural similarity with other probable temporary and recurrent use shelters (Sites 1953 and 1955) on the coast. The shelter was probably utilized on a recurrent basis (*i.e.*, longer than a day shelter and perhaps seasonally) since its architecture is more substantial and it has a larger floor area than the typical temporary habitation shelters.

The low platform measures 5.5 m. (18.0 ft.) N/S by 4.0 m. (13.1 ft.) E/W and reaches a maximum height of 0.5 m. (1.6 ft.). The perimeter of the platform is constructed of medium to large 'a'ā boulders. The surface is a rough pavement of pahoehoe cobbles with scattered boulders. Less than 2.0 m. (6.6 ft.) to the southeast, a wall segment extends and curves southward to a nearby pahoehoe outcrop. A site tag from a previous survey (PHRI flag 89-769-8 - 2/27/90) was observed at this site.

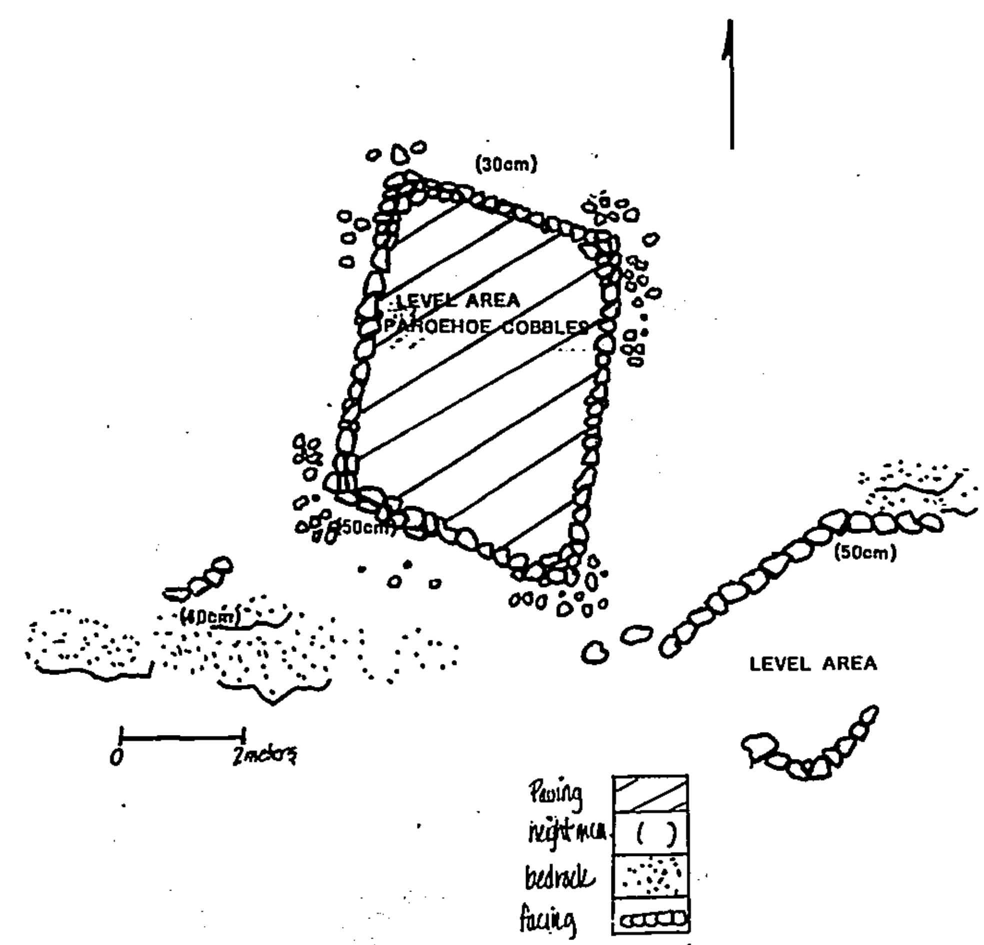

Figure 17 Site 50-10-47-1956 Platform; Plan View

Marine shell midden and two small coral branches were observed. Broken glass was observed approximately 10.0 m. (32.8 ft.) to the northeast. No indigenous artifacts were present.

Site 1956 is in poor condition and excavation potential is fair.

State Site #: 50-10-47-1957 — **CSH Site #: 23**

Site Type:	U-shaped enclosure
Age:	Prehistoric
Function:	Recurrent habitation
Features (#):	1
Dimension:	10.5 m.^{2} (113.4 ft.^{2})
Elevation:	24 ft. a.m.s.l.

Description: Site 1957 (Figure 18) is a U-shaped enclosure located in level pahoehoe lava terrain. A HRHP site tag (State site # -1957) was observed on the west side of the enclosure. The site is located approximately 30.0 m. (98.4 ft.) north of the coastline.

Site 1957 is interpreted as a recurrent habitation site because of its small size in combination with its bifaced wall architecture. It also in close proximity to other temporary and recurrent shelters (Sites 1953, 1955, 1956 and 17181).

The enclosure measures 3.5 m. (11.5 ft.) NE/SW by 3.0 m. (9.8 ft.) NW/SE with a maximum wall height of 0.8 m. (2.6 ft.) and a maximum wall thickness of 0.5 m. (1.6 ft.). The enclosure is constructed of small boulders and large cobbles. There is sand and shell midden in the interior of the enclosure. Historic glass fragments were also observed. Coral was observed west (*makai*) of the site but no other midden or artifacts were present.

Site 1957 is in good condition and excavation potential is fair to poor.

State Site #: 50-10-47-1958 — **CSH Site #: 24**

Site Type:	Complex
Age:	Prehistoric
Function:	Recurrent habitation/possible burial
Features (#):	3
Dimension:	647.8 m.^{2} (6,996.2 ft.^{2})
Elevation:	25 ft. a.m.s.l.

Description: Site 1958 (Figure 19) is a complex consisting of three features, designated Features A to C. The site is located in undulating `a`a and rough pahoehoe terrain. The vegetation in the area consists of grass and lantana. An HRHP site marker (State site # -1957) and a PHRI site marker "89-769-10", were observed at Feature B. Feature B was originally identified by Reinecke (1930) as a *heiau*. However, the HRHP records report that the "building stages and puoa appearance of [the] platforms makes it virtually certain that it is a burial" (SHPO 1971).

The remaining two features (Features A and C) are interpreted as recurrent-use habitation shelters. The construction of these features appear more substantial than

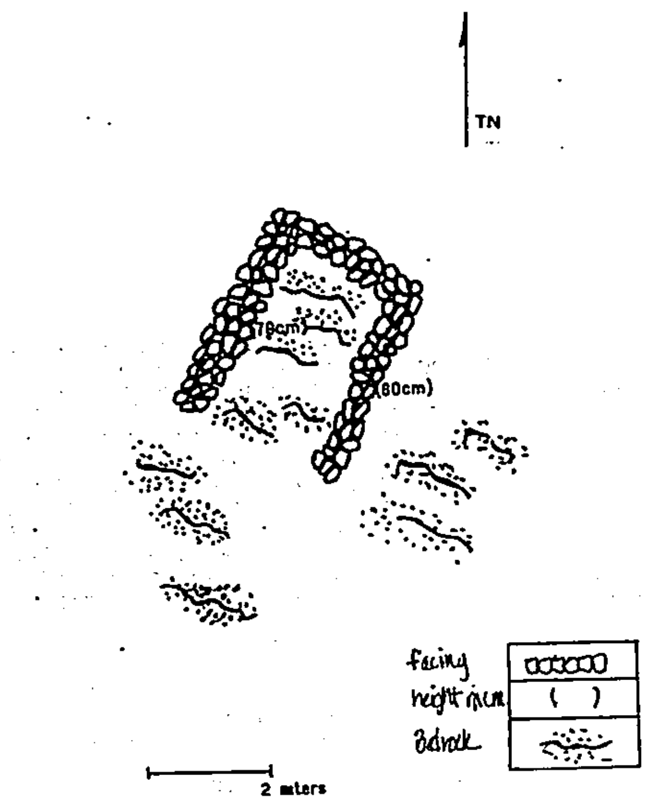

Figure 18 Site 50-10-47-1957 Enclosure; Plan View

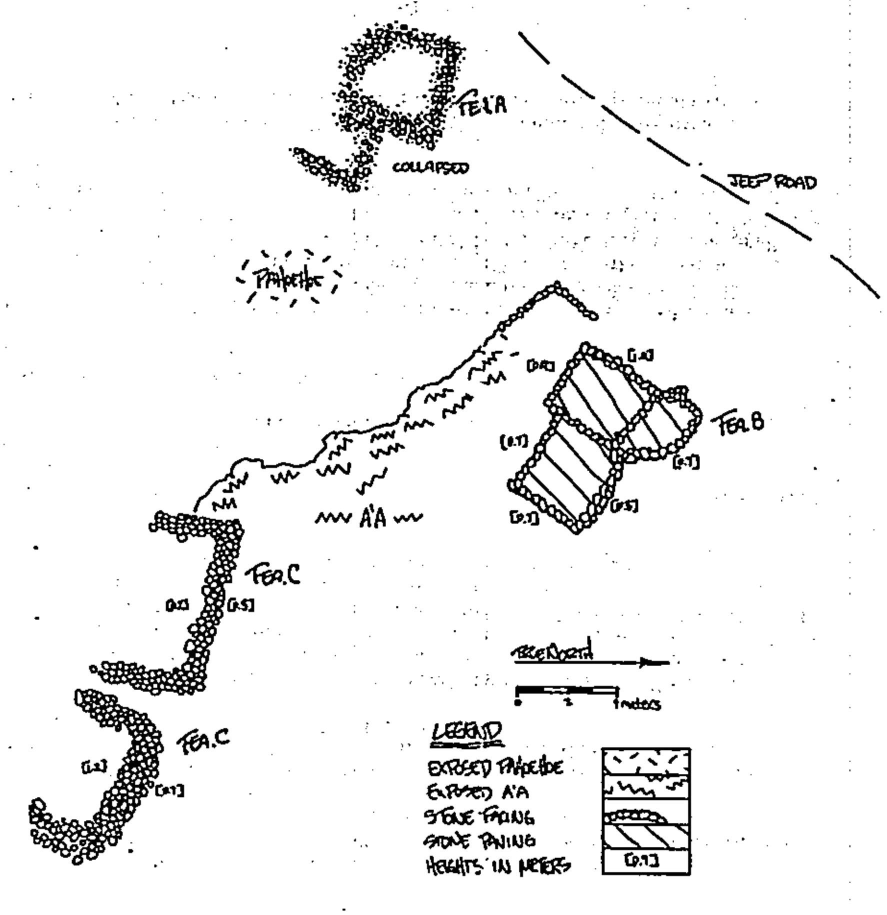

Figure 19 Site 50-10-47-1958 Complex, Features A through C; Plan View

temporary-use features, but less substantial than permanent habitation structures. The C-shape design of Feature C also supports a non-permanent shelter function. The close proximity of these features to a coastal trail (Site 17183) might also support the recurrent use interpretation.

Feature A is an irregular enclosure, measuring 6.5 m. (21.3 ft.) NW/SE by 5.5 m. (18.0 ft.) NE/SW. The walls of the enclosure measure to a maximum height of 0.9 m. (3.0 ft.) and an average thickness of 0.7 m. (2.3 ft.). The feature is constructed of small to large 'a'ā boulders. No midden or indigenous artifacts were present, but glass fragments and paper were observed.

Feature A is in poor condition and offers fair excavation potential.

Feature B is a platform located approximately 10.0 m. (32.8 ft.) northeast of Feature A. The platform comprises three distinct sections. The main section is roughly square-shaped. Two smaller, lower, platform sections abut the north and east sides of the main section. Overall, the platform measures 6.5 m. (21.3 ft.) E/W by 5.0 m. (16.4 ft.) N/S. The edges of the platform range in height from 0.7 m. to 1.0 m. (2.3 ft. to 3.3 ft.). The feature is constructed of medium to large 'a'ā boulders and is paved with small 'a'ā cobbles.

No midden or artifacts were observed. The HRHP records report (in the early 1970's) that an anthurium and breadfruit had been placed at the south end of the platform apparently as an offering.

Feature B is in fair condition and excavation potential is fair.

Feature C comprises two separate C-shaped enclosures located 10.8 m. (35.4 ft.) southeast of Feature A. Overall, the feature measures 15.0 m. (49.2 ft.) NW/SE by 5.0 m. (16.4 ft.) NE/SW. The northernmost C-shape measures 6.8 m. (22.3 ft.) E/W by 4.5 m. (14.8 ft.) N/S. The walls measure to a maximum height of 0.9 m. (3.0 ft.) and a maximum thickness of 0.8 m. (2.6 ft). It is constructed of rough pahoehoe and 'a'ā cobbles and boulders. Remnant facing was observed on the south side. Small to medium boulders are scattered *makai*. The southernmost C-shape measures 4.3 m. (14.1 ft.) N/S by 6.5 m. (21.3 ft.) E/W. The walls measure to a maximum height of 1.2 m. (3.9 ft.) and a maximum thickness of 0.9 m. (3.0 ft.). It is constructed of small boulders and large cobbles. The south side of this C-shape is well-faced.

Large amounts of marine midden were observed throughout the immediate area and included: coral, cowrie, *pipipi*, and other shells. Broken glass bottles were also observed.

Feature C is in fair condition and offers poor excavation potential.

State Site #: 50-10-47-1959 **CSH Site #:** 29

Site Type:	Pavement/C-shaped enclosure
Age:	Prehistoric
Function:	Recurrent habitation
Features (#):	1
Dimension:	80 m.^{2} (864 ft.^{2})
Elevation:	28 ft. a.m.s.l.

Description: Site 1959 comprises a pavement and C-shaped enclosure located atop a rise in undulating ʻaʻā terrain (Figure 20). The site is located 10.0 m. (32.8 ft.) from an access road and is situated at the southern edge of the vegetation line, 25.0 m. (82.0 ft.) from the ocean. Site 17183 trail runs along the *makai* end of the site. A site marker (PHRI 89-769-12 - 2/27/90) was observed on the site.

The site is interpreted as a recurrent habitation site. Although the amount of construction of the features is minimal, its sizeable floor area and its location on the trail (site 17183) suggests that it was a recurrent shelter utilized in association with the trail.

The C-shaped enclosure opens to the southeast and measures approximately 2.0 m. (6.6 ft.) N/S by 2.0 m. (6.6 ft.) E/W. The walls of the enclosure measure to a maximum height of 0.6 m. (2.0 ft.) on the east side. It is constructed of stacked cobbles and small boulders.

The pavement, surrounding the C-shaped enclosure, measures 11 m. (118.8 ft.) E/W by 8.0 m. (26.2 ft.) N/S. The edge of the pavement is lined with cobbles and small boulders and there is one interior alignment. The pavement surface is cleared and leveled with cobbles and small boulders. The interior alignment in the pavement is approximately 3.0 m. (9.8 ft.) from the west edge.

Assorted shell midden and some coral were observed. A small adze was observed roughly 5 m. (16 ft.) to the northeast, but it was not collected (it was flagged with a red marking tape). A tin can was also observed inside the enclosure.

Site 1959 is in fair condition and the excavation potential is considered fair.

State Site #: 50-10-47-1960 **CSH Site #:** 32

Site Type:	Complex
Age:	Prehistoric
Function:	Confirmed and possible burials
Features (#):	7
Dimension:	320.0 m.^{2} (3,456.0 ft.^{2})
Elevation:	43-60 ft. a.m.s.l.

Description: Site 1960 (Figure 21) is a complex consisting of seven features, terraces and platforms, designated Features A through G (see Figure 96). The complex is located on the edge of an ʻaʻā bluff, approximately 50.0 m. (164.0 ft.) east of State site 17188 shelter. A 4-wheel-drive access road runs along the western boundary of the complex. A test excavation at Feature E confirmed the presence of human remains (see *Excavation Results* section of this report). Based on this information, there is a high probability that the associated features of Site 1960 are burials.

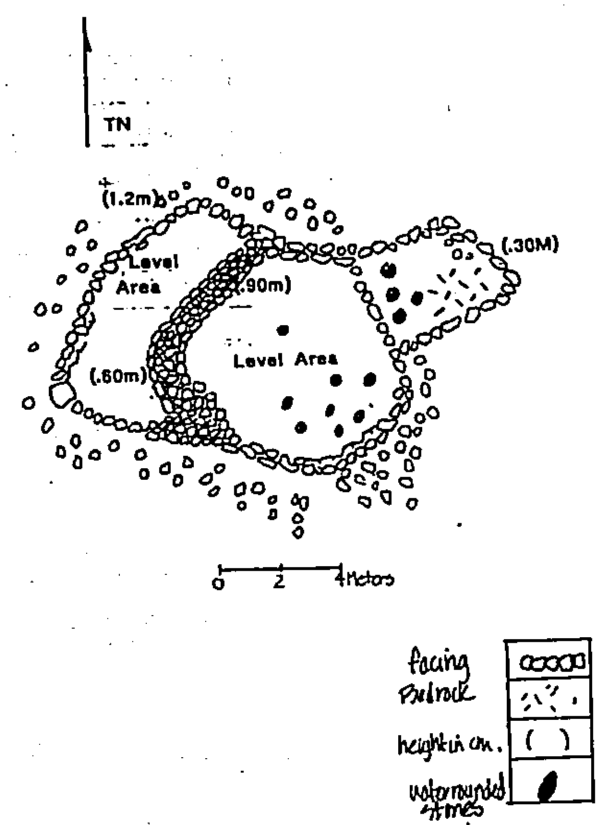

Figure 20 Site 50-10-47-1959 Enclosure-Pavement; Plan View

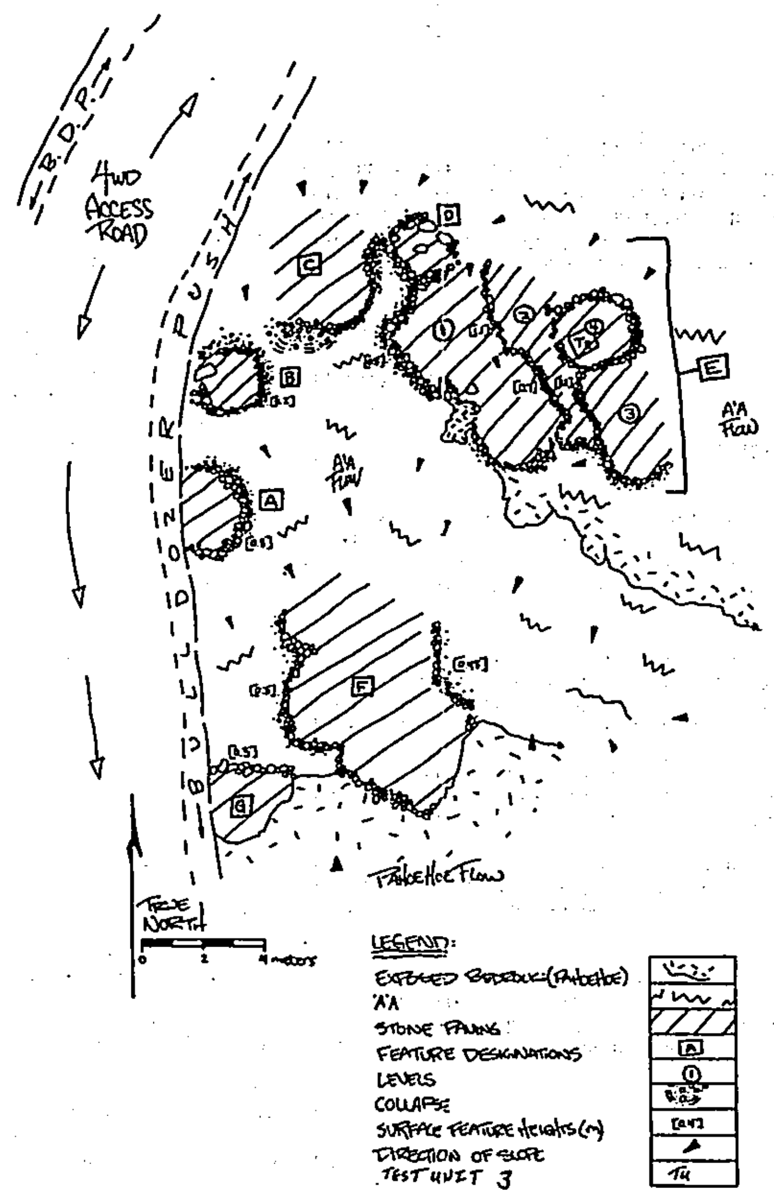

Figure 21 Site 50-10-47-1960 Complex, Features A through G; Plan View

Feature A is a circular terrace located at the western boundary of the complex. The terrace has been partially destroyed by the access road. It measures 2.5 m. (8.2 ft.)N/S by 2.0 m. (6.6 ft.) E/W. A maximum height of 0.8 m. (2.6 ft.) was measured along the eastern edge of the terrace. The perimeter of the terrace is constructed of medium to large 'a'ā boulders and the surface is paved with cobbles and small boulders.

No midden or artifacts were observed.
Feature A is in fair condition, albeit partially destroyed by the road.

Feature B is a small mounded platform located 1.5 m. (4.9 ft.) north of Feature A. The platform measures 2.0 m. (6.6 ft.) in diameter, raised to a maximum height of 0.2 m. (0.6 ft.). The perimeter of the platform is constructed of medium to large boulders and the surface is a cobble pavement.

No artifacts or midden were observed.
Feature B is in fair condition.

Feature C is a terrace located 1.0 m. (3.3 ft.) northeast of Feature B. The terrace measures approximately 3.5 m. (11.5 ft.) in diameter. The southeast edge of the terrace reaches a maximum height of 0.7 m. (2.3 ft.). The south edge is slightly collapsed. The north and west sides are flush with the slope. Construction is similar to Features A and B.

No midden or artifacts were observed.
Feature C is in fair condition.

Feature D is a circular platform located immediately east of Feature C. It measures 2.0 m. (6.6 ft.) in diameter and stands 0.8 m. (2.6 ft.) above Feature C. The perimeter is a boulder construction and the surface is level cobble pavement. There is a large rock slab present in the center of the platform. Feature E is contiguous with the southeast edge of Feature D.

No midden or artifacts were observed.
Feature D is in fair to good condition.

Feature E is a large, multi-level terrace located in sloping 'a'ā terrain. The terrace comprises four levels, designated Levels 1 through 4. The lowest level, Level 1, measures 7.0 m. (23.0 ft.) NW/SE by 3.0 m. (9.8 ft.) NE/SW. Level 1 measures to a maximum height of 1.3 m. (4.3 ft.) above the surrounding ground surface. Level 2 is located immediately northeast of, and stands 1.1 m. (3.6 ft.) above, Level 1. Level 2 measures 7.0 m. (23.0 ft.) NW/SE by 2.0 m. (6.6 ft.) NE/SW. The northwest edge of Level 2 is flush with the slope. Level 3 is adjacent to the southeastern portion of Level 2. It measures 4.0 m. (13.1 ft.) NW/SE by 2.0 m. (6.6 ft.) NE/SW and stands 0.2 m. (0.6 ft.) above Level 2. The northeastern edge of Level 3 is flush with the slope. Level 4 is contiguous with the northwest end of Level 3 and the northeast side of Level 2. Level 4 is a small circular platform measuring 2.5 m. (8.2 ft.) in diameter. It is constructed 0.4 m. (13.1 ft.) high, above Level 2.

Each terrace level of Feature E is faced with 'a'ā boulders and the surfaces are fairly level cobble to small boulder paving.
No artifacts or midden were observed.
Feature E was considered to be in good condition and subsurface testing of this feature confirmed a burial function (see *Excavation Results* section of this report).

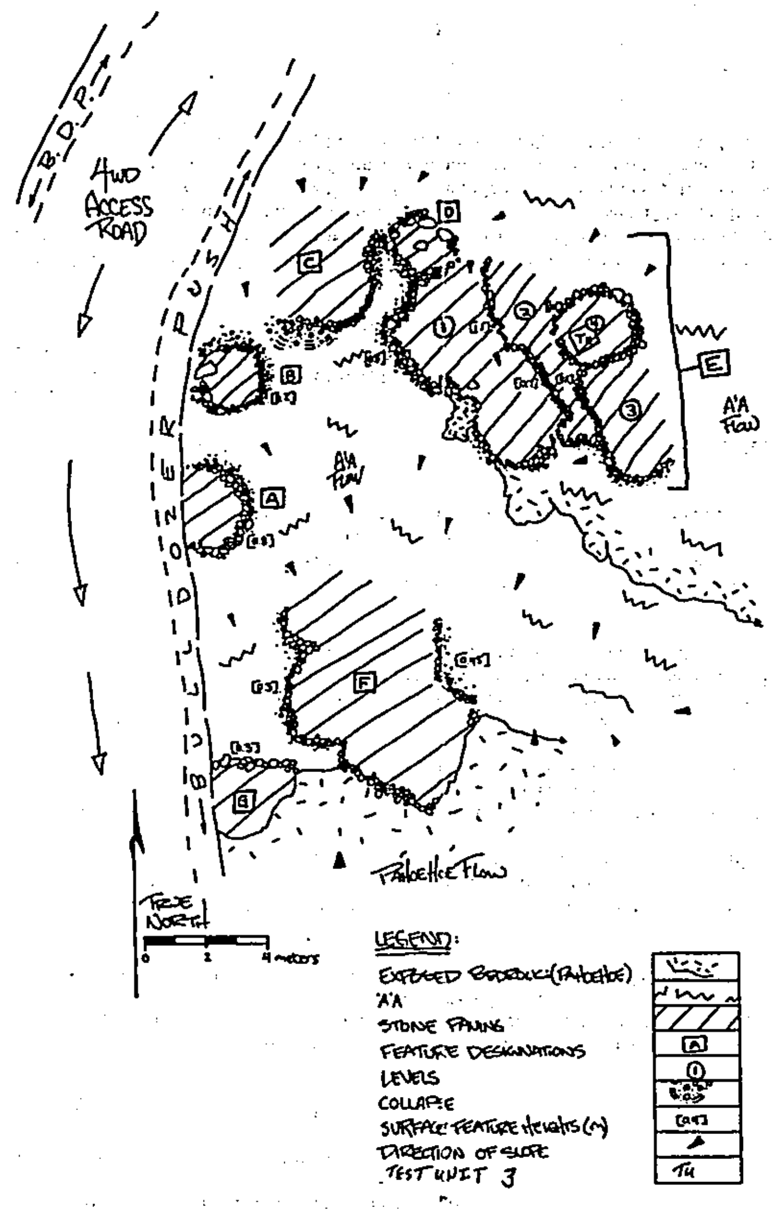

Figure 21 Site 50-10-47-1960 Complex, Features A through G; Plan View

Feature A is a circular terrace located at the western boundary of the complex. The terrace has been partially destroyed by the access road. It measures 2.5 m. (8.2 ft.)N/S by 2.0 m. (6.6 ft.) E/W. A maximum height of 0.8 m. (2.6 ft.) was measured along the eastern edge of the terrace. The perimeter of the terrace is constructed of medium to large 'a'ā boulders and the surface is paved with cobbles and small boulders.

No midden or artifacts were observed.
Feature A is in fair condition, albeit partially destroyed by the road.

Feature B is a small mounded platform located 1.5 m. (4.9 ft.) north of Feature A. The platform measures 2.0 m. (6.6 ft.) in diameter, raised to a maximum height of 0.2 m. (0.6 ft.). The perimeter of the platform is constructed of medium to large boulders and the surface is a cobble pavement.

No artifacts or midden were observed.
Feature B is in fair condition.

Feature C is a terrace located 1.0 m. (3.3 ft.) northeast of Feature B. The terrace measures approximately 3.5 m. (11.5 ft.) in diameter. The southeast edge of the terrace reaches a maximum height of 0.7 m. (2.3 ft.). The south edge is slightly collapsed. The north and west sides are flush with the slope. Construction is similar to Features A and B.

No midden or artifacts were observed.
Feature C is in fair condition.

Feature D is a circular platform located immediately east of Feature C. It measures 2.0 m. (6.6 ft.) in diameter and stands 0.8 m. (2.6 ft.) above Feature C. The perimeter is a boulder construction and the surface is level cobble pavement. There is a large rock slab present in the center of the platform. Feature E is contiguous with the southeast edge of Feature D.

No midden or artifacts were observed.
Feature D is in fair to good condition.

Feature E is a large, multi-level terrace located in sloping 'a'ā terrain. The terrace comprises four levels, designated Levels 1 through 4. The lowest level, Level 1, measures 7.0 m. (23.0 ft.) NW/SE by 3.0 m. (9.8 ft.) NE/SW. Level 1 measures to a maximum height of 1.3 m. (4.3 ft.) above the surrounding ground surface. Level 2 is located immediately northeast of, and stands 1.1 m. (3.6 ft.) above, Level 1. Level 2 measures 7.0 m. (23.0 ft.) NW/SE by 2.0 m. (6.6 ft.) NE/SW. The northwest edge of Level 2 is flush with the slope. Level 3 is adjacent to the southeastern portion of Level 2. It measures 4.0 m. (13.1 ft.) NW/SE by 2.0 m. (6.6 ft.) NE/SW and stands 0.2 m. (0.6 ft.) above Level 2. The northeastern edge of Level 3 is flush with the slope. Level 4 is contiguous with the northwest end of Level 3 and the northeast side of Level 2. Level 4 is a small circular platform measuring 2.5 m. (8.2 ft.) in diameter. It is constructed 0.4 m. (13.1 ft.) high, above Level 2.

Each terrace level of Feature E is faced with 'a'ā boulders and the surfaces are fairly level cobble to small boulder paving.
No artifacts or midden were observed.
Feature E was considered to be in good condition and subsurface testing of this feature confirmed a burial function (see *Excavation Results* section of this report).

Feature F is a large terrace located at the southern edge of the complex. The terrace measures 7.0 m. (23.0 ft.) N/S by 5.0 m. (16.4 ft.) E/W. A maximum height of 0.5 m. (1.6 ft.) was measured along the east side. The perimeter of the terrace is constructed with boulders and the surface is level 'a'ā cobbles and small boulders. The north edge of the terrace is flush with the surrounding terrain. The south edge abuts pahoehoe outcrop.

No artifacts or midden were observed.

Feature F is in fair to good condition.

Feature G is a small terrace located just west of Feature F. It measures 2.5 m. (8.2 ft.) N/S by 2.8 m. (9.2 ft.). A maximum height of 0.3 m. (1.0 ft.) was measured on the north side. The south and east sides of the terrace abuts pahoehoe outcrop. The west side is immediately adjacent to the access road and may have been partially destroyed.

No artifacts or midden were observed.

Feature G is in fair condition.

State Site #: 50-10-47-1961 **CSH Site #:** 31

Site Type:	Complex
Age:	Prehistoric - Modern
Function:	Recurrent habitation/Modern hearth
Features (#):	2
Dimension:	66.0 m.^{2} (712.8 ft.^{2})
Elevation:	25 ft. a.m.s.l.

Description: Site 1961 (Figure 22) is a complex comprising an irregular enclosure and an alignment, designated Features A and B. The site is located in level pahoehoe, shallow soil, terrain. Surrounding vegetation consists of *kiawe, koa haole, noni*, and grasses. A PHRI site tag (PHRI 89-769-15) was observed at this site. Feature A is interpreted as a remnant of a recurrent habitation site, and Feature B is a modern fire-pit. In the HRHP site files, a low platform feature was recorded within this site (between the features designated A and B in the course of this inventory survey) however, this platform was not observed during the survey and it is likely that it had been inadvertently destroyed or dismantled since the SHPO survey of 1971.

Feature A is an irregularly shaped enclosure comprising two contiguous C-shapes and a roughly rectangular enclosure. Overall, Feature A measures 11.0 m. (36.1 ft.) NW/SE by 6.0 m. (19.8 ft.) wide. The maximum height of the enclosure walls measured 0.7 m. (2.3 ft.) high. Feature A is constructed of small boulders, cobbles, and small water-rounded boulders. An entrance at the north end of the feature opens to the southeast. The interior consists of soil and scattered cobbles.

No midden or artifacts were observed.

Feature A is in good to fair condition and its excavation potential is considered fair.

Feature B is a small hearth alignment. The alignment is C-shaped and measures approximately 2.0 m. (6.6 ft.) in diameter and is open to the south. Feature B is constructed

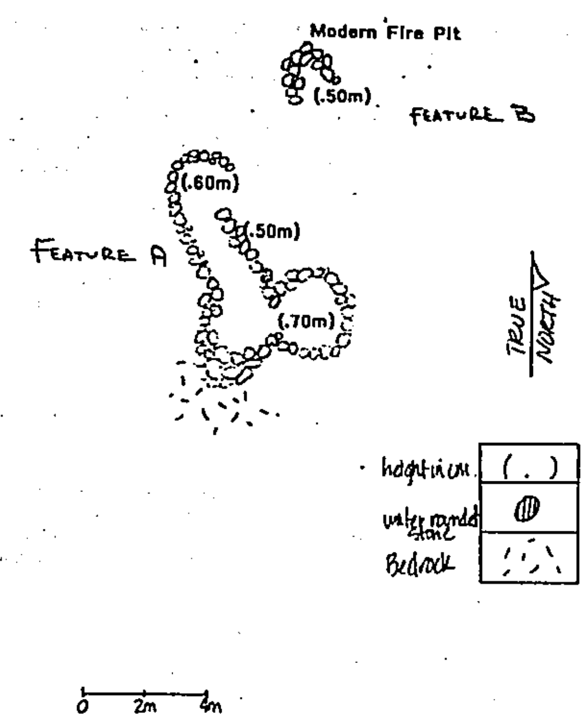

Figure 22 Site 50-10-47-1961 Complex, Features A and B; Plan View

of small boulders and cobbles, 0.5 m. (1.6 ft.) thick, stacked to a maximum height of 0.5 m. (1.6 ft.). The interior is filled with ash and modern trash. This feature is a modern fire pit.

No other artifacts or midden were observed.

Feature B is in fair condition and offers fair excavation potential.

State Site #: 50-10-47-7727 **CSH Site #:** 26

Site Type:	Trail
Age:	Prehistoric
Function:	Transportation
Features (#):	1
Dimension:	20.0 m.^{2} (216.0 ft.^{2})
Elevation:	30-35 ft. a.m.s.l.

Description: Site 7727 (see Figure 4) is a stepping-stone trail remnant located near the shoreline in 'a'ā terrain. The trail extends 36.6 m. (120.0 ft.) in an east-west direction paralleling the coastline. It has an approximate width of 0.5 m. (1.6 ft.) and the stones are placed approximately 0.5 m. (1.6 ft.) apart.

The trail consists of a worn, leveled path in the 'a'ā with pahoehoe slabs set into the 'a'ā as stepping stones. The east end of the trail terminates in a small pocket of pahoehoe and soil. The west end has been destroyed by a jeep road. This trail was originally identified by Lloyd Soehren during his 1981 reconnaissance survey and assigned state site number 7727 at that time (Soehren 1981).

No artifacts or midden were observed.

Site 7727 is in fair and remnant condition and offers no excavation potential.

State Site #: 50-10-47-7728 **CSH Site #:** 38, 42

Site Type:	Trail complex
Age:	Prehistoric
Function:	Transportation
Features (#):	1
Dimension:	606.1 m. (2,000.0 ft.) long
Elevation:	20-300 ft. a.m.s.l.

Description: Site 7728 (see Figure 4 and 97) is a trail composed of two separate remnant sections. This trail, together with Site 7727 trail, was identified in 1981 during the reconnaissance survey of Lloyd Soehren and was assigned a state site number at that time (Soehren 1981).

The southwest end of the trail begins within 50.0 m. (164.0 ft.) of the shoreline behind an inlet that was possibly used as a canoe landing. This area of the coast is also the center of permanent settlement in Keopuka. Therefore, Site 7728 trail likely functioned as the primary transportation route between the coastal settlement and various *mauka* lands. The trail varies between a stepping-stone design to a trodden surface, sizable for both foot and horse travel. The trail extends *mauka*, oriented generally north/south upslope across the 'a'ā, and then extends toward the jeep road and through a *kipuka* in the pahoehoe lava. With slight switchbacks it ascends a steep cliff and leads outside of the project area to the southeast. During the survey, the two sections of this trail site were designated temporary field numbers CSH 38 and 42, but subsequently designated sections of the same trail, site 7728.

Section A comprises the western branches of Site 7728. At the *makai* end it skirts along the south side of Site 17198, where extensive midden deposits are scattered on and near the trail. The trail is 1.0 to 1.5 meters (3.3 to 4.9 ft.) wide and consists of a worn path in the 'a'ā. Some sections of the trail are built up along the edge of an 'a'ā gully, and a 2.0 m. (6.6 ft.) high retaining wall, faced to the downslope side, runs continuously for approximately 45.0 m. (147.6 ft.).

Further upslope, Section A is a water-rounded stepping stone trail. As the trail ascends pahoehoe lava, it becomes difficult to discern and only an occasional slab or water-rounded stepping stone marks its continuation. Above the *mauka* jeep road, Section A splits into two trails which join again at the base of Pali Kapu O Keoua. Also at the base of the cliff, Section A joins Section B and forms one trail which proceeds up the cliff.

Section B is a stepping-stone trail consisting of an almost continuous alignment of water-rounded boulder stepping-stones. Section B extends from the shoreline *mauka*, across 'a'ā lava terrain, to the base of the Kealakekua cliff line at 125 ft. a.m.s.l. The trail measures approximately 300.0 m. (984.0 ft.) long and is in good condition except where it is cut by a modern jeep road. Section B joins with the two branches of Section A at the base of the cliff and ascends the cliff outside the project area.

Section A Feature B is easily traceable because a greater part of it crosses 'a'ā lava and the water-rounded stepping stones extend the entire length of the trail up to the base of the cliff. In general, this trail is better preserved than Feature A. At the *makai* end it traverses south of Site 17198 and through Site 17202.

No artifacts or midden were observed along the trail.

Feature B is in good condition and offers poor excavation potential.

State Site #: 50-10-47-10290 **CSH Site #:** 90

Site Type:	Trail
Age:	Historic
Function:	Transportation
Features (#):	1
Dimension:	see below
Elevation:	360-500 ft. a.m.s.l.

Description: Site 10290 (see Figures 4, 98 and 99) is an historic-era road (or trail) that runs parallel to the coast. It is historically referred to as the "Old Government Road". That portion of the road that traverses Keopuka lies at 360 feet a.m.s.l. at the southern boundary and 500 feet a.m.s.l. at the northern boundary. It crosses undulating 'a'ā and pahoehoe for approximately 1,130.0 m. (3729.0 ft.). It ranges from 1.5 m. to 3.5 m. wide. A typical cross-section is 1.5 m. (4.9 ft.) wide with curbing on either side measuring 0.5 m. (1.6 ft.) wide and 0.3 m. (1.0 ft.) high. The retaining walls on the *makai* side vary from 1.0 m. to 2.0 m. (3.3 ft. to 6.6 ft.) high.

This road is almost certainly of historic construction which may have incorporated an earlier trail. Its route is virtually straight, as if laid out by surveyors. The road is defined by a pavement with a low curbing on each side. The retaining walls keep the road on a level bed as the road crosses gullies and low points. The construction material varies with the bedrock which it crosses. For example, across an 'a'ā flow, the road bed consists of 'a'ā pebbles and the curbing is constructed of 'a'ā cobbles. On pahoehoe, there is slab paving of pahoehoe and pahoehoe curbing.

The road construction has the markings of a pre-planned public works project. The road crosses the *ahupua'a* and probably is part of a complex of historic roads or trails that extended from Honaunau to Keauhou and possibly farther. The road dimensions and construction suggest it was mostly for horse traffic - pack horses as well as riding horses. In some areas the 'a'ā paving is well-worn and shows signs of heavy use. The road is in excellent condition throughout the project area. The most impressive sections are where the road has been built up to cross low points in the topography.

No midden or artifacts were observed.
The site is in excellent condition. It offers no excavation potential.

State Site #: 50-10-47-14185 **CSH Site #: 87**

Site Type:	Lava tube
Age:	Prehistoric
Function:	Burial
Features (#):	1
Dimension:	638.0 m.² (6,890.4 ft.²)
Elevation:	719-731 ft. a.m.s.l.

Description: Site 14185 (Figure 23) is a lava tube located in gently sloping pahoehoe lava terrain. The vegetation surrounding the site consists of Christmas-berry, grass and fern.

The lava tube site appears to have been utilized exclusively as a burial site, in which at least four individuals were interred. Crab claws were also placed in the lava tube and probably represent a ceremonial item associated with the burials.

The lava tube measures extends 116.0 m. (380.5 ft.) northeast of a main entrance accessed through a sink. The sink measures 3.0 m. (9.8 ft.) E/W by 1.0 m. (3.3 ft.) N/S. The entrance is filled with 'a'ā boulders and cobbles and may block an eastern continuation of the tube.

The interior of the tube is approximately 3.0 m. (9.8 ft.) wide and 3.0 m. (9.8 ft.) in height. The floor divides approximately 5.0 m. (16.4 ft.) east of the entrance into two tiers; the upper floor acting as an overhang for the lower floor. The lower floor consists of an uneven, sharp lava surface. A single water-rounded boulder and a concentration of crab claws were observed scattered in this area.

A human burial - Burial 1 - was identified 6.0 m. (19.7 ft.) east of the entrance under a shelf. The skeletal remains are poorly preserved due to the dampness of the cave. The sharp, uneven floor continues for the remainder of the tube.

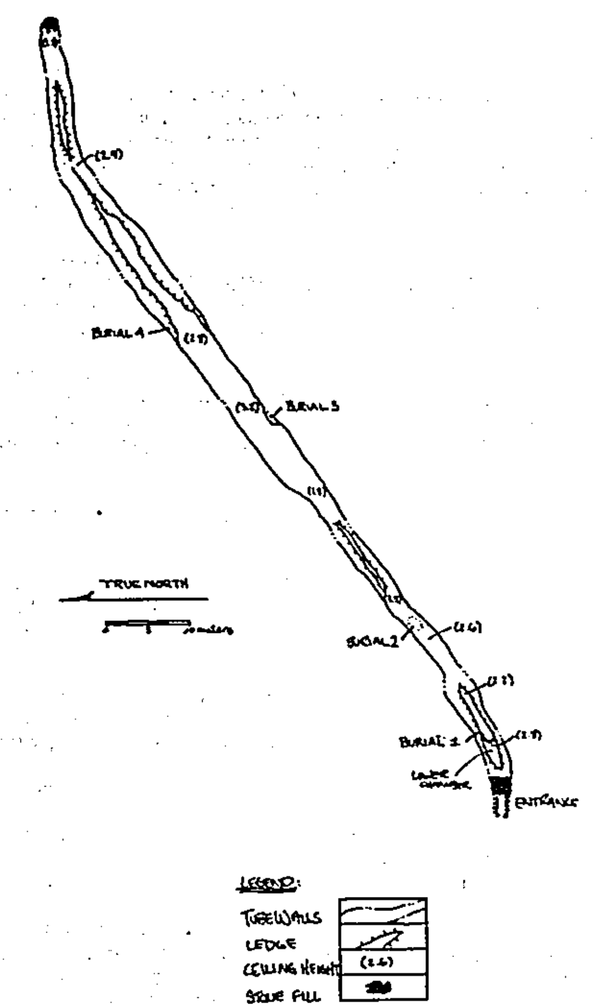

Figure 23 Site 50-10-47-14185 Lava Tube, Showing Burial Locations; Plan View

At approximately 23.0 m. (75.4 ft.) east of the entrance, a small, 0.7 m. (2.3 ft.) high, blister was utilized for the location of a second burial, Burial 2.. Crab claw and burnt *kukui*-nut shell were observed in association with the burial. The skeletal remains were poorly preserved with a few bones remaining intact.

At 55.0 m. (180.4 ft.) east of the tube entrance, a third human burial, Burial 3, was identified on a small shelf projecting off of the south side of the tube. Some of the skeletal remains were burned.The shelf measures 0.8 m. (2.6 ft.) high, 1.4 m. (4.6 ft.) wide, and 1.0 m. (3.3 ft.) deep.

At approximately 65.0 m. (213.2 ft.) east of the entrance, shelves are present on both sides of the tube for the rest of the length. On the north shelf, approximately 70.0 m. (229.6 ft.) east of the entrance, a disturbed burial, Burial 4, was present.

At approximately 116.0 m. (380.5 ft.) east of the entrance the tube is walled up. The site remains in fair condition.

State Site #: 50-10-47-14186 **CSH Site #:** ---

Site Type:	Trail
Age:	Prehistoric
Function:	Transportation
Features (#):	1
Dimension:	198.0 m. long
Elevation:	575-850 ft. a.m.s.l.

Description: Site 14186 (see Figure 4) is a stepping-stone trail section. A small portion of this trail was identified during the present inventory survey as part of site 14190, but this site was described thoroughly by PHRI in their 1991 inventory survey. The description that follows is taken from the draft report for that project (Walker et al. 1991:A-25).

> This site consists of a steppingstone trail built of pahoehoe slabs. It is oriented c. east-west (inland-seaward), is discontinuous and disappears at the flat outcrops. One section has kerbstones on each side for a length of c. 7.8 m. The trail meanders along the northwest project boundary and passes across SIHP No. 14190, Feature B Terrace.
>
> A piece of broken waterworn basalt and three pieces of marine shell are near the trail. One piece of waterworn coral is southwest of the trail. A petroglyph is on one of the steppingstones.
>
> The trail continues west c. 45 m. and stops at a flat pahoehoe outcrop. The steppingstones continue some distance some distance west in a discontinuous manner.

State Site #: 50-10-47-14188 **CSH Site #:** 83

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	6
Dimension:	3,276.0 m.^{2} (35,380.8 ft.^{2})
Elevation:	560-585 ft. a.m.s.l.

Description: Site 14188 is a complex located in mixed `a`ā and pahoehoe lava terrain. Vegetation consists of grass, *koa haole* and morning glory. The complex includes six features, designated Features A to F (Figures 24 and 25). Features B and C are portions of a lava tube and the rest are surface features.

Site 14188 is interpreted as a permanent habitation site because of the sizable floor areas and relatively substantial architecture of the surface features. The associated lava tube, being only moderately modified near the light zones, was probably used as an auxiliary component of the site, possibly for the preparation and storage of perishable items (*e.g.*, tapa) and the collection of water.

Feature A is an irregularly shaped terrace located at the north edge of the site. The terrace measures 15.0 m. (49.2 ft.) N/S by 5.0 m. (16.4 ft.) E/W). A maximum faced height of 1.3 m. (4.3 ft.) is measured on the west side. The surface is paved with medium to large `a`ā cobbles.

A mound is located approximately 2.8 m. (9.2 ft.) south of Feature A. It measures 4.0 m. (13.1 ft.) N/S by 12.5 m. (41.0 ft.) E/W. Facing remains along the north side and reaches a maximum height of 0.5 m. (1.6 ft.). The surface of the mound is paved with medium to large `a`ā cobbles.

No midden or artifacts were observed. Feature A is in remnant condition with poor excavation potential.

Feature B is a small lava tube that is accessed through an entrance approximately 2.0 m. (6.6 ft.) west of Feature A's south end. Feature B tube is actually the east portion of a single lava tube and Feature C is the southwest portion. A gully that is a collapsed section of the tube connects the two features.

Feature B tube extends 13.6 m. (44.6 ft.) to the east and has a width of 4.6 m. (15.1 ft.), with a maximum ceiling height of 1.5 m. (4.9 ft.). The tube entrance measures 2.0 m. (6.6 ft.) E/W by 1.0 m. (3.3 ft.) N/S. Small boulders and large cobbles fill the entrance and provide a sloping ramp into the tube.

Small boulders are scattered throughout Feature B tube, a rough wall occurs along the south wall of the tube. Sparse cultural material was observed in the tube, including: a coconut shell fragment approximately 1.0 m. (3.3 ft.) from the entrance; a shell fragment 3.0 m. (9.8 ft.) from the entrance; a small bird bone on the south side of the tube roughly 7.0 m. (23.0 ft.) from the entrance; and charcoal at the east end of the tube.

No artifacts were observed. Feature B is in good condition. It offers good to fair excavation potential.

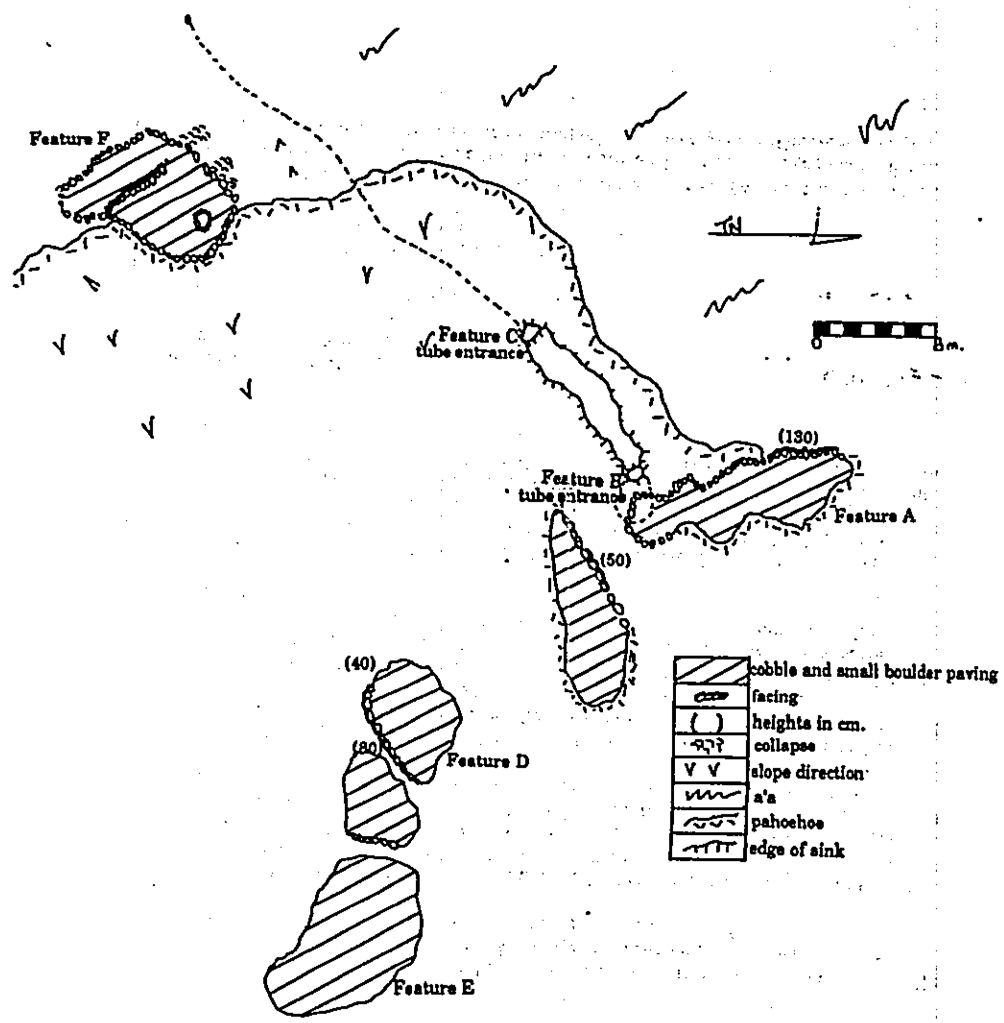

Figure 24 Site 50-10-47-14188, Features A and D through F, Showing Entrances to Lava Tube Features B and C; Plan View

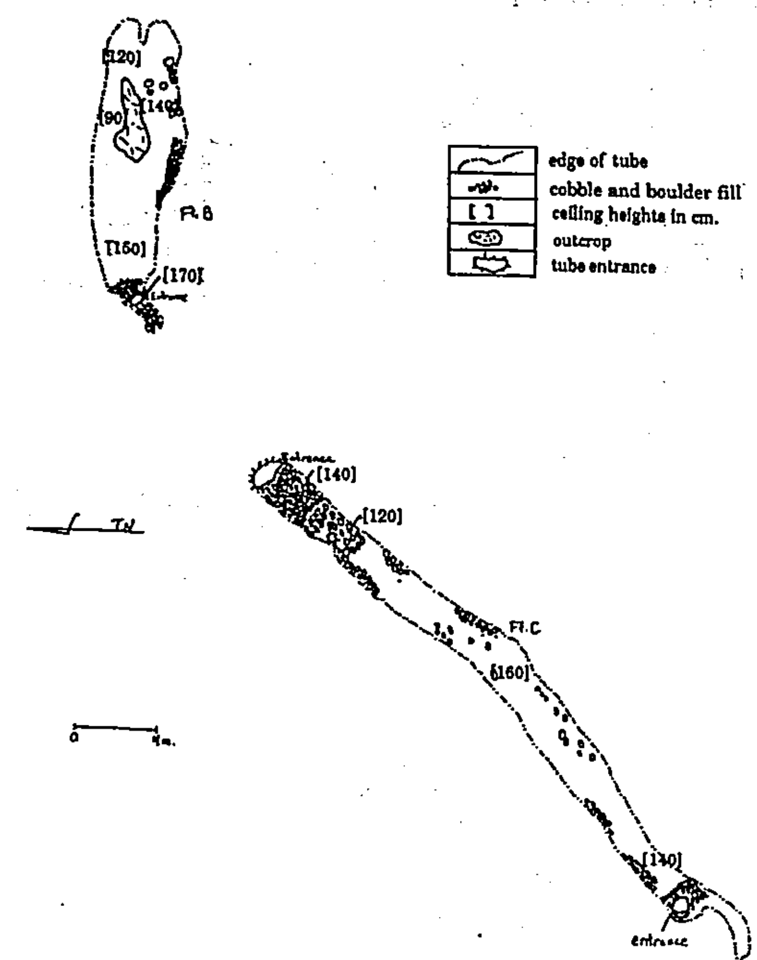

Figure 25 Site 50-10-47-14188, Showing Subterranean extent of Feature B and C Lava Tubes; Plan View

Feature C is the southeast section of the lava tube oriented *mauka/makai*. It has two entrances on its southeast and northwest ends. The *mauka* (northeast) entrance lies roughly 10.0 m. (32.8 ft.) west of Feature B. The lava tube measures 30.0 m. (98.4 ft.) NE/SW by 2.0 m. (6.6 ft.) wide, with a maximum ceiling height of 1.6 m. (5.2 ft.). A small pavement lies just inside the southwest entrance. It measures 1.0 m. (3.3 ft.) NE/SW. The southeast floor of the tube is paved with small boulders and medium to large cobbles. A small amount of *kukui* was observed.

At the northeast entrance a second pavement is present. It measures 2.0 m. (6.6 ft.) N/S by 1.0 m. (3.3 ft.) E/W. Small amounts of *kukui* nut were observed in this area, as well as a small bird bone. Feature C is in fair condition with poor excavation potential.

Feature D is a terrace located approximately 15.0 m. (49.2 ft.) southeast of Feature A. The terrace measures 6.0 m. (19.7 ft.) N/S by 8.0 m. (26.2 ft.) E/W. Facing remains on the south and west sides to heights ranging from 0.4 m. (1.3 ft.) to 0.8 m. (2.6 ft.). Large pahoehoe boulders form the sides. The surface is paved with medium to large ʻaʻā cobbles. No midden or artifacts were observed. Feature D is in fair condition with poor excavation potential.

Feature E is a pavement located 5.0 m. (16.4 ft.) the southeast of Feature D. The pavement measures 12.0 m. (39.4 ft.) NW/SE by 6.0 m. (19.7 ft.) NE/SW. The surface is paved with small to medium-sized ʻaʻā cobbles. No facing was observed.

Another pavement lies between Features D and E. This pavement measures 2.0 m. (6.6 ft.) N/S by 3.3 m. (10.8 ft.) E/W. A small wall segment stands along the west edge of the pavement. No midden or artifacts were observed. Feature E is in poor condition with poor excavation potential.

Feature F is a terrace located 8.0 m. (26.2 ft.) southeast of the west entrance to Feature C. The terrace measures 10.0 m. (32.8 ft.) N/S by 7.0 m. (23.0 ft.) E/W. The feature is faced along the west side where it stands to a height of 0.6 m. (1.97 ft.). The north side is collapsed. The terrace is constructed of small to large pahoehoe boulders. A small pavement lies near the west side of the terrace. No midden or artifacts were observed. The feature is in poor condition and excavation potential is poor.

State Site #: 50-10-47-14190 **CSH Site #:** 84

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation; Burial
Features (#):	4
Dimension:	9,758.0 m.^{2} (105,386.4 ft.^{2})
Elevation:	590-605 ft. a.m.s.l.

Description: Site 14190 (Figures 26 and 27) is a complex consisting of four features: a terrace (Feature A), a pavement (Feature B), a lava tube (Feature C) and two wall segments (Feature D). The complex is located on an ʻaʻā flow running over a pahoehoe flow. The terrain slopes

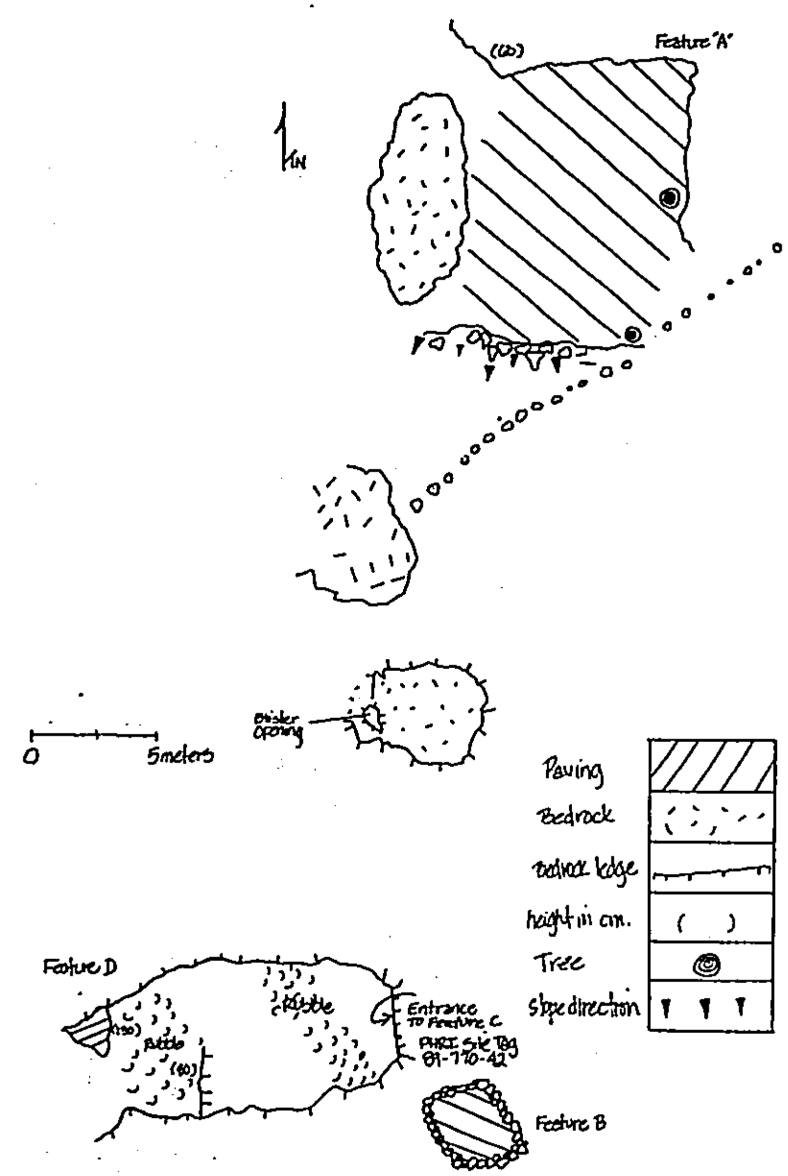

Figure 26 Site 50-10-47-14190, Features A, B and D, Showing Entrance to Feature C Lava Tube; Plan View

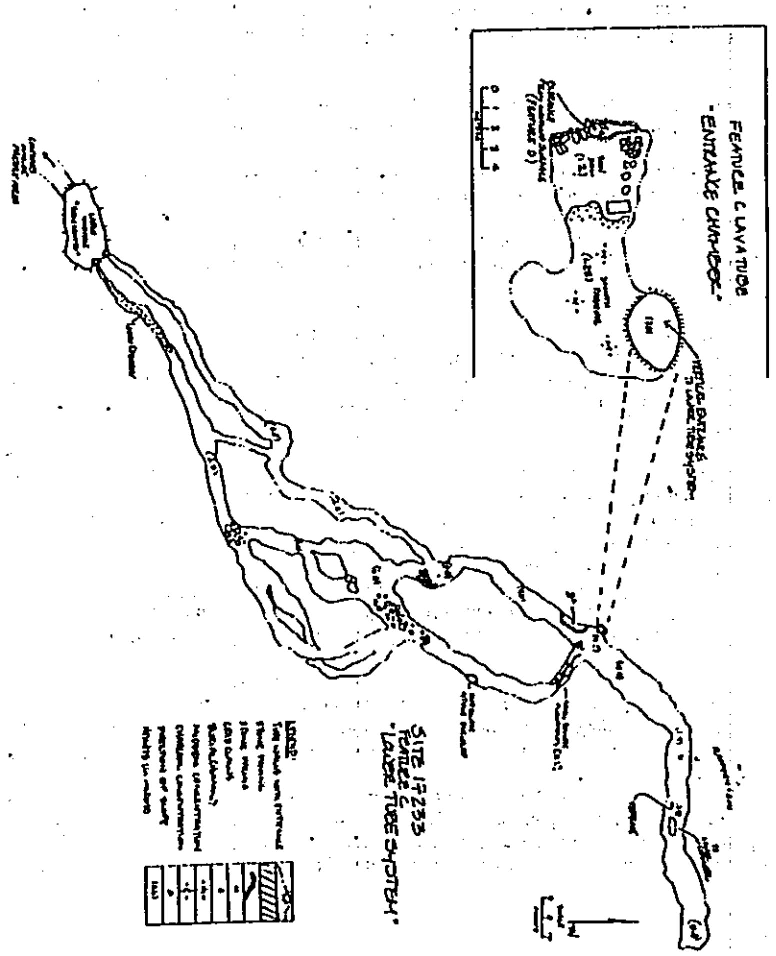

Figure 27 Site 50-10-47-14190 Lava Tube, Showing "Entrance Chamber" and "Lower Tube System"; Plan View

steeply west. Vegetation at the site consists of ferns, cactus, grass, lantana, morning glory, and Christmas-berry.

Site 14190 is interpreted as a permanent habitation complex because of the sizable floor area and substantial architecture of Feature A; and its association with other, although smaller, component features (Feature B and D). Feature C lava tube is a complicated, tri-leveled system that contains at least one confirmed burial and a few possible burials. The upper "Entrance Chamber" is clearly a habitation component of the tube (and the overall complex), with the lower tube system probably functioning primarily for burial placement.

Feature A is a terrace located along the north edge of the site. It measures 8.0 m. (26.2 ft.) E/W by 10.0 m. (32.8 ft.) N/S to a maximum height of 0.6 m. (2.0 ft.). The pavement is constructed of small water rounded boulders and large cobbles. The east edge of the terrace is flush with the surrounding outcrop. The south and west sides are collapsed. The north side has a small section of facing which stands 0.6 m. (2.0 ft.) high.

A trail constructed of flat, smooth pahoehoe slabs leads upslope beyond the site area from the southeastern corner of the terrace (a portion of site 14186).

No midden or artifacts were observed on the surface of the feature or in association with the trail.

Feature A is in fair condition with fair excavation potential.

Feature B is a pavement located approximately 30.0 m. (98.4 ft.) south of Feature A. The dimensions are 3.2 m. (10.5 ft.) NW/SE by 2.5 m. (8.2 ft.) E/W. The surface is paved with ʻaʻā cobbles.

No midden or artifacts were observed.

Feature B is in fair condition with fair excavation potential.

Feature C is an extensive lava tube system consisting of an upper Entrance Chamber and a deep sink that drops vertically to a Lower Tube system. The Entrance chamber is accessed through the east edge of the sink that contains the two wall segments that comprise Feature D. The lower tube system contains a main tube extending to the east of the entrance (gained through the Entrance Chamber) and another tube that extends to the southwest. The tube that extends to the southwest diverges into numerous lateral tubes which eventually converge again at a large sink area. A single main tube continues beyond the sink area to the southwest, outside of the project area.

The Entrance Chamber measures 11.5 m. (37.7 ft.) E/W by 6.5 m. (21.3 ft.) N/S with a maximum ceiling height of 1.2 m. (3.9 ft.). The entrance to this chamber measures 1.0 m. (3.3 ft.) high by 2.4 m. (7.9 ft.) wide. A stacked stone wall (portion of Feature D) constricts the size of the entrance. There is a shallow soil deposit in the light zone of the chamber.

Cultural material observed in the chamber includes marine midden, basalt flakes, mammal bones and *kukui* nut shell. A test unit excavated by Paul H. Rosendahl, Inc. is located 3.0 m. (9.8 ft.) east of the entrance along the north wall. It appears to measure 1.0 m. by 0.5 m. (3.3 ft. by 1.6 ft.) and is 8.0 cm. deep to bedrock. The test unit is labelled "PHRI test pit 89-770, Site 770-42, 31 May 1990". A back dirt pile was observed in front of the lava tube entrance.

There are two small alcoves 7.0 m. (23.0 ft.) east of the entrance along the south wall of the Entrance Chamber. Both have low ceilings, sharp lava floors, and extend approximately 2.0 m. (6.6 ft.) beyond which, access becomes impossible. The east alcove has an opening in the ceiling which allows light into the back portion of the Entrance Chamber. No midden or artifacts were observed in either of the alcoves.

The opening to the Lower Tube System lies at the east end of the Entrance Chamber and it measures 3.8 m. (12.5 ft.) E/W by 2.5 m. (8.2 ft.) N/S, dropping approximately 10.0 m. (32.8 ft.) down to the floor of the main tube. This drop makes the Lower Tube System inaccessible from the Entrance Chamber without the use of a rope or ladder.

The Lower Tube System is extensive and branching. The overall area covered by the Lower Tube System measures approximately 238.0 m. (780.6 ft.) E/W by 41.0 m. (134.5 ft.) N/S. The maximum width of any section of tube in the system is 15.0 m. (49.2 ft.) and the maximum ceiling height is 10.0 m. (32.8 ft.).

From the drop-in entrance, the Main Tube extends in both northeast-east and southwest directions. Two burials are located near the main entrance.Burial 1 is located on a small shelf, 5.0 m. (16.4 ft.) east of the drop-in entrance. This burial is well preserved and several diagnostic bones indicate it to be human. Burial 2 is opposite Burial 1 on a shelf against the west wall of the tube. Burial 2 lies 3.0 m. (9.8 ft.) south of the drop-in entrance and is too fragmentary and powdery to confirm whether it is human or other mammal; its close proximity to the confirmed human burial suggests it to be human as well. Cultural remains observed near the main entrance include marine midden, *kukui*, charcoal, and wood fragments.

Approximately 35.0 m. (114.8 ft.) northeast of the entrance in the main tube are a small platform and *ahu*. The *ahu* and platform are both constructed of small boulders and cobbles. A terrace is situated approximately 10.0 m. to 12.0 m. (32.8 ft. to 39.4 ft.) east of the *ahu* and platform. The terrace is well paved with a small amount of facing remaining and abuts the south side of the lava tube. Both of these features are possible burial monuments.

An entrance to a lower chamber lies in the floor directly east of the terrace. The opening measures 1.0 m. (3.3 ft.) N/S by 5.0 m. (16.4 ft.) E/W and drops 2.2 m. (7.2 ft.) below the floor of the main tube. The floor of this lower chamber is uneven and rough. The lower chamber parallels the upper chamber for approximately 20.0 m. to 30.0 m. (65.6 ft. to 98.4 ft.) before becoming inaccessible. Scattered crab pinchers were observed throughout its length.

This section of the main tube continues eastward beyond the terrace and lower chamber entrance for an additional 30.0 m. (98.4 ft.) and terminates. Crab pinchers were observed throughout this chamber.

The southwest section of the main tube is very complex and branching. From the main entrance, the main tube divides into two, roughly parallel tubes, on the west and east sides.

The tube on the west side continues approximately 150.0 m. (492.0 ft.) southwest from the main entrance, until terminating at a large sink area covered with ferns (*i.e.*, the "fern grotto"). Along the course of the west tube, two additional tubes extend to the south until intersecting the east tube. The first connector tube is located 40.0 m. (131.2 ft.) southwest of the main entrance and the second connector tube is located 50.0 m. (164.0 ft.) further to southwest.

The east tube begins 10.0 m. (32.8 ft.) east of the main entrance and roughly parallels the course of the west tube. A group of single-course, interconnected alignments are present between 8.0 m. (26.2 ft.) and 13.0 m. (42.7 ft.) southeast of the main entrance. These alignments are organized into six small, contiguous enclosures, each measuring approximately 3.0 m. (9.8 ft.) in diameter. The alignments are constructed of medium to large cobbles atop the tube floor and measure 0.2 m. (0.7 ft.) high. Another similar alignment was observed approximately 15.0 m. (49.4 ft.) south of the first group of alignments. This alignment

measures 2.0 m. (6.6 ft.) N/S by 1.0 m. (3.3 ft.) E/W. These alignments may have marked drip lines and functioned as container foundations for water collection.

The east tube continues to the southwest where it intersects the first connector tube (joining it to the west tube) at about 60 m. (198 ft.). This same connecter tube intersects the east tube again, roughly 50 m. t the southeast. The east tube diverges into two smaller tubes in between the two intersections of the first connecter tube. Beyond this point the east tube extends approximately 20 m. () until intersecting the second connecter tube (from the west tube) and then 50 m. () to the southwest until terminating at the "fern grotto" sink area. A lower chamber was also present at the end of the east tube. It was roughly 20 m. () long and paralleled the course of the east tube.

The lava tube system continues to the southwest of the "fern grotto" sink area, but these sections were not mapped nor inspected since they extend well beyond the south boundary of the project area.

Feature C lava tube is in good condition.

Feature D comprises two wall segments located in a sink outside the entrance to the Entrance Chamber of Feature C lava tube. The east wall segment lies 8.0 m. (26.2 ft.) west of the Feature C entrance. It measures 2.7 m. (8.9 ft.) N/S by 0.5 m. (1.6 ft.) E/W with a maximum height of 0.8 m. (2.6 ft.). A small section of facing remains.

The second wall segment is wedge-shaped, located 11.5 m. (37.7 ft.) west of the Feature C entrance. It measures 2.0 m. (6.6 ft.) N/S by 1.9 m. (6.2 ft.) E/W to a maximum height of 1.3 m. (4.3 ft.). The surface is paved with ʻaʻā cobbles.

No midden or artifacts were observed.

The feature is in poor condition and excavation potential is poor.

State Site #: 50-10-47-14192 **CSH Site #:** 86

Site Type:	Lava tube
Age:	Prehistoric
Function:	Burial
Features (#):	1
Dimension:	3,740.0 m.^{2} (40,392.0 ft.^{2})
Elevation:	672-685 ft. a.m.s.l.

Description: Site 14192 (Figure 28) is a lava tube system consisting of a main lava tube and two lateral tubes (designated Tube A and B). The site is located in both pahoehoe and 'a'ā lava terrain. The surrounding ground surface has scattered pockets of soil which supports grass, lantana, and *koa haole*.

Site 14192 lava tube appears to have been used exclusively as a burial site. The lava tube contains the skeletal remains of at least 19 individuals. Crab claws identified throughout the lava tube probably represent a ceremonial item associated with the burials.

The entrance into the lava tube is a small opening located in the west end of a sink. The sink measures 3.0 m. (9.8 ft.) wide and about 2.0 m. (6.6 ft.) deep. The entrance has a steep talus slope which leads into a small chamber, followed by a second drop of approximately 2.0 m. (6.6 ft.). Marking the entrance chamber inside the tube is an *ahu* constructed of four rocks, measuring 0.5 m. (1.6 ft.) high and 0.5 m. (1.6 ft.) in diameter. The *ahu* lies at the intersection of a lateral tube that diverges to the west (Tube A) and the northeast-southwest trending main tube. A large slab was observed at the lower part of the entrance chamber and indicates that the entrance may have once been sealed.

Lateral Tube A extends 125 m. (412.5 ft.) east of the entrance chamber. The average width of the lateral tube measures 5.0 m. (16.4 ft.) and the ceiling is consistently high enough to allow upright walking.

The main tube extends approximately 21 m. to the northeast of the *ahu*, where it diverges into several small tubes, one of which extends to the northeast for approximately 97.0 m. (318.2 ft.). The northeast or *mauka* section of the main tube is multi-leveled consisting of 3 levels from approximately 10.0 m. (32.8 ft.) to 21.0 m. northeast of the entrance chamber *ahu*. Three separate burials, designated Burials 1 through 3, were observed on the upper most level.

Burial 1 is the most *mauka* burial and consists of the skeletal remains of a single individual. The remains are distributed over an area of 1.0 m. (3.3 ft.) in diameter, located against the northwest wall of the tube. Most of the bone fragments are very small and bone dust is visible. The larger pieces are cranium fragments, vertebrae, finger and toe bones. Associated charcoal chunks were observed 0.5 m. (1.64 ft.) to the southwest. The burial is resting on a bare bedrock ledge 3.0 m. (9.8 ft.) above the main tube floor.

Burial 2 is on the southeast side of the same ledge approximately 5.0 m. (16.4 ft.) southwest of Burial 1. Burial 2 is located under angular boulders of roof-fall. Long bones of the arms and legs are visible and in excellent condition. The bones are disarticulated and are probably of a single individual. The boulders were probably placed by human hand over the bones not subsequent roof collapse.

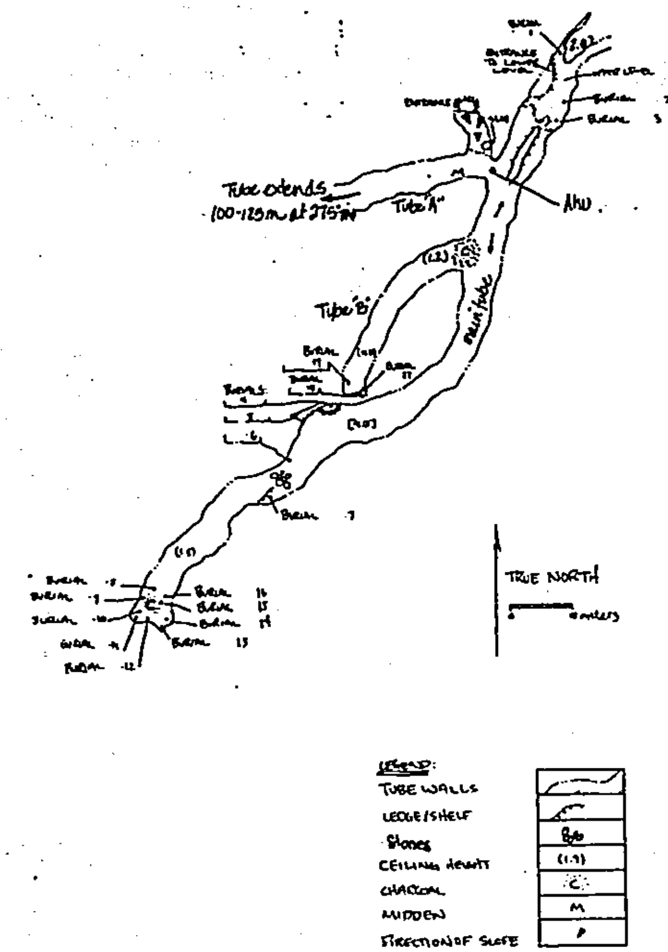

Figure 28 Site 50-10-47-14192 Lava Tube; Plan View

Burial 3 is on a ledge at the end of the upper tube, 4.0 m. (13.1 ft.) south of Burial 2. These bones are in a powdered, decomposed condition. Only a few rib and finger bone fragments were visible. The bones are scattered over an area of 0.3 m. (1.0 ft.) by 0.4 m. (1.3 ft.) in diameter.

The northeast portion of the main tube continues *mauka* past the three burials for an additional 97.0 m. (318.2 ft.) with no cultural material or modification observed. The *mauka* section of the main tube averages 4.0 m. (13.1 ft.) wide and the ceiling height ranges from 1.5 m. (4.9 ft.) to 4.0 m. (13.1 ft.).

From the *ahu* at the entrance chamber, the main tube continues 90 m. (297 ft.) to the southwest (*makai*). Diverging off the main tube 10.0 m. (32.8 ft.) southwest of the entrance chamber *ahu* is a lateral tube extending toward the southwest, designated Tube B. Thirteen individual burials (Burials 4 through 16) were observed in the southwest portion of the main tube, and three burials (Burials 17 through 19) were observed in the end of Tube B.

Burial 4 is located approximately 50.0 m. (164.0 ft.) southwest of the *ahu*, resting against the southwest wall of the tube. This burial is located in a pit which measures 1.0 m. (3.3 ft.) long, parallel to the tube, by 0.6 m. (2.0 ft.) wide and 0.4 m. (1.3 ft.) deep. The pit is excavated into red scoria boulders and filled with the same. The remains are scattered at the base of the pit and along the sides on the surface. The identifiable bones are cranium and long bone fragments. The remains indicate a single individual.

Burial 5 is located on a shelf directly west of Burial 4. The shelf is 1.6 m. (5.2 ft.) above the tube floor. The scattered remains are poorly preserved. Vertebrae, pelvis and foot fragments were observed. There are red scoria boulders scattered around the burial, perhaps once existing as an *ahu*. The bones are scattered on a ledge over an area measuring 1.0 m. (3.3 ft.) in diameter, and probably are those of a single individual.

Burial 6 is located 10.0 m. (32.8 ft.) southwest of Burial 4. The burial was formerly buried under a boulder *ahu* located along the north side of the main tube. The *ahu* of red scoria boulders has been disturbed and the bones are scattered around the rocks. The long bones are fragmentary and in poor condition. The remains appear to be of a single adult individual.

Burial 7 is located against the south wall of the main chamber, approximately 7.0 m. (23.0 ft) southwest of Burial 6. Two complete, but broken femurs were observed and many small fragments of bone were scattered in a 1.0 m. (3.3 ft.) square pit in the `a`ā floor of the tube. The burial was originally placed in the pit and the pit was then filled with boulders. However, the pit has been disturbed and emptied of boulders and the bones are now exposed and scattered in and around the pit. The bones are probably those of a single individual. At 1.0 m. (3.3 ft.) west, in a crevice, another possible burial was observed. The remains are in poor condition and consist of mostly powder. It may represent another individual.

The southwest section of the main tube continues 30.0 m. (98.4 ft.) southwest of Burial 7. Nine additional burials were observed here, at the *makai* end of the main tube, designated Burials 8 through 16.

Burials 8 through 16 are in nine separate scatters along the walls and at the back of the southwest section of the main tube. All are disturbed and long bones appear scattered or sorted. Most appear to have been placed directly on the floor with no covering. All bones are in poor condition and appear to be adults -- though one cranium of a juvenile was observed. The bones are powdery and could not be moved intact. This is probably a family interment. All are separated spatially by 1.0 m. (3.3 ft.) or more.

Tube B extends 16.0 m. (52.5 ft.) southwest of the main tube. It measures 2.0 m. (6.6 ft.) wide with a maximum ceiling height of 4.0 m. (13.1 ft.). Three burials, Burial 17 through 19, were observed in the southwest end of the tube.

Burial 17 is on a ledge on the east side of the end of the tube. The burial was placed directly on the smooth lava ledge. The ledge is 1.9 m. (6.2 ft.) above the tube floor. These are perhaps the remains of a single individual, probably an adult. A few bones have fallen down from the ledge.

Burial 18 is on the left (southeast) side in a nook at the end of the tube. The bones are scattered on the smooth bedrock. Burial 18 comprises the bones of one individual which are in a poor state of preservation.

Burial 19 is on the floor at the back of the tube. The bones are powdery and scattered among two to three small boulders.

All burials appeared to be disturbed. Those observed on the floor have been unearthed and their bones scattered. Crab claws and charcoal - some in chunk form - were observed throughout the lava tube.

State Site #: 50-10-47-17172 **CSH Site #:** 1

Site Type:	Pahoehoe and `a`ā lava excavations
Age:	Prehistoric
Function:	Agricultural
Features (#):	500-750
Dimension:	see below
Elevation:	30-75 ft. a.m.s.l.

Description: Site 17172 consists of `a`ā and pahoehoe excavations comprising between 500 and 750 well-defined pit features. The excavations occur mostly in the northern portion of the project area, between the coast and the historic Cart Road (Site 17189)(see Figure 4). These features are typically in lower elevations of the lava terrain and are more densely concentrated between the coast and approximately 300 m. (1000 ft.) inland.

The majority of the excavations are interpreted as agricultural planting basins, especially those features located close to the coast and the permanent residences of Keopuka. As agricultural features, the excavations likely represented gardens that were associated directly with permanent habitation on the coast. In consideration of the sparsity of intensive, upland agriculture identified in Keopuka, this type of "pit" agriculture close to the coast may have been a significant method for cultivation of subsistence goods in Keopuka.

The excavations measure an average of 1.0 m. (3.3 ft.) to 3.0 m. (9.8 ft.) in diameter and have a range of depths from 0.5 m. (1.6 ft.) to 2.0 m. (6.6 ft.). Typically, the excavated blocks of `a`ā or pahoehoe had been placed around the perimeter of the depression. Occasionally the rocks, most commonly blocky boulders, were stacked or made into a rough, level paving.

As many as 30 excavations were counted in a 30.5 m. by 30.5 m. (100.0 ft. by 100.0 ft.) area, at the 30 to 40 foot elevation, 243.9 m. (800.0 ft.) from the coast. The excavations are especially numerous around habitation sites and shelters. Behind Site 1948 and Site 1949, excavations were observed in virtually all low points in the topography. Associated with several excavations are water-rounded boulders. These water-rounded boulders may have been used to fracture the lava surface when the excavations were formed. In some areas the bedrock surrounding the pits is heavily scarred with signs of previous bashing, but no excavations were formed.

The excavations that were used for agricultural purposes were probably located in close proximity to the coastal habitation sites and are characterized by pits with hollow spaces in the broken lava. Suggesting that the excavations were carefully tended on a continuous basis, the agricultural pits sometimes have adjacent pavings or rough walls around their perimeter. Based on historic accounts (see Agriculture summary of this report), sweet potatoes were commonly planted within lava excavations using a mulch medium.

The individual excavations are in variable conditions and all have fair to poor excavation potential.

CSH Site #: 2

State Site #:	50-10-47-17173
Site Type:	*Ahu*
Age:	Prehistoric
Function:	Marker
Features (#):	1
Dimension:	1.0 m.^{2} (10.8 ft.^{2})
Elevation:	29 ft. a.m.s.l.

Description: Site 17173 is a single *ahu* located in undulating pahoehoe terrain (see Figure 4). Sparse vegetation of grasses and *noni* trees was observed in the site area. The *ahu* measures 1.0 m. (3.3 ft.) in diameter to a maximum height of 1.0 m. (3.3 ft.). It is constructed of small to medium sized pahoehoe slabs and boulders. One medium-sized, water-rounded, boulder was observed.

The *ahu* probably marks an undefined trail.

No midden or artifacts were observed.

Site 17173 is in fair condition and there is no excavation potential.

CSH Site #: 3

State Site #:	50-10-47-17174
Site Type:	Trail
Age:	Prehistoric
Function:	Transportation
Features (#):	1
Dimension:	12.0 m.^{2} (129.6 ft.^{2})
Elevation:	25-30 ft. a.m.s.l.

Description: Site 17174 is a trail located in rough and undulating, mixed 'a'ā and pahoehoe lava terrain (see Figure 4). Vegetation is sparse, consisting of grasses.

The trail is characterized by a faint trodden surface oriented NW/SE across a'ā lava terrain and exposed, flat, pahoehoe outcrops. The trail measures approximately 15.0 m. (49.2 ft.) in length and has a maximum width of 0.8 m. (2.6 ft.). No water-rounded stepping stones or curbing were observed. The unmodified nature and minimal impact of the trail on the lava terrain suggests that it was an infrequently travelled route.

No midden or artifacts were observed.

Site 17174 is in fair condition and there is no excavation potential.

CSH Site #: 4

State Site #:	50-10-47-17175
Site Type:	C-shaped enclosure
Age:	Prehistoric
Function:	Temporary habitation
Features (#):	1
Dimension:	5.5 m.^{2} (59.4 ft.^{2})
Elevation:	20 ft. a.m.s.l.

Description: Site 17175 (Figure 29) is a C-shaped enclosure located on level pahoehoe outcrop. Sparse grass was observed around the site. Based on its small size and lack of substantial architecture, the site is interpreted as a temporary habitation shelter.

The C-shape measures 2.5 m. (8.2 ft.) N/S by 2.2 m. (7.2 ft.) E/W with a maximum wall thickness of 0.7 m. (2.3 ft.) and a maximum height of 0.5 m. (1.6 ft.). The C-shape opens to the west (*makai*) and is constructed of piled pahoehoe boulders. No soil deposit was observed within the enclosure. The site is surrounded by pahoehoe excavations. No midden or artifacts were observed.

Site 17175 is in poor condition and excavation potential is poor.

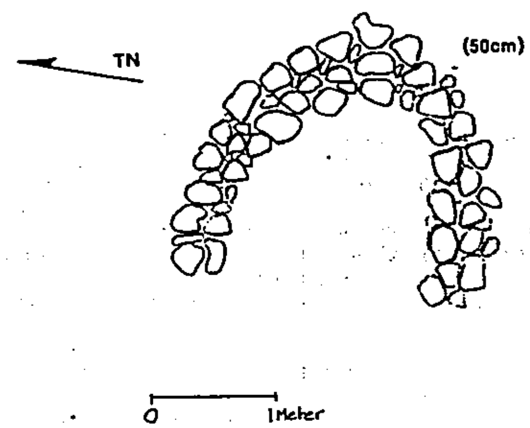

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Figure 29. Site 50-10-47-17175 Enclosure; Plan View

State Site #: 50-10-47-17178		**CSH Site #:** 10
Site Type:	Lava blister	
Age:	Prehistoric	
Function:	Temporary habitation	
Features (#):	1	
Dimension:	3.5 m.^{2} (37.8 ft.^{2})	
Elevation:	25 ft. a.m.s.l.	

Description: Site 17178 (Figure 30) is a lava blister located in undulating pahoehoe lava terrain near the coastline. Surrounding the blister are areas of shallow soil deposits which support fern and grasses. The lava blister is interpreted as a temporary habitation site because of the presence of midden and a manuport. The blister's small size and minor structural modifications suggests short-term use.

The blister is accessed through a small opening created from ceiling collapse. The floor of the opening is scattered boulder rubble that gently slopes into the lava blister. The shelter area of the blister measures 3.5 m. (11.5 ft.) E/W by 1.0 m. (3.3 ft.) N/S with a maximum ceiling height of 1.0 m. (3.3 ft.). The walls and the ceiling of the blister are rough and jagged Minimal modifications were observed. The floor consists of a lava surface and a scattering of cobbles. Marine shell midden and a water-rounded basalt stone were observed. A modern bottle was also observed.

Site 17178 is in fair condition and excavation potential is poor.

State Site #: 50-10-47-17179		**CSH Site #:** 14
Site Type:	Petroglyph	
Age:	Historic	
Function:	Special	
Features (#):	1	
Dimension:	0.3 m.^{2} (32.4 ft.^{2})	
Elevation:	20 ft. a.m.s.l.	

Description: Site 17179 is an historic petroglyph located on a pahoehoe bluff approximately 61.0 m. (200.1 ft.) from the coast. The petroglyph consists of two lines of writing, pecked into a south facing pahoehoe bluff. The petroglyph is English writing spelling "J.S. Kainoa" with a 5-pointed star at the end of the name. Beneath the first line is the date "Feb. 6, m. 1891." The writing is deeply pecked and easily visible.

Scattered marine midden was observed on the opposite side of the ridge. Three water-rounded stones were observed in close proximity to the petroglyph.

Site 17179 is in good condition and has no excavation potential.

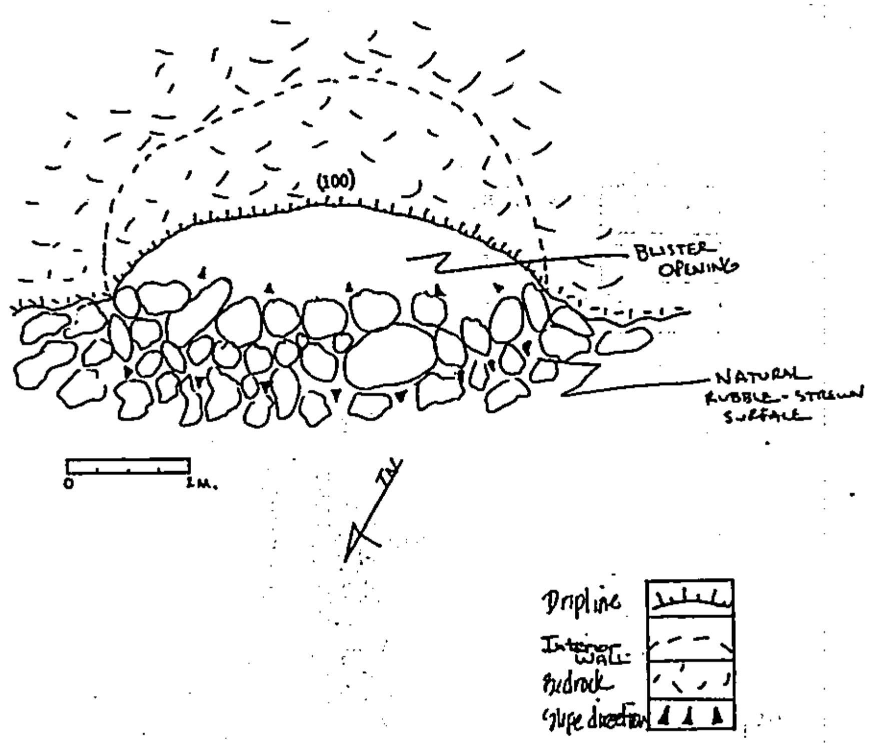

Figure 30 Site 50-10-47-17178 Lava Blister Shelter; Plan View

State Site #: 50-10-47-17181	**CSH Site #:** 21
Site Type:	Lava blister
Age:	Prehistoric
Function:	Temporary habitation
Features (#):	1
Dimension:	13.5 m.^{2} (145.8 ft.^{2})
Elevation:	1 ft. a.m.s.l.

Description: Site 17181 (Figure 31) is a lava blister located in undulating pahoehoe lava terrain (see Figure 100). The blister is interpreted as a temporary habitation site because of its naturally small size and minimal modification (both indicating short term use), and the presence of midden and artifacts.

The shelter area of the lava blister measures 4.5 m. (14.8 ft.) N/S by 3.0 m. (9.8 ft.) E/W with a maximum ceiling height of 1.4 m. (4.6 ft.). The entrance or opening of the blister has been constricted along its southeastern side by a wall segment. The wall is constructed of medium to large 'a'ā slabs, 2.0 m. (6.6 ft.) long N/S and reaches a maximum height of 1.1 m. (3.6 ft.).

Marine shell midden was observed. Historic artifacts observed included a bottle and a battery.

Site 17181 is in fair condition and excavation potential is poor.

State Site #: 50-10-47-17182	**CSH Site #:** 15
Site Type:	Rectangular enclosure
Age:	Prehistoric
Function:	Temporary habitation
Features (#):	1
Dimension:	4.1 m.^{2} (44.3 m.^{2})
Elevation:	15 ft. a.m.s.l.

Description: Site 17182 (Figure 32) is a rectangular enclosure located approximately 35.0 m. (114.8 ft.) to 40.0 m. (131.2 ft.) east of the coast, in a low gully between two pahoehoe fingers. The surrounding vegetation consists of sparse grass and shrubs. The site is interpreted as a temporary habitation structure because of its small size and relatively minimal degree of construction.

The enclosure exterior measures 2.7 m. (8.9 ft.) N/S by 2.7 m. (8.9 ft.) E/W. The wall measures 0.6 m. (2.0 ft.) thick and 0.6 m. (2.0 ft.) high on average. The enclosure is constructed of pahoehoe boulders and large cobbles and the interior is uneven with loose cobbles, boulders and exposed pahoehoe. Abutting the enclosure to the east is a roughly leveled area of boulders and cobbles which measures 1.5 m. (4.3 ft.) N/S by 1.5 m. (4.3 ft.) E/W.

No midden or artifacts were observed.
Site 17182 is in fair to poor condition and excavation potential is poor.

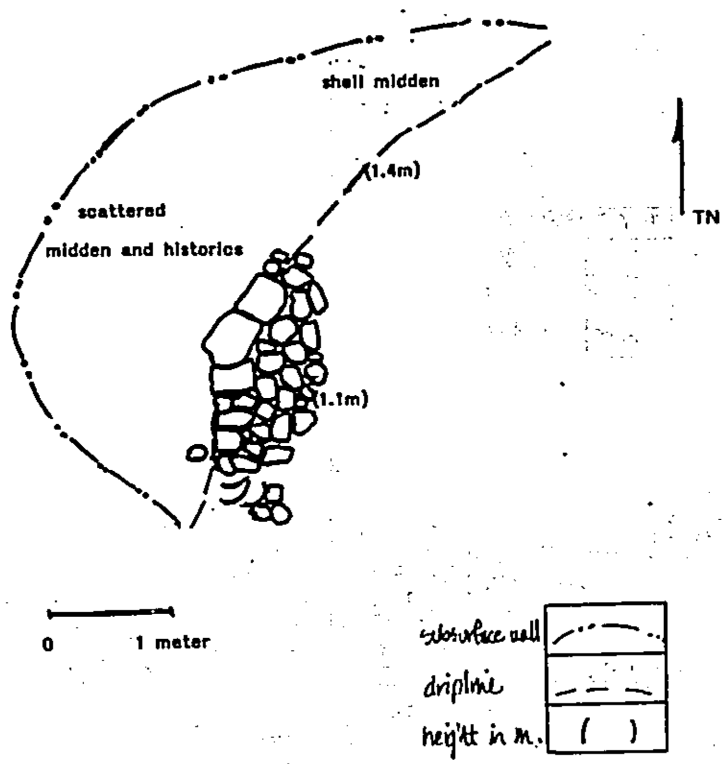

Figure 31 Site 50-10-47-17181 Lava Blister Shelter; Plan View

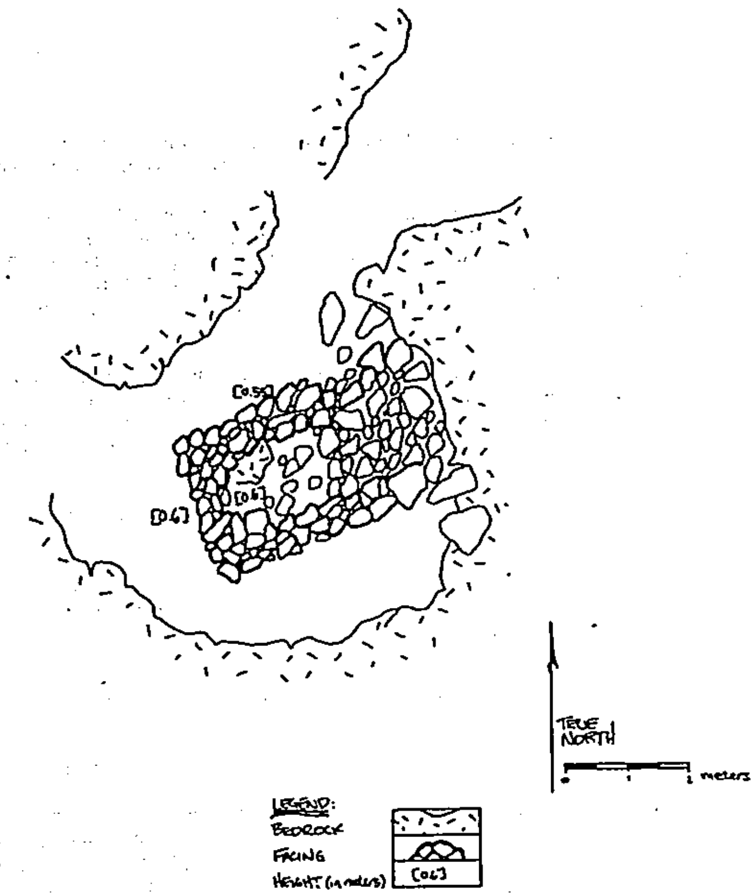

Figure 32 Site 50-10-47-17182 Enclosure; Plan View

State Site #: 50-10-47-17183 **CSH Site #:** 25

Site Type: Trail
Age: Prehistoric
Function: Transportation
Features (#): 1
Dimension: at least 72.0 m. (237.6 ft.) long
Elevation: 15 ft. a.m.s.l.

Description: Site 17183 (see Figure 4) is a trail that extends across undulating 'a'ā and pahoehoe lava adjacent to the coast. It is the *makai*-most trail of three trail sections (including Site 7727 and 17185) present in the area. All three of these trails run parallel to the coast. A site tag (PHRI #11) was observed.

Site 17183 trail is oriented 105° (TN), west to east, paralleling the shoreline at distances between 30.5 m. to 61.0 m. (100 ft. to 200 ft.) from the coast. The trail begins as a trodden path at the west end of an 'a'ā flow and crosses two pahoehoe *kipuka* as it extends to the east. The trail is level and paved with 'a'ā pebbles and coral cobbles placed on rocks on either side to mark the trail. In its east end, the trail is delineated with stepping stones using water-rounded boulders and pahoehoe slabs. The most obvious course of the trail terminates on a pahoehoe flow on its east end. However, remnant sections were observed further to the east for an additional 128.0 m. (420 ft.). These remnant sections appear to terminate just *makai* of Site 1961.

No midden or artifacts were observed.
Site 17183 is in fair condition and there is no excavation potential.

State Site #: 50-10-47-17185 **CSH Site #:** 27

Site Type: Trail
Age: Prehistoric
Function: Transportation
Features (#): 1
Dimension: 80.0 m.^{2} (864.0 ft.^{2})
Elevation: 30-45 ft. a.m.s.l.

Description: Site 17185 (see Figure 4) is a trail consisting of a worn, leveled path in 'a'ā lava. There were no stepping-stones observed on this trail, the only indication of the trail is the levelling and wear on the 'a'ā. The trail measures 80.0 m. (262.4 ft.) long.

Similar to the two neighboring trails to the south or *makai* (Site 7727 and 17183, respectively), the west end of the trail begins on the edge of an 'a'ā lava flow. Moving to the east, it is interrupted for 6.0 m. (19.8 ft.) by a jeep road then continues at 105° TN direction to a pahoehoe *kipuka* in the 'a'ā (the *kipuka* measures approximately 91.5 m. [300 ft.] in diameter). The trail is not visible to the southeast of the *kipuka*.

One piece of volcanic glass was observed midway along the trail.
Site 17185 is in poor condition and there is no excavation potential. Based on the apparent absence of stepping stones and outer curbing, Site 17185 trail was probably traversed less frequently than the other two trails (*i.e.*, Site 7727 and 17183) to the east.

State Site #: 50-10-47-17186 **CSH Site #:** 28

Site Type: Lava blister
Age: Prehistoric
Function: Temporary habitation
Features (#): 1
Dimension: 7.0 m.^{2} (75.6 ft.^{2})
Elevation: 55 ft. a.m.s.l.

Description: Site 17186 (Figure 33) is a small lava blister located on the west side of an 'a'ā lava knoll. Both lava types occur in this site area. The site is interpreted as a temporary habitation shelter because of its naturally small size and the minimal amount of apparent modification.

The blister interior is accessed through a 0.9 m. (3.0 ft.) in diameter vertical opening, which drops 0.8 m. (2.6 ft.) to the floor of the blister. On the surface the entrance is roughly modified with a pavement of boulders and cobbles.

The blister interior measures 3.5 m. (11.5 ft.) N/S by 2.0 m. (6.6 ft.) E/W and the ceiling height measures 0.6 m. (2.0 ft.), average. A rough stacking of boulders and cobbles are present against the eastern wall of the interior.

No artifacts were observed. A few pieces of midden were observed.
Site 17186 is in fair condition and the excavation potential is considered poor.

State Site #: 50-10-47-17188 **CSH Site #:** 30

Site Type: Lava blister
Age: Prehistoric
Function: Temporary habitation
Features (#): 1
Dimension: 25.2 m.^{2}(272.2 ft.^{2})
Elevation: 40 ft. a.m.s.l.

Description: Site 17188 (Figure 34) is a lava blister located approximately 38.1 m. (125 ft.) *makai* of Site 17186, in an area of undulating pahoehoe. There is some grass and fern growing out of the collapsed sink of the blister but there is little vegetation surrounding the shelter on the ground surface. West of the entrance, an associated stepping-stone trail leads toward Site 17186. The site is interpreted as a temporary habitation shelter because of the presence of midden and artifacts. Short-term use is suggested by the small size of the blister.

The blister is accessed through a 2.0 m. (6.6 ft.) in diameter opening that drops vertically 1.0 m. (3.3 ft.) to the floor of the blister. No modifications to the surface or interior of the blister were observed. The blister interior measures 6.0 m. (19.8 ft.) N/S by 4.2 m. (13.8 ft.) E/W with a maximum ceiling height of 0.6 m. (2.0 ft.).

Scattered midden, two water-rounded boulders, three bamboo poles, and historic bottle glass were observed inside the blister. Outside the shelter, glass bottles and a some midden were also observed. Site 17188 is in fair condition and offers poor excavation potential given the absence of soil.

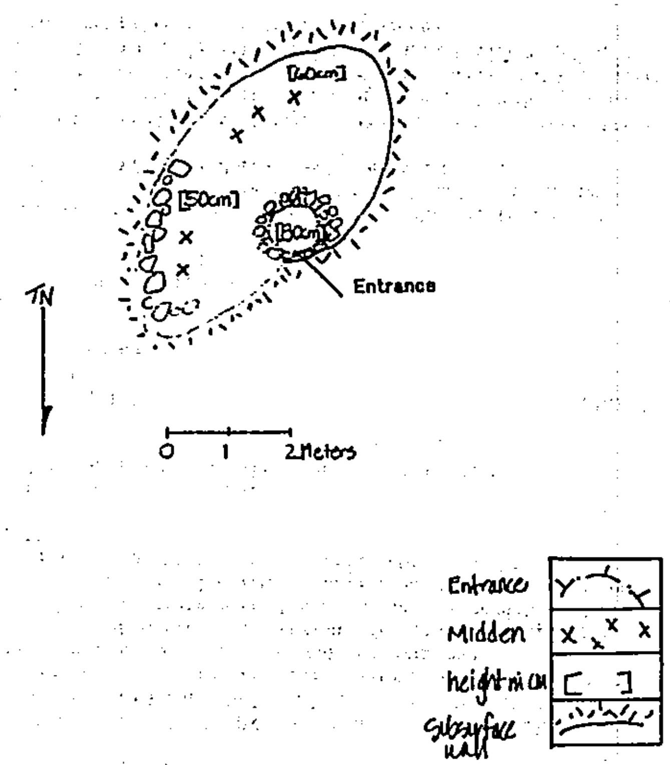

Figure 33 Site 50-10-47-17186 Lava Blister; Plan View

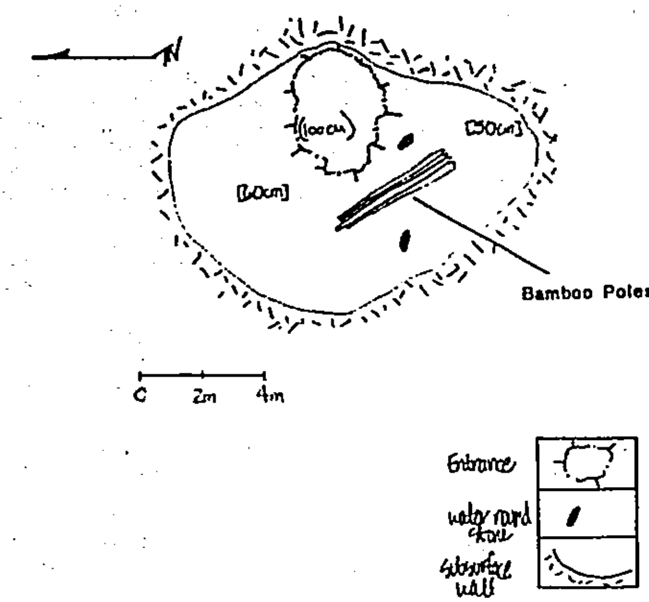

Figure 34 Site 50-10-47-17188 Lava Blister; Plan View

State Site #: 50-10-47-17189 **CSH Site #:** 33

Site Type: Cart Road
Age: Historic
Function: Transportation
Features (#): 1
Dimension: see below
Elevation:

Description: Site 17189 (see Figure 4) refers to an historic-era road, commonly referred to as the "Cart Road", that extends parallel to the coast between Ka'awaloa to the south to as far as Keauhou *ahupua'a* to the north.

Site 17189 Cart Road crosses Keopuka in a north-south direction along the roughly 75 foot contour. The site was constructed for use as a cart road sometime during the 1870's (see Background section of this report). The Cart Road was apparently constructed over an older *ca.* 1820-1830 foot/horse trail, a travel route utilized by resident missionaries traveling between the coastal settlements at Ka'awaloa and Keauhou.

The site is currently a maintained jeep road that measures approximately 4 to 5 m. (13.2 to 16.5 ft.) wide. It is intermittently curbed with water-worn boulders. This curbing is probably remnant material that once formed the perimeter of the Cart Road, as well as possibly components (such as stepping stones) of the earlier foot path/horse trail. The Cart Road most likely evolved into a wider jeep road sometime after WWII, when surplus jeeps became available for use and mechanized machinery enabled the formation and easy maintenance of such jeep roads.

Site 17189 Cart Road is in remnant condition, evidenced only by the intermittent curbing material and its route that is recorded on various maps. The site has no excavation potential.

State Site #: 50-10-47-17191 **CSH Site #:** 33

Site Type: Lava tube
Age: Prehistoric
Function: Temporary habitation
Features (#): 1
Dimension: 30.0 m.² (324.0 ft.²)
Elevation: 45 ft. a.m.s.l.

Description: Site 17191 (Figure 35) is a partially collapsed pahoehoe lava tube surrounded by 'a'ā lava. The collapsed portion of the tube has created a sink in the ground surface. This sink is modified at its south end. The northeast portion of the lava tube has not collapsed and forms an overhang that appears to have been used as a shelter. The site is interpreted as a temporary habitation site, given its small size, minimal degree of modification and presence of midden and manuports.

The sheltered area at the north end of the collapsed tube measures approximately 3.0 m. (9.8 ft.) E/W by 2.0 m. (6.6 ft.) N/S, with a ceiling height of 0.8 m. (2.6 ft.) at the entrance,

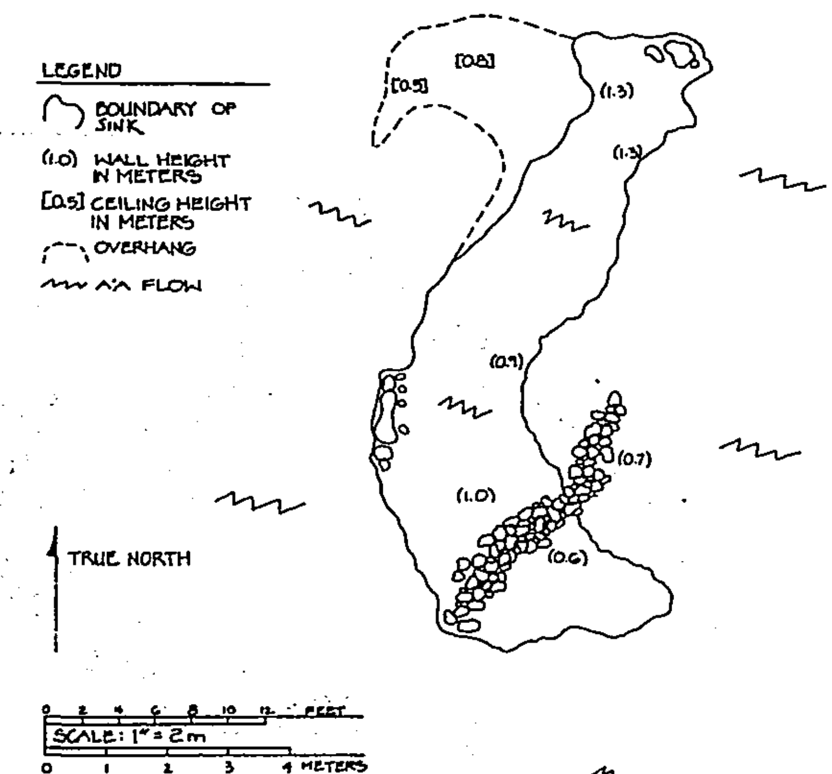

Figure 35 Site 50-10-47-17191 Lava Tube; Plan View

gradually pinching to approximately 0.5 m. (1.6 ft.) at the back. The collapsed tube or sink measures 10.0 m. (32.8 ft.) N/S by 3.0 m. (9.8 ft.) E/W.

A wall segment at the south end of the sink is the only modification present at the site. Constructed of small to large 'a'ā slabs, the wall measures approximately 4.0 m. (13.1 ft.) long, NE/SW, and 1.0 m. (3.3 ft.) high. It essentially closes off the south end of the sink. A trodden path runs north/south approximately 5.0 m. (16.4 ft.) east of the wall.

Several water-rounded stones and an urchin spine were observed within the shelter.

Site 17191 is in fair condition and excavation potential is fair.

State Site #: 50-10-47-17192 **CSH Site #:** 34

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	4
Dimension:	536.5 m.² (5771.9 ft.²)
Elevation:	26-33 ft. a.m.s.l.

Description: Site 17192 (Figures 36 and 37) is a complex consisting of four features, designated Features A to D. The terrain is level pahoehoe lava and vegetation includes *koa haole*, *kiawe*, and grass. The complex is interpreted as a permanent habitation site because the primary habitation features (Feature A and B) are solidly built and define sizable floor areas. These two features are contained within an enclosing wall (Feature C). Feature D is a lava blister that was probably utilized as a day shelter and/or storage area ancillary to the habitation complex. The presence of historic and modern artifacts at Feature D suggests the lava blister was used in historic and modern times.

This site was originally identified by Reinecke (1930) and subsequently recorded as Site 1962 during the 1971 state-wide SHPO survey. The HRHP records show that the site also included numerous features to the south of the present complex. Because a spatial separation was observed between the present complex boundary and the features to the south, the latter features were designated under a separate site number (Site 17193). To avoid potential confusion, the original site number - 1962 - has been discarded.

Feature A is a terrace, roughly square in shape, measuring 5.5 m. (18.0 ft.) NE/SW by 4.5 m. (14.8 ft.) NW/SE and 1.0 m. (3.3 ft.) high. The perimeter of the terrace is constructed of small boulders. The terrace surface is *'ili'ili* stone paving. The terrace is situated within the northwest corner of Feature C enclosure wall.

Shell midden was observed on and around the terrace and a possible salt pan was observed in the southeast corner of the terrace.

Feature A is in good condition and offers good excavation potential.

Feature B is a square platform located approximately 5.0 m. (16.4 ft.) south of the north corner of Feature C. The platform measures 4.5 m. (14.8 ft.) NW/SE by 3.5 (11.5 ft.) NE/SW and is approximately 0.3 m. (1.0 ft.) high. The platform is constructed of small boulders and cobbles and the surface is *'ili'ili* paving.

Shell midden was observed on the platform. A modern Hawai'ian sling spear was also observed on the platform. Feature B is in good condition and offers fair to good excavation potential. A site marker (PHRI) was observed on the site.

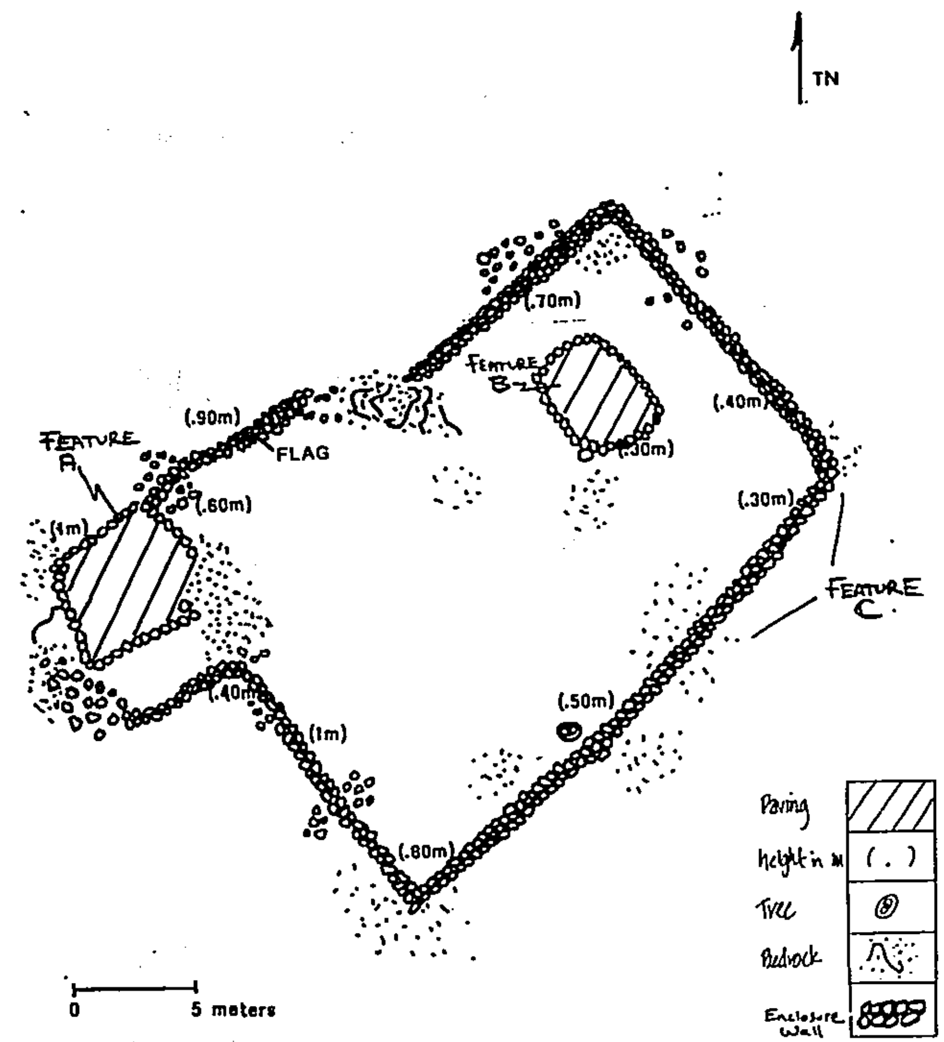

Figure 36 Site 50-10-47-17192 Complex, Features A through C; Plan View

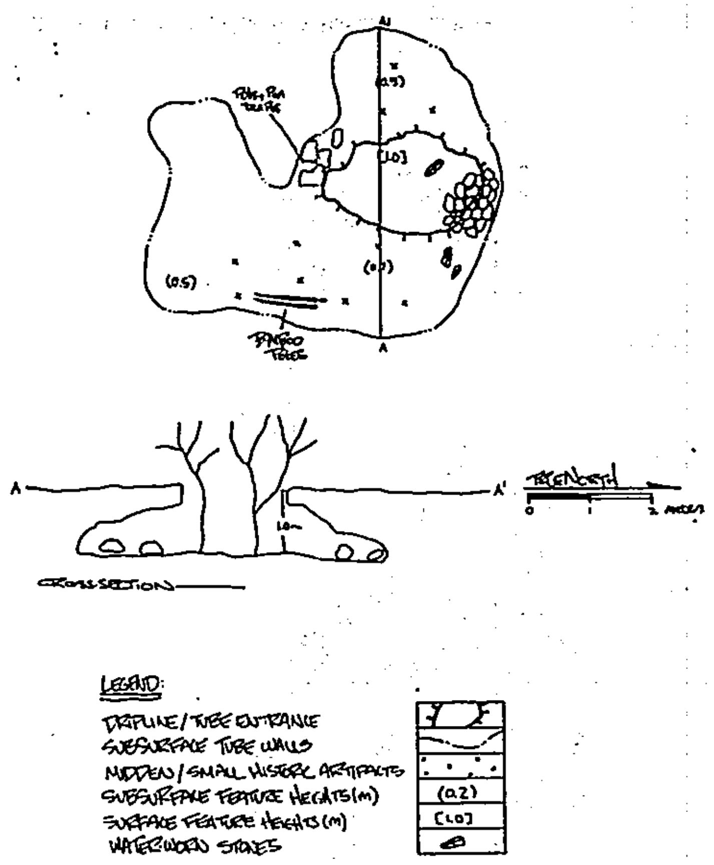

Figure 37 Site 50-10-47-17192, Feature D Lava Blister; Plan View

Feature C consists of a rectangular enclosure, enclosing Feature B and abutting Feature A. The enclosure measures 25.0 m. (82.0 ft.) NE/SW by 20.0 m. (65.6 ft.) NW/SE. The wall is constructed of small boulders and small to large cobbles stacked to a height of 0.8 m. (2.6 ft.) with an average width of 1.5 m. (4.9 ft.).

A large amount of shell midden is scattered throughout the enclosure. Several water-rounded stones were also observed.

Feature C is in fair to good condition and offers good excavation potential.

Feature D is a lava blister shelter located in pahoehoe lava, to the west of Feature A, and 9.0 m. (29.5 ft.) south (*makai*) of the access road. The blister measures 4.0 m. (13.1 ft.) N/S by 5.0 m. (16.4 ft.) E/W, and 1.0 m. (3.3 ft.) high, at the entrance. It is accessed through a vertical collapse in the blister ceiling measuring 2.5 m. (8.2 ft.) N/S by 1.5 m. (4.9 ft.) E/W. The blister is modified by a two-course boulder stacking at the north end. The interior is level soil.

Midden, coconut shells, and water-rounded boulders were observed.

Historic artifacts observed include: wood with wire nails, bamboo fishing poles, an aluminum frying pan marked "West Bend," a possible boat transom and a grooved, disc-shaped piece of wood (a possible fishing reel).

Feature D is in good condition and the excavation potential is good.

State Site #: 50-10-47-17193 **CSH Site #:** 35

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	2
Dimension:	185.0 m^2 (1998.0 ft^2)
Elevation:	25 ft. a.m.s.l.

Description: Site 17193 (Figure 38) is a complex consisting of two features, designated Features A and B. The site is located approximately 30.0 m. (100.0 ft) northeast of the coast in pahoehoe, mixed soil pocket terrain. Vegetation consists of *koa haole* and lantana bushes. The complex is interpreted as a permanent habitation site based on the substantial architecture of Feature A and its large floor area. Feature B is a remnant structure that is probably a permanent habitation feature because of its proximity to Feature A. Site 17192 habitation complex is located to the north of the site.

Feature A of this site was originally identified by Reinecke (1930) and subsequently recorded in the HRHP as a component feature of Site 1962 (SHPO 1971). The HRHP Site 1962 records show that the site included numerous features to the north of the present complex. Because a spatial separation was observed between Feature A of the present complex and the other Site 1962 features to the north, the latter features were designated under a separate site number (Site 17192). To avoid potential confusion, the original site number - 1962 - has been discarded.

Feature A is a platform and two contiguous enclosures. Overall, Feature A measures 20.0 m. (65.6 ft.) NW/SE by 8.0 m. (26.2 ft.) NE/SW. The platform is rectangular in shape,

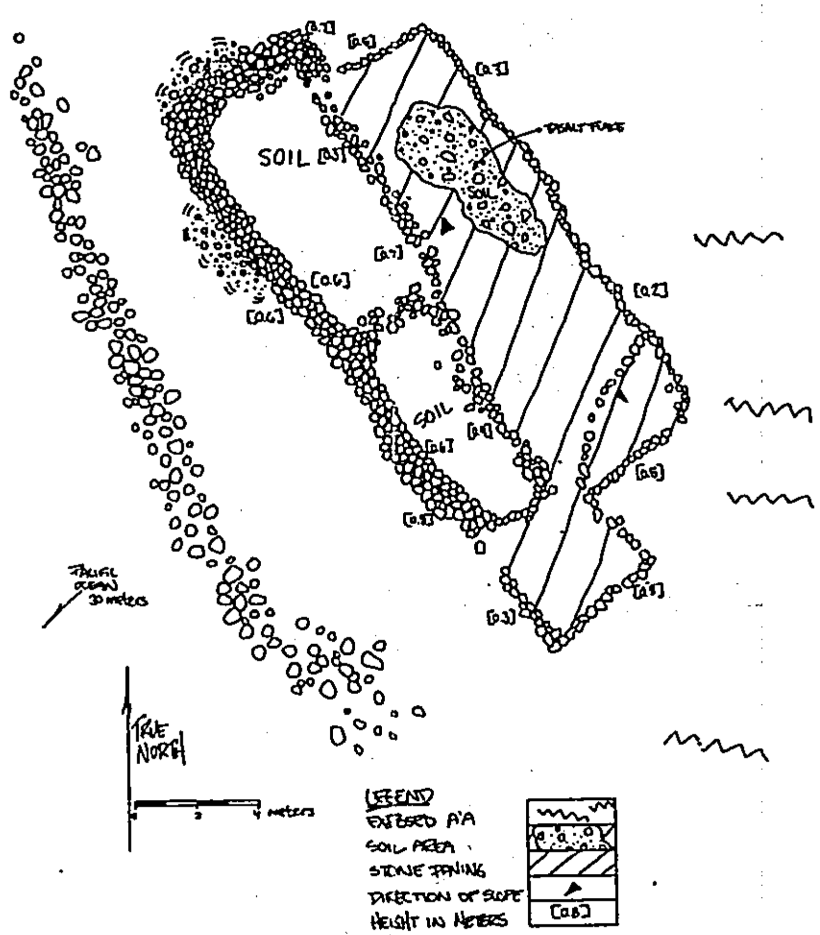

Figure 38 Site 50-10-47-17193, Feature A Platform; Plan View

measuring 15.0 m. (49.2 ft.) NW/SE by 5.0 m. (16.4 ft.) NE/SW. A maximum height of 0.7 m. (2.3 ft.) is measured at the north side of the platform. The perimeter construction is of boulders and cobbles, and the surface is fairly level cobble pavement. There is a soil deposit on the surface of the platform, at the north end, within which a basalt flake was observed.

Two rectangular contiguous enclosures abut the southwest edge of the platform. Together, the enclosures measure 17.0 m. (55.8 ft.) long NW/SE by 4.0 m. (13.1 ft.) wide NE/SW. The enclosure walls measure 1.5 m. (4.9 ft.) thick and 0.6 m. (2.0 ft.) high. The enclosures are separated into roughly equal areas by a collapsed wall. The walls of the enclosures are constructed of stacked cobbles and small boulders. The interior of both enclosures is level soil.

Historic artifacts observed include a rubber slipper and a glass bottle.
Feature A is in fair to good condition and offers good excavation potential.

Feature B is a feature remnant consisting of a midden scatter located 30.5 m. (100.0 ft.) southeast of Feature A. The midden scatter measures 5.0 m. (16.4 ft.) in diameter. There is evidence of bulldozing at Feature B and a rough alignment and cobble scatter suggests that the feature may have once been a platform.

CSH Site #: 36

State Site #: 50-10-47-17194	
Site Type:	Complex
Age:	Prehistoric
Function:	Recurrent habitation; possible burial
Features (#):	6
Dimension:	99.3 m.^{2} (1,072.4 ft.^{2})
Elevation:	30-49 ft. a.m.s.l.

Description: Site 17194 (Figure 39) is a complex comprising six features, designated Features A to F. The complex is located in mixed ʻaʻā and pahoehoe terrain. Features A, B, C and F are located primarily on pahoehoe outcrop. Features D and E are situated in a barren ʻaʻā field. Vegetation consists of grass and *noni* in the northern portion of the complex.

Two of the features of this complex, Features A and B, were originally interpreted as possible burial features, and both were subsequently subjected to limited subsurface testing (see *Excavation Results* section of this report). The absence of human remains in the test units excavated at these features then required alternative functional interpretations.

The majority of the complex features (Features A through C, and F) are now interpreted as recurrent habitation features based on structural similarities with other recurrent habitation features within the site complex and within the project area in general. Features A through C are clustered and their locations, oriented roughly *mauka-makai*, may indicate that a presently undefined travel route once existed in the area. Feature D, with its small size and elevated surface, and Feature E lava tube - because its entrance is blocked - are interpreted as possible burials. Limited testing conducted at Features A and B provided no additional information of the site's function, other than that cultural material (including human remains) was absent from the excavations.

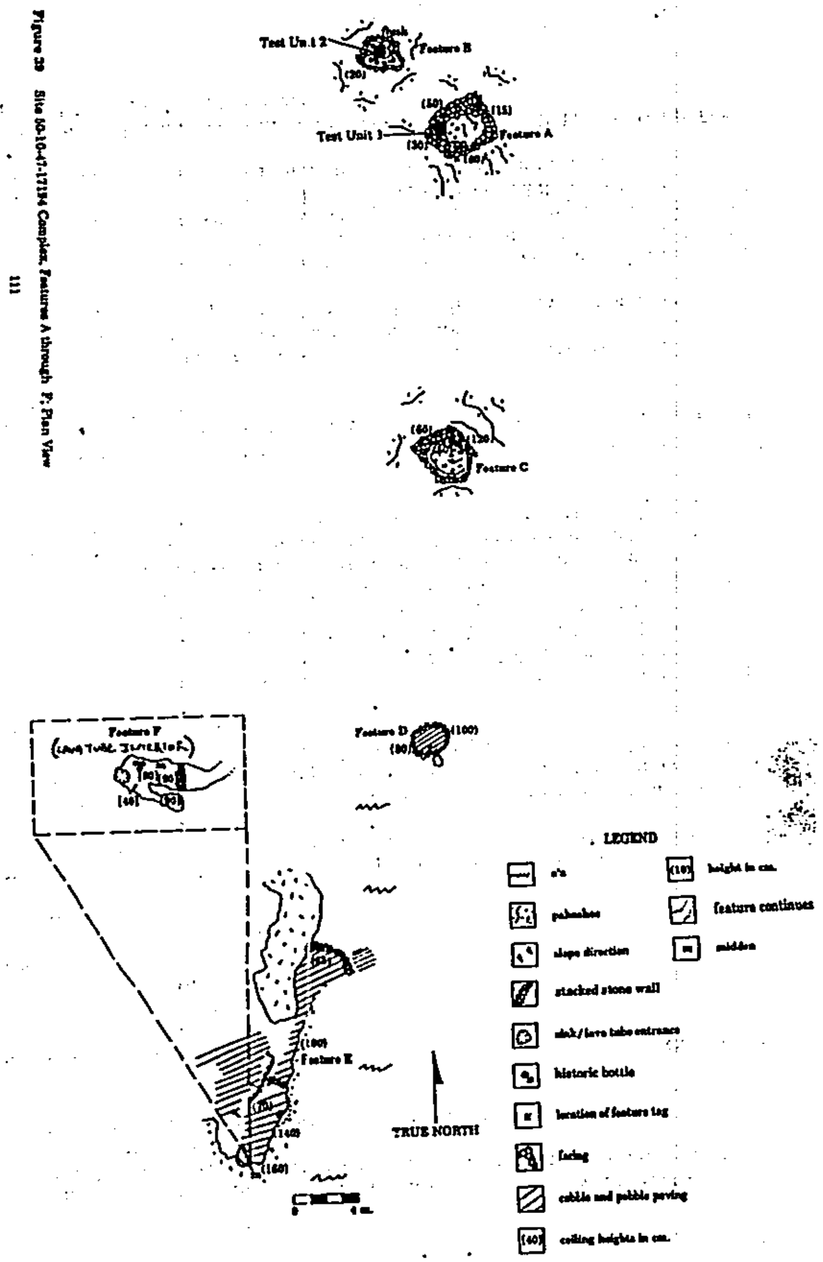

Figure 39 Site 50-10-47-17194 Complex, Features A through F; Plan View

Feature A is a small, roughly square platform measuring 4.5 (14.8 ft.) E/W by 3.5 m. (11.5 ft.) N/S. The platform measures 0.8 m. (2.6 ft.) above the ground surface. There is vertical facing on the northwest and south sides. A large portion of the platform surface is pahoehoe bedrock. The platform is constructed of pahoehoe boulders and cobbles and water-rounded stones.

No midden was observed. A site marker (PHRI) was observed on the west side of the platform.

Feature B is a terrace located approximately 4.0 m. (13.1 ft.) northwest of Feature A. It measures 2.5 m. (8.2 ft.) E/W by 2.0 m. (6.6 ft.) N/S and 0.2 m. (0.6 ft.) high, on the south side. The north side is flush with the surrounding terrain. Feature B is constructed of small boulders and cobbles. The perimeter of the terrace is constructed of small boulders and the surface is small cobble and pebble pavement. An upright water-rounded boulder was observed on the south end of the terrace.
No midden or artifacts were observed.

Feature C is a modified outcrop located approximately 16.0 m. (52.5 ft.) south/southeast of Feature A. Feature C, like Features A and B, is constructed on a high point in the terrain. Feature C measures 3.5 m. (11.5 ft.) NW/SE by 3.0 m. (9.8 ft.) NE/SW. The interior and *makai* section of Feature C are bedrock and there is stacking of small boulders and large cobbles around the exterior. There is vertical facing on the northwest and northeast sides of Feature C. A water-rounded boulder was observed on the south side of the feature. Coral was observed. Feature C is in fair condition.

Approximately 15.0 m. (49.2 ft.) south of Feature C, a remnant platform is located atop a similar high point. This remnant structure was not given a feature designation.

Feature D is a small circular platform. Constructed of small to medium 'a'ā boulders, this platform measures 2.0 m. (6.6 ft.) in diameter to a maximum height of 1.0 m. (3.3 ft.). The perimeter of the platform is vertically faced and the surface is level cobble pavement. No artifacts or midden were observed. Feature D remains in good condition.

Feature E is a rockshelter located 13.0 m. (42.6 ft.) southwest of Feature D. The rock shelter is essentially a modified depression, or a linear swale, within a'a terrain. The depression measures 9.0 m. (29.5 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE and is 1.6 m. (5.2 ft.) deep. The modifications consist of a large rectangular pavement of cobbles and pebbles roughly 13.0 m. N/S by 4.0 m. E/W, a rough wall segment that intersects with a boulder alignment within the center of the depression, and a wall segment 3.0 m. (9.8 ft.) long and 0.6 m. (2.0 ft.) wide located along the northern edge of the pavement.
Shell midden, a glass bottle, and a tin can were observed in the shelter depression.

Feature F is a lava tube, the entrance of which is located on the southern end of the rockshelter (Feature C). The length of the tube is undetermined because approximately 4.0 m. (13.1 ft.) east of the tube entrance, a wall effectively blocks off the rest of the tube. The wall is constructed to the ceiling, but the tube was observed to continue, following the removal of some of the wall. The deliberate obstruction of the lava tube indicates a possible burial. The accessible part of the tube is a chamber approximately 4.0 m. (13.1 ft.) long, E/W, and 2.0 m. (6.6 ft.) wide. The maximum height of the lava tube ceiling is 0.9 m. (3.0 ft.).

Four glass bottles, fragments of rotting lumber (some with nails), metal fragments, coral, and shell midden were observed. A single indigenous artifact, a coral sinker, was collected from Feature F (Acc. 9).

The constructed wall in the lava tube is in fair condition.

State Site #: 50-10-47-17195 **CSH Site #:** 37
Site Type: Complex
Age: Prehistoric
Function: Permanent habitation
Features (#): 3
Dimension: 432.0 m.^{2} (4,665.6 ft.^{2})
Elevation: 15-20 ft. a.m.s.l.

Description: Site 17195 (Feature 41) is a complex comprising three features, designated Features A to C. This site is located in broken pahoehoe lava terrain. The surrounding vegetation is *kiawe*, *koa haole*, and *noni*.

The site is interpreted as a permanent habitation complex because of the substantial architecture of the features and the large floor area of Feature A. Feature is interpreted as the primary habitation feature, with Features B and C serving as auxiliary habitation features, such as storage or special work areas.

Feature A is a large rectangular enclosure located just *makai* of the access road. The enclosure measures 8.0 m. (26.2 ft.) N/S by 14.0 m. (45.9 ft.) E/W. The walls measure 1.0 m. (3.3 ft.) in thickness and range in height from 0.5 m. to 1.1 m. (1.6 to 3.6 ft.). The walls are in poor condition, with the best preserved portion in the northwest wall. The walls appear to have been core-filled, constructed of medium to large pahoehoe boulders (also incorporating some water-rounded boulders) and filled with cobbles. The north wall abuts pahoehoe outcrop. The western half of the enclosure interior is paved with water-rounded boulders and pahoehoe boulders and cobbles. The eastern interior is grainy, sandy soil and scattered boulders and cobbles.

A wall remnant extends off the southeast corner of Feature A. Construction is mostly of large pahoehoe boulders and water-rounded boulders. This wall measures approximately 9.0 m. (29.5 ft.) long, N/S.

Midden, coral, and broken bottles were observed scattered on the surface of the enclosure interior and the area surrounding the enclosure.

Feature A is in fair to poor condition and offers fair to good excavation potential.

Feature B consists of a pavement and an adjoining overhang shelter located roughly 5.2 m. (17.1 ft.) from the east corner of Feature A. The pavement, measures 7.5 m. (24.6 ft.) E/W by 4.0 m. (13.1 ft.) N/S. The north end of the pavement is roughly faced with boulders, measuring 0.4 m. (1.3 ft.) high. The overhang measures 1.6 m. (5.2 ft.) wide and is 1.0 m. (3.3 ft.) high by 1.0 m. (3.3 ft.) deep. No modifications were observed in the interior.

Midden, coral, and broken bottles were observed at Feature B. Feature B is in fair condition and excavation potential is fair.

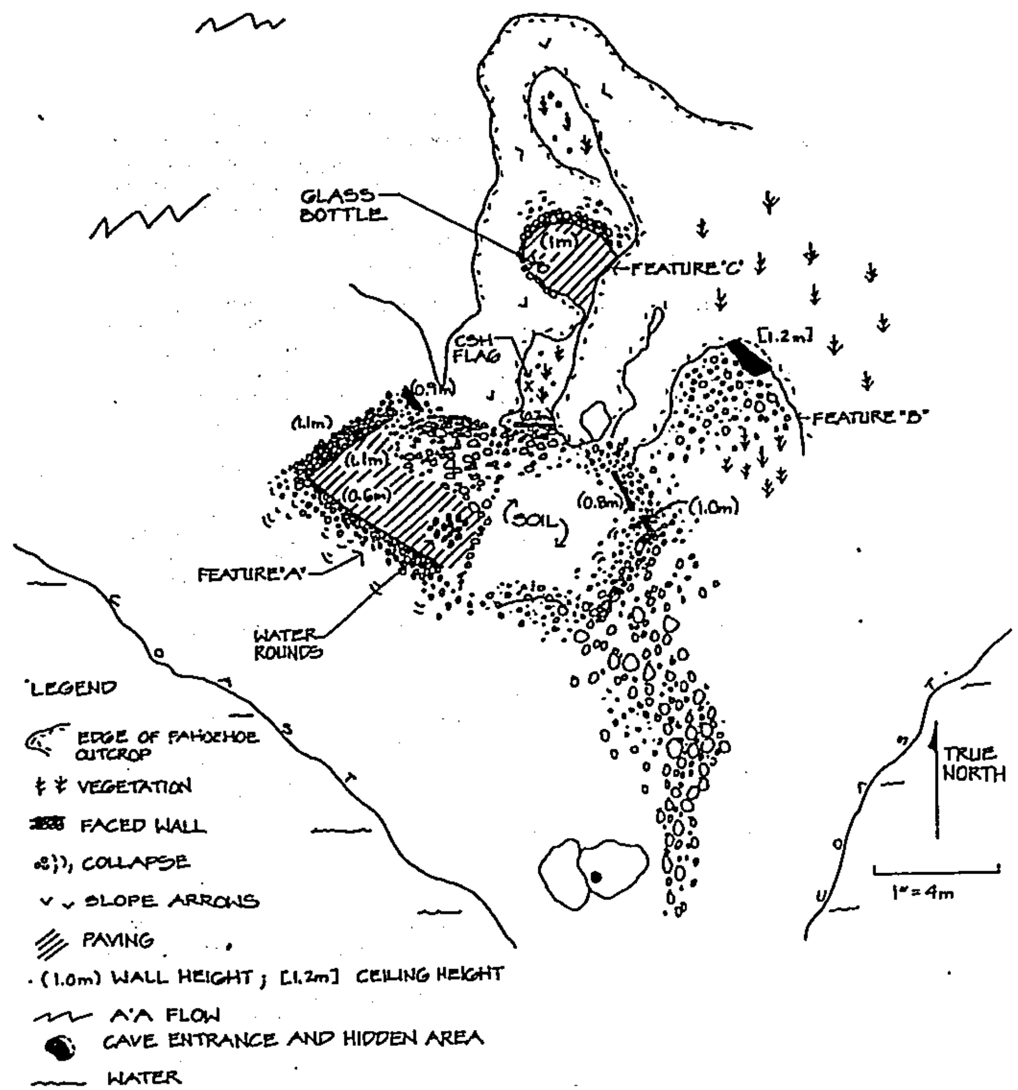

Figure 40 Site 50-10-47-17195 Complex, Features A through C; Plan View

Feature C consists of a modified depression. The depression measures 3.0 m. (9.8 ft.) in diameter. It is walled on the north and west sides with stacked pahoehoe boulders and cobbles. The walls measure to a height of 0.4 m. (1.3 ft.). The interior is undulating pahoehoe.
Bottles were observed in the west end of the depression. Feature C is in poor condition and excavation potential is poor.

State Site #: 50-10-47-17197 **CSH Site #:** 39

Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	6
Dimension:	1,440.0 m.² (15,552.0 ft.²)
Elevation:	20-25 ft. a.m.s.l.

Description: Site 17197 (Figure 41) is a complex consisting of six features, designated Features A through F. Vegetation in the area is *kiawe*, *koa haole*, *noni*, and grass. The complex is located in gently undulating pahoehoe lava terrain with scattered shallow soil pockets. The site is interpreted as a permanent habitation complex because of the substantial architecture of the features, interconnecting walls between the individual features, sizable floor areas and the presence of internal features (*i.e.*, entry-ways and hearth). The presence of salt pans also indicated salt production at this site.

Limited subsurface testing was conducted at Feature A of this site, and the results of that excavation support the interpretation of Feature A platform as a component feature of a permanent habitation site complex (see *Excavation Results* section of this report). The presence of a probable hearth in the platform, in conjunction with the extensive variety and quantity of midden recovered, indicates that food preparation and probably consumption occurred at Feature A. Based on the midden observed and collected, the foods prepared and/or consumed at this site included primarily shellfish, some fish (including shark), pig and possibly dog.

Feature A is a large, rectangular-shaped platform that measures 11.0 m. (36.1 ft.) NW/SE by 8.5 m. (27.9 ft.) NE/SW, and raises to a maximum height of 0.8 m. (2.6 ft.). The platform edges are constructed of small to medium boulders and cobbles and the surface paving consists of *'ili'ili* stones. The platform has vertical facing on all sides. Boulders abut the center of the *makai* side of the platform in a possible entrance. A wall extends 7.5 m. (24.6 ft.) NW/SE to the northeast from the northern corner of the platform. There is a circular, cobble-lined depression in the western corner of the platform. This is interpreted as a probable hearth feature.

Numerous shell fragments and branch coral were observed on the platform surface. One indigenous artifact, a basalt pestle, was collected from the surface (Acc. 11). Bottle glass fragments were also observed on and around the platform. Several other artifacts were recovered from a subsurface context of this feature (see *Excavation Results* section of this report).
Feature A is in good condition and excavation potential is good.

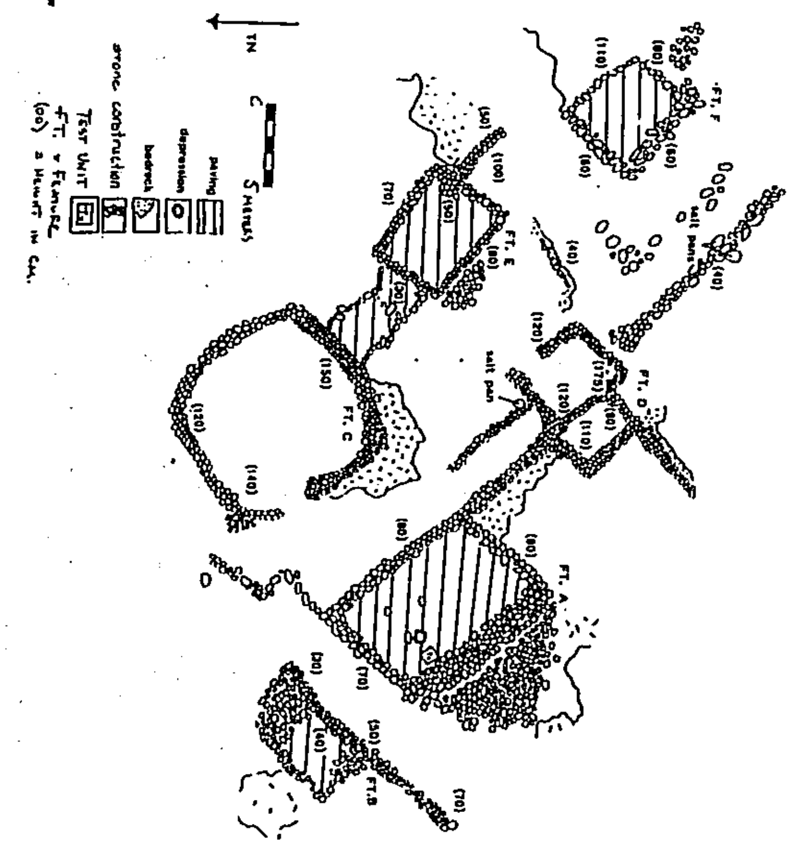

Figure 41 Site 50-10-47-17197 Complex, Features A through F; Plan View

Feature B comprises a platform and wall segment located 2.5 m. (8.2 ft.) west of Feature A. Feature B measures 7.0 m. (23.0 ft.) NE/SW by 4.5 m. (14.8 ft.) NW/SE to a maximum height of 0.4 m. (1.3 ft.). The perimeter of the platform is constructed of small boulders and large cobbles. The surface is *'ili'ili* pavement and scattered small boulders. There are also small water-rounded boulders intermixed in the construction of Feature B. Low vertical facing was observed on the northwest and southeast sides. The other sides of the platform are tumbled, sloping down to the bedrock and soil. From the south corner of the platform, a wall segment extends 7.0 m. (23.0 ft.) to the southwest. The wall measures to a maximum height of 0.7 m. (2.3 ft.) and is 1.0 m. (3.3 ft.) thick.

Coral and shell midden were observed on and around Feature B. A piece of volcanic glass was observed in the northeast corner of the platform. Modern artifacts including glass bottle fragments and cans were observed in the area.
Feature B is in fair condition and offers good excavation potential.

Feature C is a large circular enclosure located in level pahoehoe and shallow soil, approximately 8.0 m. (26.2 ft.) northeast of Feature A. The enclosure measures 12.0 m. (39.4 ft.) NW/SE by 11.5 m. (37.7 ft.) NE/SW. The walls are 1.5 m. (4.9 ft.) high and are 1.0 m. (3.3 ft.) thick. Construction is of small to medium boulders and vertical facing remains in tact. The interior is level soil scattered with boulders. Small water-rounded boulders are intermixed in the enclosure construction material. An entrance, measuring 2.0 m. (6.6 ft.) wide, is located just south of the west corner. The interior of Feature C is level soil with grass.

Shell midden and coral were observed in the interior of the enclosure. No artifacts were observed. Feature C is in good condition and offers good excavation potential.

Feature D consists of two contiguous rectangular enclosures located approximately 9.0 m. (29.5 ft.) southeast of Feature A. The enclosures are oriented roughly east-west and are divided by a boulder wall, which extends northwest and connects to the east corner of Feature A (and continues as the northeastern wall of Feature A).
The eastern enclosure measures 5.0 m. (16.4 ft.) NW/SE by 4.5 m. (14.8 ft.) NE/SW. The walls measure to a maximum height of 1.7 (5.6 ft.). There is a break in the northeastern wall of this enclosure which forms a 1.3 m. entrance into the enclosure. Near the entrance and abutting the northwestern wall of the enclosure, a wall segment extends to northeast toward Feature A parallel to the wall that connects Features A and D. This wall segment measures 6.0 m. (19.8 ft.) long and creates a narrow enclosed area.

The western enclosure measures 4.5 m. (14.8 ft.) NW/SE by 3.0 m. (9.8 ft.) NE/SW. A wall extends 5.0 m. (16.4 ft.) southwest from the south corner of this enclosure. The walls average 0.8 m. (2.6 ft.) thick. Both enclosures are constructed of small to medium boulders and cobbles. The interior of both enclosures consists of shallow, sandy soil and pahoehoe bedrock.

Shell midden, coral, and glass fragments were observed. A salt pan was observed just outside the northwestern wall of the *mauka* enclosure.
Feature D is in good condition and excavation potential is good.

Feature E is a platform located approximately 10.0 m. (32.8 ft.) northeast of Feature D and 5.0 m. (16.4 ft.) east of Feature C. The platform measures 7.0 m. (23.0 ft.) NW/SE by 5.0 m. (16.4 ft.) NE/SW. The perimeter of the platform is constructed of small to medium boulders and the surface is level *'ili'ili* paving. There is vertical facing on all sides of the platform. At the west corner of the platform there is a pavement constructed of small water-rounded boulders.

A wall segment abuts the east portion of the platform, and extends 4.0 m. (13.1 ft.) to the southeast. This wall segment if constructed of small to medium boulders, 0. stacked to a height of 0.5 m. (1.6 ft.).

Scattered shell midden was observed on and around the platform. A basalt flake was observed on the platform surface.

Feature E is in good condition and excavation potential is good.

Feature F is a platform located approximately 7.0 m. (23.0 ft.) southeast of Feature E. Feature F measures 6.0 m. (19.8 ft.) NW/SE by 5.5 m. (18.0 ft.) NE/SW. The maximum vertically faced height measures 1.1 m. (3.6 ft.), on the northeast side. The perimeter of the platform is constructed of small to medium boulders. The surface is level pavement of small water-rounded boulders. Vertical facing exists on all sides.
A basalt hammerstone was observed on the platform surface. Large amounts of cowrie and *opihi* shell midden were observed. In areas between Features D, E, and F there are apparent rock alignments with unknown functions.

Feature F is in good condition and excavation potential is good.

State Site #: 50-10-47-17198 **CSH Site #:** 40
Site Type: Complex
Age: Prehistoric
Function: Recurrent habitation; possible burials; marker
Features (#): 4
Dimension: 3,500.0 m.^{2} (37,800.0 ft.^{2})
Elevation: 22-45 ft. a.m.s.l.

Description: Site 17198 (Figure 42) is a complex comprising four features, designated Features A to D. The complex is located in undulating pahoehoe lava terrain. Two sections of Site 7728 trail are present along the eastern edge of this complex. One segment runs in a north-south direction, and the other runs in a north/northeast - south/southwest direction. Vegetation includes fountain grass and ferns.

The site is interpreted as a multiple function complex which includes: two possible burial platforms (Feature A and C); a recurrent habitation pavement (Feature B) and a platform that probably functioned as a trail marker (Feature D). Features A and C are interpreted as possible burials because of their substantial architecture and elevated heights. Feature B borders the trail (Site 7728) and is interpreted as a recurrent habitation feature based on its location, its construction, the size of its floor area, and presence of cultural material on the feature surface. Feature D is a platform interpreted as a trail marker based on its location adjacent to the trail and on a high spot overlooking the ocean, and its small size which would likely preclude a habitation function.

Feature A is a large square platform located atop a pahoehoe bluff. It measures 6.5 m. (21.3 ft.) NE/SW by 6.0 m. (19.7 ft.) NW/SE. Vertical facing measures to a maximum height of 1.7 m. (5.6 ft.) on the northeast and southwest sides. The southeast side of the platform shows remnants of vertical facing, but has suffered heavy collapse. The platform facing on the northwest side is 0.8 m. (2.6 ft.) high and is built up from the bedrock bluff. The perimeter of the platform is constructed of well-stacked pahoehoe boulders. The surface of the platform is pahoehoe and ʻaʻā cobble pavement.

There are several internal features associated with this platform. At the *makai* (southwest) side of the platform, the facing is notched and a constructed extension juts out southward. At the west corner of the platform, an inset of formal stairs leads from the bedrock surface to the top of the platform surface. A stone-lined depression, measuring 0.5 m. (1.6 ft.) in diameter and 0.5 m. (1.6 ft.) deep, is located on the northwest side of the platform. An *ahu* constructed of pahoehoe boulders, measuring 1.2 m. (3.9 ft.) in diameter and 0.4 m. (1.3 ft.) high, is also located on the platform surface, 3.0 m. (9.8 ft.) southeast of the depression. A raised area of the platform surface, measuring 1.0 m. (3.3 ft.) in diameter and 0.5 m. (1.6 ft.) high, is located in the south corner.

A wall extends north from the bluff, 4.0 m. (13.1 ft.) north of the platform. This wall measures 8.0 m. (2.6 ft.) long, N/S, and 1.0 m. (3.3 ft.) high.

Four meters (13.1 ft.) west of the north end of the wall is an associated *ahu* constructed of pahoehoe and ʻaʻā. This *ahu* measures 0.5 m. (1.6 ft.) high and 1.5 m. (4.9 ft.) in diameter. It is partially collapsed. Mined pits are visible in the pahoehoe northwest of Feature A.

No midden or cultural material was observed at Feature A.A site tag (PHRI Site 19) was located on the platform surface.

Feature A is in good condition.

Feature B is a level pavement on the ʻaʻā located 5.0 m. (16.4 ft.) east of Feature A, across a natural depression. In the center of the level area is a pebble pavement measuring 2.0 m. (6.6 ft.) square. The entire feature measures 10.0 m. (32.8 ft.) N/S by 6.0 m. (19.8 ft.) E/W. On the east side of Feature B, there is an alignment and retaining wall of Site 7728 trail. The walking surface of the trail is 1.8 m. wide.

Midden, branch coral, and volcanic glass are thinly scattered across the level pavement of Feature B. Plentiful midden is also scattered on the surface of the trail from Feature B to Feature D to the south.

Feature B is in fair to poor condition and excavation potential is fair to poor.

Feature C is a well-constructed platform located 15.0 m. (49.2 ft.) west of Feature A. The platform is square, with sides measuring approximately 5.0 m. (16.4 ft.). It is faced on all sides with pahoehoe boulders. The surface of the platform is level, pahoehoe cobble and ʻaʻā

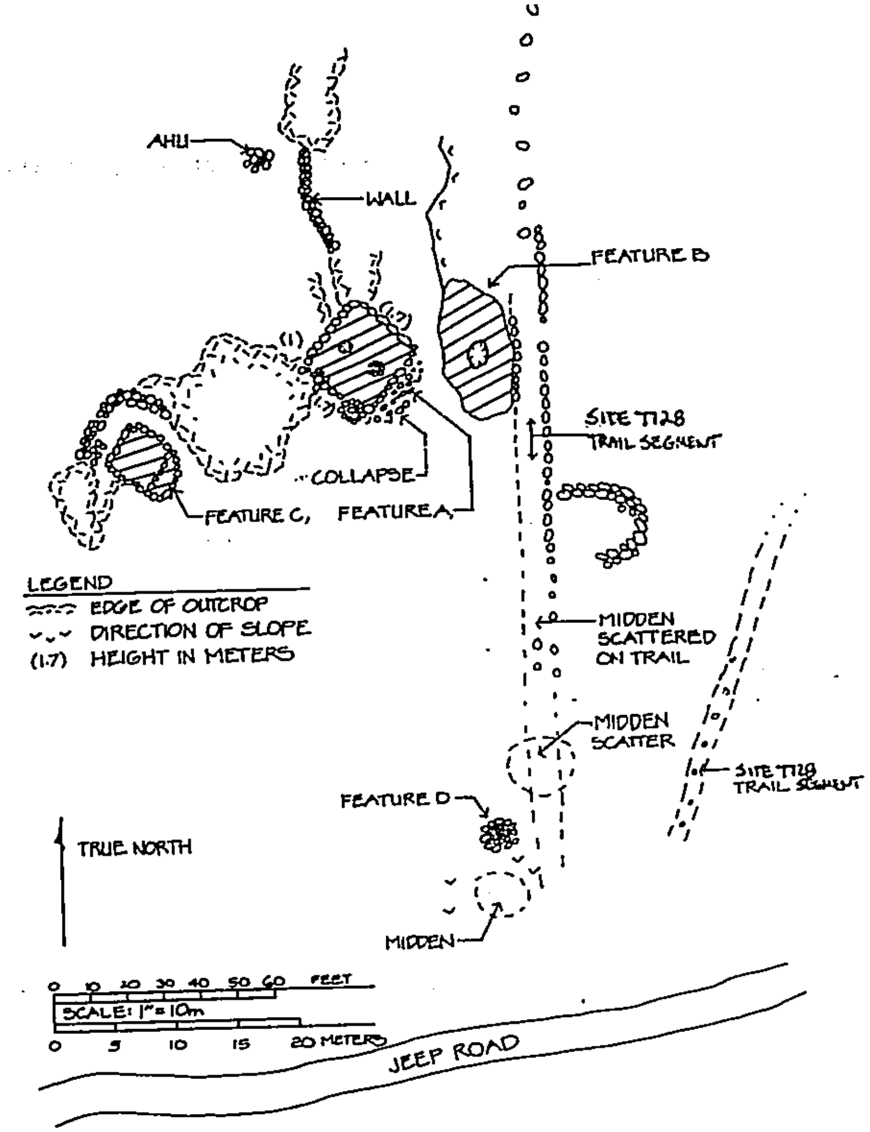

Figure 42 Site 50-10-47-17198 Complex, Feature A through D, (Site 50-10-7728 Trail); Plan View

pebble pavement. Water-rounded boulders are also incorporated into the facing on the southeast side. Vertical facing measures 0.7 m. (2.3 ft.) high at the southeast side.

An L-shaped wall parallels the northwest and northeast sides of the platform at a distance of 3.0 m. (9.8 ft.). The wall is in poor condition.

A moderate amount of branch coral and other types of coral were observed on the surface of the platform. No artifacts or midden were observed.

Feature C is in good condition.

Feature D is a rough platform or *ahu* located 30.0 m. (98.0 ft.) south of Feature B, on the west side of Site 7728 trail. The platform measures 2.5 m. (8.2 ft.) N/S by 2.5 m. (8.2 ft.) E/W. The surface is level and construction is of `a`ā cobbles. The west face, oriented N/S, measures 0.6 m. (2 ft.) high, and is partially buried by collapse. The northeast and south sides are in poor condition and have collapsed. Six meters (19.8 ft.) northeast of the platform is an area of dark organic soil with visible midden. The soil deposit measures roughly 4.0 m. (13.1 ft.) in diameter and appears to be a living floor. This midden deposit is located where the two branches of Site 7728 trails converge near at the coast.

No midden or artifacts were observed on the platform.

State Site #: 50-10-47-17199 **CSH Site #:** 41

Site Type:	Complex
Age:	Prehistoric
Function:	Recurrent habitation
Features (#):	2
Dimension:	289.0 m.^{2} (3,121.2 ft.^{2})
Elevation:	20 ft. a.m.s.l.

Description: Site 17199 (Figures 43 and 44) is a complex comprising a terrace and a lava tube shelter, designated Features A and B. The complex is located in undulating pahoehoe terrain to the east of Site 7728 trail.

Site 17199 is interpreted as recurrent habitation complex based on the large floor size of Feature A terrace, as well as the abundance of cultural material observed at both features. The architecture of Feature A was not considered substantial enough to be interpreted as a permanent habitation feature. Similar to Feature B of the neighboring Site 19198, the site was probably utilized in association with the adjoining trail (Site 7728).

Limited subsurface testing was conducted at feature B of this site and the results of that excavation supported the functional interpretation of this site as recurrent habitation (see *Excavation Results* section of this report).

Feature A is a long, linear paved terrace constructed of pahoehoe boulders and cobbles. The terrace measures 10.0 m. (32.8 ft.) NW/SE by 4.0 m. (13.1 ft.) NE/SW and 0.8 m. (2.6 ft.) high at the northwest corner. One large, upright pahoehoe boulder is located in the

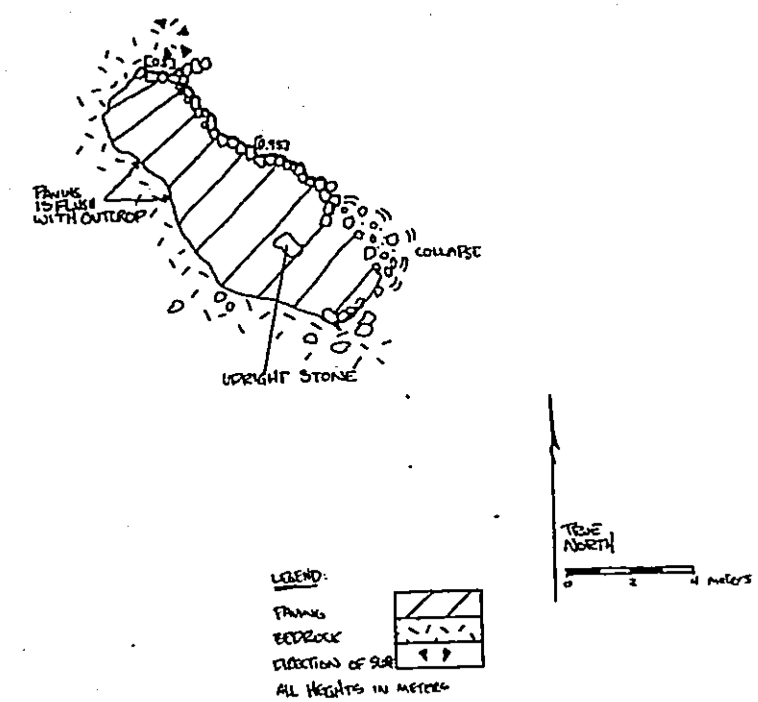

Figure 43 Site 50-10-47-17199 Complex, Feature A; Plan View

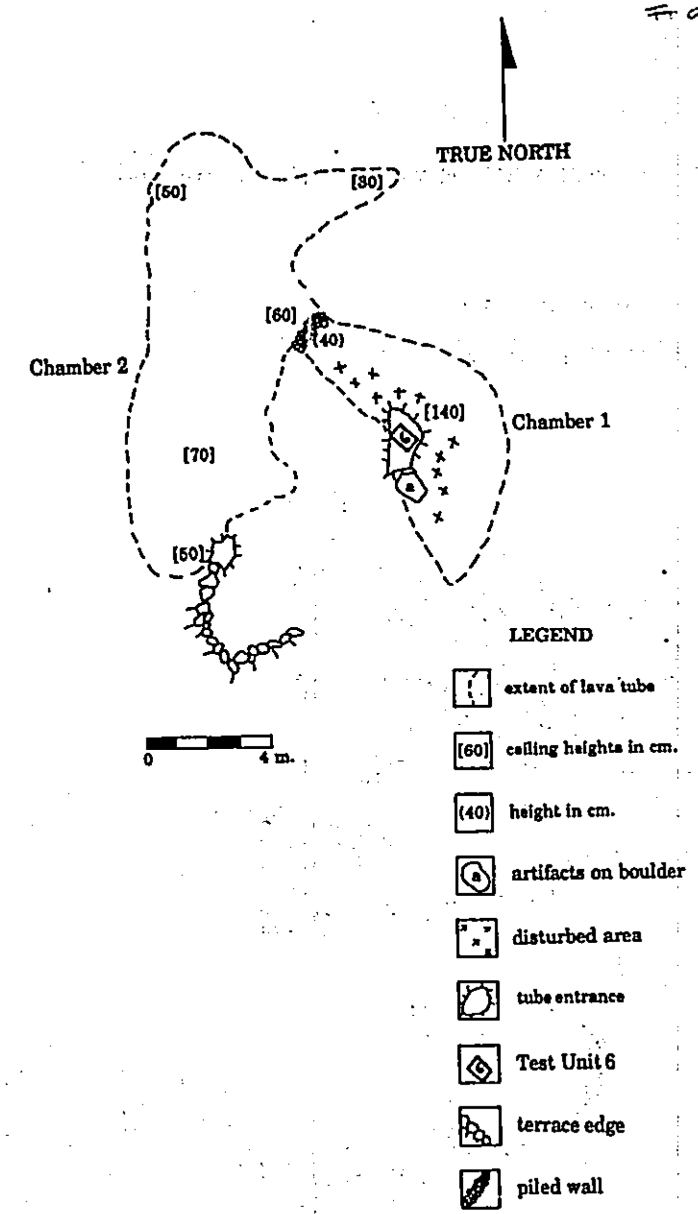

Figure 44 Site 50-10-47-17199 Complex, Feature B; Plan View

northeastern end of the terrace. The terrace is flush with outcrop to the southwest, but the northeast edge is faced, in sections, with boulders.

Scattered midden was observed. No artifacts were observed. Feature A is in fair to poor condition. The excavation potential is considered fair to poor.

Feature B is a lava tube shelter located approximately 24.4 m. (80.0 ft.) southeast of Feature A. The entrance measures 1.5 m. (4.9 ft.) wide by 1.7 m. (5.6 ft.) high and has been modified on the southeast and west sides with boulder stacking. Two chambers are present within the lava tube and have been designated Cambers 1 and 2 for descriptive purposes.

Chamber 1, the main chamber, measures 8.0 m. (26.2 ft.) N/S by 3.7 m. (12.1 ft.) E/W with a ceiling height of 1.4 m. (4.6 ft.). The interior of this chamber has been disturbed by recent looting as is evidenced by the scattering of boulders and cobbles throughout the floor of the chamber. The interior floor appears to have been once paved with rocks.

An abundance of marine shells, mammal bone, and artifacts (basalt artifacts, coral files, sea urchin files, and cut bone) were observed in Chamber 1. The artifacts had been placed on a large boulder at the south side of the entrance probably by recent pot hunters. Three indigenous artifacts were collected and include two sea urchin files (Acc. 14), and one basalt file (Acc.15). A 1.0 M. by 0.5 m. test unit was excavated near the entrance of this chamber and yielded subsurface deposits of midden, artifacts and charcoal (see *Excavation Results* section of this report).

Chamber 2 is located to the north and west of Chamber 1. Access from Chamber 1 to Chamber 2 is blocked by a 0.4 m. high wall in the north corner of Chamber 1. Chamber 2 measures 14.0 m. (45.9 ft.) N/S by 5.0 m. (16.4 ft.) E/W and ceiling height averages 0.7 m. (2.3 ft.) high. The floor consists of pahoehoe boulders and cobbles. A very small entrance to Chamber 2 is located approximately 6.5 m. (21.3 ft.) southwest of the Chamber 1 entrance. The ceiling in Chamber 2 is low but there is a substantial cultural deposit exposed on the floor. Midden and coral were observed throughout the chamber.

CSH Site #: 43

State Site #: 50-10-47-17201
Site Type: Complex
Age: Prehistoric
Function: Permanent habitation
Features (#): 5
Dimension: 784.0 m.^{2} (8,467.2 ft.^{2})
Elevation: 12 ft. a.m.s.l.

Description: Site 17201 (Figure 45) is a complex consisting of five features, designated Features A through E. The site is located in undulating pahoehoe lava with intermittent soil pockets. Vegetation consists of *koa haole*, *kiawe*, and grasses. The site is situated approximately 12 m. (40 ft.) northwest of Site 17207 Hōlua slide.

Site 17201 is interpreted as a permanent habitation complex because of the substantial architecture exhibited in Feature A platform and the fact that the complex is

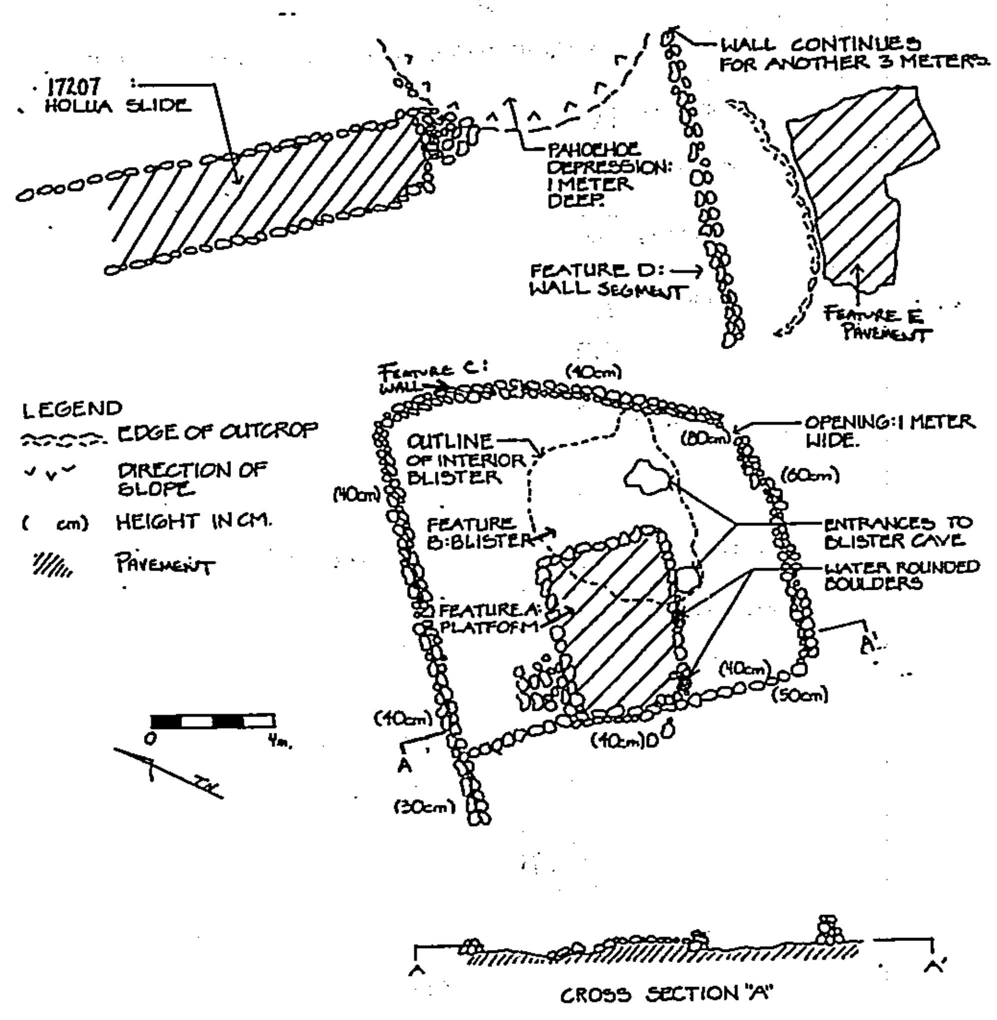

Figure 45 Site 50-10-47-17201 Complex, Feature A through E (and Site 17207 *Holua* Slide); Plan View

enclosed by Feature C wall. An entrance is also constructed into Feature C wall. Feature B lava blister seems to represent a natural shelter that the site complex may have been built around. The lava blister also likely functioned as a component feature of the complex, perhaps as a storage and/or special work area. It is unclear what the relationship is between this habitation complex and the nearby *Hōlua* slide (Site 17207).

Feature A is a platform measuring 5.5 m. (18.0 ft.) NW/SE by 4.0 m. (13.1 ft.) NE/SW. It is roughly rectangular with intact facing on all sides measuring 0.6 m. (2.0 ft.) high. Construction is of pahoehoe cobbles and small boulders. The northwest side is slightly elevated above the platform surface by 0.3 m. (1.0 ft.). A large water-rounded boulder is present in the construction at the center of the *makai*-facing edge of the platform. The surface of the platform is level pavement consisting of pahoehoe slabs and cobble chinking.

No midden or artifacts were observed on the platform surface.

Feature A is in good to excellent condition and offers good excavation potential.

Feature B is a small lava blister rockshelter that lies partially underneath the eastern half of Feature A platform. The lava blister is accessed through two entrances, one of which is located adjacent to the south edge of Feature A platform, and the other is located 2.5 m. to the northeast of that entrance. Both entrances are roughly 1.0 m. in diameter and drop 1.3 m. (4.3 ft.) from the ground surface to the interior floor of the blister. The interior of the lava blister is roughly circular and measures 5.0 m. (16.4 ft.) in diameter. The ceiling height reaches a maximum of 0.8 m. (2.6 ft.). The blister floor is level soil overlying bedrock. The soil has a maximum depth of 10 cm. No modifications were present in the blister.

Fair amounts of indigenous artifacts and midden were observed on the blister floor.

Feature B is in fair condition and excavation potential is good.

Feature C is a wall which completely surrounds Features A and B creating a distinct enclosure. The enclosure measures 11.0 m. (36.1 ft.) N/S by 10.5 m. (34.4 ft.) E/W. An entrance measuring 1.0 m. (3.3 ft.) wide is located at the southeast corner of the enclosure. The enclosing wall is constructed of pahoehoe boulders with some placed upright near the entrance. The wall averages 0.3 to 0.4 m. (1.0 to 1.3 ft.) high and is 0.6 m. (2.0 ft.) thick. There are partially collapsed sections on the southwest and northwest sides, and on the southeast side, the wall is constructed directly atop bedrock.

No artifacts or midden were observed. Feature C is in fair to good condition and offers good excavation potential.

Feature D is a wall segment which begins 2.5 m. east of the southeast corner of Feature C enclosing wall (at the opening) the extends northeastward for 13.0 m. (42.7 ft.). The wall is situated on a low pahoehoe ridge, and oriented NE/SW. The wall is constructed of loosely piled boulders, is triangular in cross section, and measures to a maximum thickness of 0.5 m. (1.6 ft.) and a maximum height of 0.5 m. (1.6 ft.).

A pahoehoe depression 1.0 m. deep and approximately 6.0 m. (19.8 ft.) in diameter lies to the north of this wall and the wall appears to partly surround it.

No artifacts or midden were observed. Feature D is in poor condition and offers poor excavation potential.

Feature E is an L-shaped pavement located 3.0 m. south of Feature D wall segment. The pavement measures 5.0 m. (16.4 ft.) NE/SW by 3.0 m. (9.8 ft.) NW/SE. The feature is rough cobble pavement. The pavement conforms to the bedrock and only rough alignments define the edge of the paving.

Coral and a water-rounded boulder were observed. Feature A is in good to fair condition and excavation potential is poor.

State Site #: 50-10-47-17202 **CSH Site #:** 44
Site Type: Complex
Age: Prehistoric
Function: Permanent habitation; possible burial
Features (#): 9
Dimension: 1,040.0 m.^{2} (11,232.0 ft.^{2})
Elevation: 30-50 ft. a.m.s.l.

Description: Site 17202 (Figure 46) is a complex comprising nine features, designated Features A through I. Site 7728 trail extends through the center of the complex, dividing it into three areas. The surrounding terrain consists of gently to moderately sloping 'a'ā flow with little or no vegetation.

Site 17202 is interpreted primarily as a permanent habitation complex because of the sizable floor areas of most of the features, evidence of substantial construction (*i.e.*, facing, pavements, and internal features), and the site's multiple-feature design. Three of the complex features (Features E and G) are possible burials monuments because of their small size and elevated height. Each feature is constructed of medium cobbles to medium 'a'ā boulders, unless otherwise indicated.

Feature A is a rectangular enclosure located at the eastern boundary of the complex. It measures 6.0 m. (19.8 ft.) N/S by 4.0 m. (13.1 ft.) E/W. The walls measure to a maximum height of 1.1 m. (3.6 ft.). Most of the walls are partially collapsed and a small amount of facing is present only on the exterior face of the southern wall. The interior is partially paved.

No artifacts were observed but some shell midden was observed. Feature A is in poor condition and the excavation potential is considered fair.

Feature B is a small C-shaped enclosure located directly west of Feature A. It measures 2.0 m. (6.6 ft.) N/S by 1.5 m. (4.9 ft.) E/W with a maximum height of 0.3 m. (1.0 ft.). The interior is paved with small cobbles and the north wall is faced.

Coral and shell midden were observed. No artifacts were observed. Feature B is in fair to poor condition and the excavation potential is considered fair.

Feature C is a large platform and contiguous C-shaped enclosure located 2.0 m. (6.6 ft.) northwest of Feature B. The platform measures 8.0 m. (26.2 ft.) N/S by 5.0 m. (16.4 ft.) E/W. The platform construction consists of medium 'a'ā cobble paving and a stacked

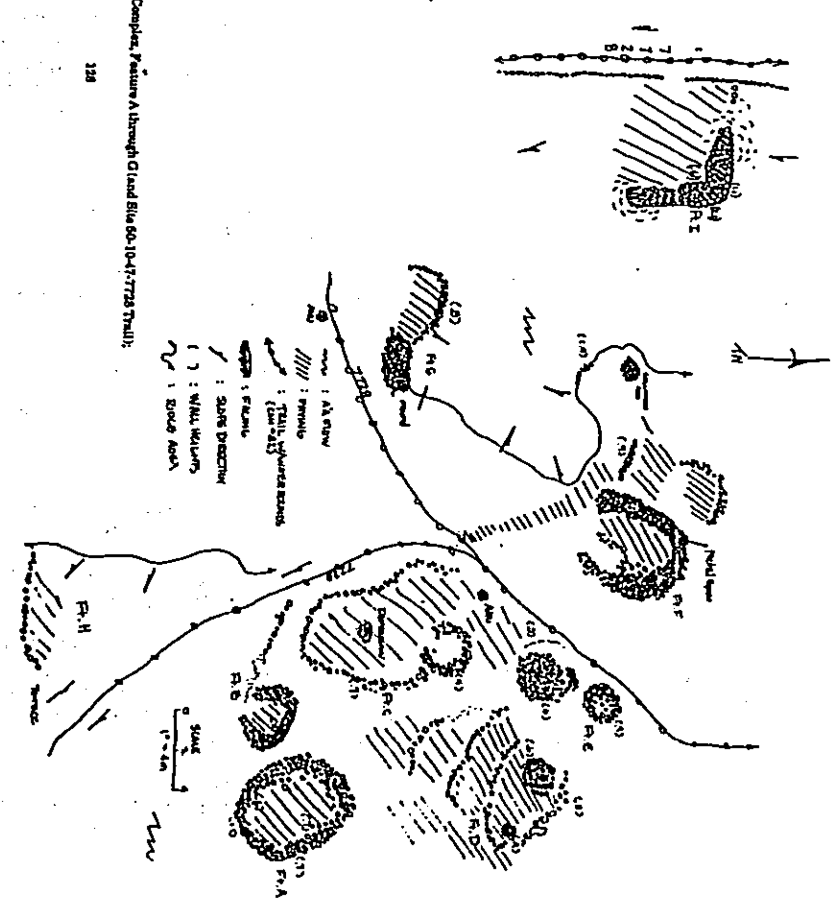

Figure 46 Site 50-10-47-17202 Complex, Feature A through G (and Site 50-10-47-7728 Trail); Plan View

perimeter, which is not evident on the north side. The east side of the platform rises to a maximum height of 0.7 m. (2.3 ft.).

A small depression measuring 1.0 m. (3.3 ft.) in diameter by 0.3 m. (1.0 ft.) deep is located in the approximate center of the platform. A small *ahu*, measuring 0.5 m. (1.6 ft.) high, is located off the northwest corner of the platform. This *ahu* most likely marks the Site 7728 trail, which runs through the complex.

The C-shape is located at the northeast corner of the platform. The C-shape measures 2.0 m. (6.6 ft.) in diameter with a maximum height of 0.5 m. (1.4 ft.). The interior of the C-shape is paved with small ʻaʻā cobbles. Most of its walls are tumbled.

No artifacts or midden were observed. Feature C is in poor condition and the excavation potential is fair.

Feature D is a three-level terrace located 2.0 m. (6.6 ft.) northeast of Feature C. The terrace is constructed on a south-facing slope of ʻaʻā lava and covers a total area of approximately 8.0 m. (26.2 ft.) N/S by 7.0 m. (23.0 ft.) E/W. Each level is paved with small to medium ʻaʻā cobbles and contributes approximately one-third to the entire area of Feature D. The lowest level lies at the southern end of Feature D. Its south edge is faced and measures 1.0 m. (3.3 ft.) above the ground. The middle level is constructed to a height of 0.6 m. (2.0 ft.) above the lowest level. The top level is constructed to a height of 0.7 m. (2.3 ft.) above the middle level. A strip of pebble/*ʻiliʻili* paving, 0.5 m. (1.6 ft.) wide, runs E/W across the length of this top level. A circular mound is constructed on the surface of the top level. The mound measures approximately 1.5 m. (4.9 ft.) in diameter with a maximum height of 0.6 m. (2.0 ft.) on its faced south side. A depression lies on the east edge of the top level and measures approximately 0.5 m. (1.6 ft.) in diameter and 0.4 m. (1.3 ft.) deep.

No artifacts or midden were observed. Feature D is in fair condition and its excavation potential is fair.

Feature E consists of two mounds located 2.0 m. (6.6 ft.) west of Feature D. The north mound measures 1.5 m. (4.9 ft.) in diameter and 0.9 m. (3.0 ft.) high. The south mound measures 2.5 m. (8.2 ft.) in diameter and 0.6 m. (2.0 ft.) high. A trail (Site 7728B) runs alongside these mounds, to the northwest. The mounds are constructed of ʻaʻā cobbles.

No midden or artifacts were observed. Feature E is in poor condition and its excavation potential is fair.

Feature F consists of a large C-shaped enclosure located 5.0 m. (16.4 ft.) west of Feature E, across the Site 7728 trail. The enclosure measures 4.0 m. (13.1 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE with a maximum height of 0.9 m. (3.0 ft.) at vertically faced sections. The C-shape is well-constructed and opens to the south. The interior consists of ʻaʻā cobble pavement. An interior alignment partitions off the southeast corner of the enclosed area.

A small terrace is located directly west of the enclosure. The terrace measures approximately 4.0 m.^{2} (43.0 ft.^{2}) and its south edge is faced to a height of 0.9 m. (3.0 ft.). A paved pathway leads north from Site 7728 to Feature F.

No midden was observed. A 0.8 m. (2.6 ft.) long metal spear was observed on the northwest corner of the C-shape enclosure wall.
Feature F is in fair to poor condition and its excavation potential is fair.

Feature G consists of a terrace and a mound located 8.0 m. (26.2 ft.) west of Feature C. The terrace measures approximately 6.0 m. (19.8 ft.) E/W by 3.0 m. (9.8 ft.) N/S. Vertical facing on the north side measures 0.8 m. (2.6 ft.) high. A small mound is located atop the east side of the terrace. The mound measures 3.0 m. (9.8 ft.) E/W by 2.0 m. (6.6 ft.) N/S and 0.8 m. (2.6 ft.) high.

The trail, Site 7728, is located 1.5 m. (4.9 ft.) south of the mound. No artifacts or midden were observed. Feature G is in poor condition and its excavation potential is fair.

Feature H is a large, level ʻaʻā cobble pavement measuring approximately 25.0 m. (82.0 ft.) E/W by 12.0 m. (39.4 ft.) N/S. The area is separated in two levels by a natural ridge line.

Shell and coral were observed. No artifacts were observed. Feature H is in fair condition and its excavation potential is fair.

Feature I is an L-shaped enclosure located 9.0 m. (29.5 ft.) northwest of Feature G. The N/S leg of the L-shape measures approximately 5.3 m. (17.4 ft.) long. The E/W leg of the L-shape measures approximately 2.0 m. (6.6 ft.) long, and is extensively tumbled at its western end. The northeast corner is faced, with a maximum height of 1.5 m. (4.9 ft.). The interior and the area extending south of the feature are paved with small to medium cobbles.

No artifacts were observed. A small amount of shell midden was observed.
Feature I is in poor condition and its excavation potential is considered fair.

State Site #: 50-10-47-17203		**CSH Site #:** 45
Site Type:	Complex	
Age:	Prehistoric	
Function:	Permanent habitation	
Features (#):	5	
Dimension:	1200.0 m.^{2}	(12,960.0 ft.^{2})
Elevation:	14-30 ft. a.m.s.l.	

Description: Site 17203 (Figure 47) is a complex comprising an enclosing wall (Feature A), a platform (Feature B), an enclosure remnant (Feature C); a pavement (Feature D) and a rectangular enclosure (Feature E) incorporated into Feature A wall. The complex is located on the coast in gently undulating pahoehoe lava terrain. Intermittent pockets of soil and sand are observed. Vegetation consists of *kiawe* and *koa haole* trees and some grasses.

Site 17203 is interpreted as a permanent habitation complex based on the substantial construction style of the features, sizable floor areas, and multifarious design of the complex. A narrow, rectangular enclosure (Feature E) incorporated into the northwest end of Feature A may have functioned as a canoe house; it is located 40 m. (132 ft.) from the coastal edge.

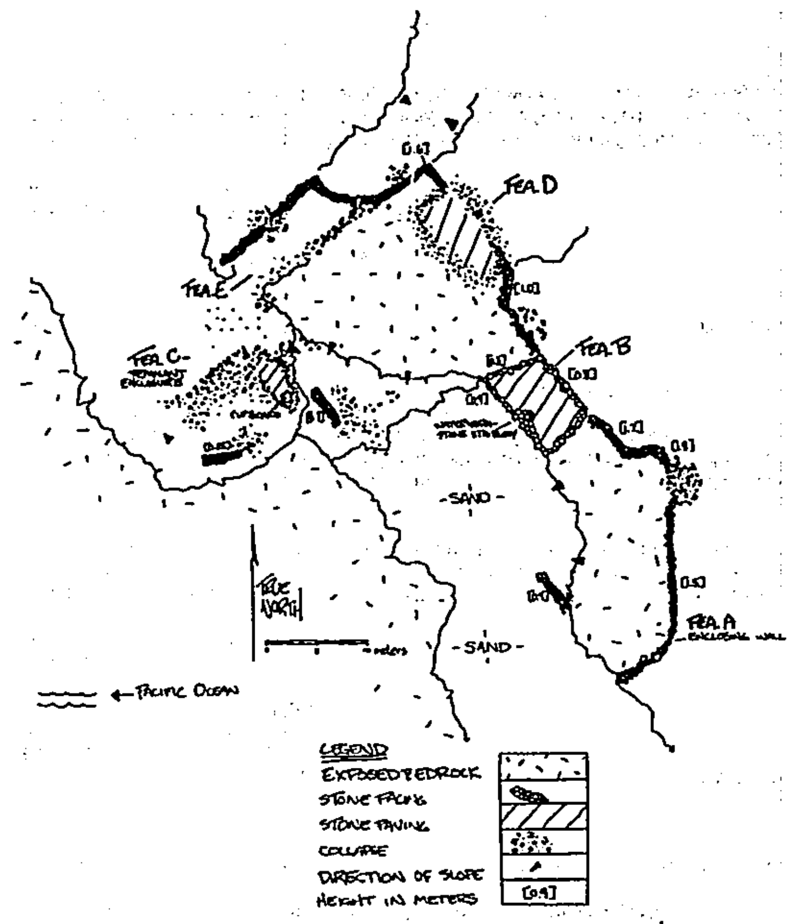

Figure 47 Site 50-10-47-17203 Complex, Feature A through E; Plan View

Feature A is a wall which encloses the complex features on the *mauka* (northeast) side. The wall encloses an area measuring 60.0 m. (196.9 ft.) NW/SE by 20.0 m. (65.6 ft.) NE/SW, and has a maximum height of 1.8 m. (5.9 ft.). Features B, D, and E are enclosed within this wall. Feature C is located just northwest of the northwest edge of this enclosed area.

Feature A is constructed of pahoehoe boulders and cobbles and varies in its level of preservation. Some sections are core-filled and faced on both sides, other sections have tumbled.

Midden was observed scattered within the enclosed area of Feature A. No artifacts were observed.

Feature A is in fair condition and its excavation potential is good.

Feature B is a large rectangular platform located approximately 50.0 m. (164.0 ft.) north of the shoreline Keopuka Survey marker. The platform is constructed atop the level pahoehoe outcrop with some *koa haole* growing within the platform. A gully or depression densely vegetated with *koa haole* lies *mauka* (west) and a level beach sand and soil deposit lies *makai* (east). The platform measures 10.0 m. (32.8 ft.) NW/SE by 7.0 m. (23.0 ft.) NE/SW with a maximum faced height of 0.9 m. (3.0 ft.) on its *makai* (western) side. The *mauka* (eastern) side of the platform is incorporated into Feature A wall.

The perimeter of Feature B is constructed of large pahoehoe and water-rounded boulders. The platform surface consists of a level cobble pavement scattered with large boulders and water-rounded boulders. An assemblage of large water-rounded boulders resembling a stairway is constructed mid-way along the *makai* (south facing) side of the platform.

Coral pebbles were observed scattered on the platform surface. A bamboo pole measuring approximately 3.0 m. (9.8 ft.) long was observed along the east side of the platform. One piece of midden was observed.
Feature B is in good condition and the excavation potential is good.

Feature C is a remnant enclosure, located 20.0 m. (65.6 ft.) west of Feature B. The feature measures approximately 12.0 m. (39.4 ft.) NE/SW by 10.0 m. (32.8 ft.) NW/SE with a remaining faced section measuring 0.85 m. (2.8 ft.) high. A cupboard is present in the eastern corner which is the only well preserved area of this feature.

The feature appears disturbed primarily by intruding *kiawe* trees, but may have also sustained damage from high waves as this feature is the closest to the shoreline. Coral, cobbles and boulders are scattered over the level pahoehoe outcrop surface which may have been the interior of the enclosure. Two partially fallen *kiawe* trees extend across the feature. Both historic glass and modern trash were observed. Shell midden is abundant.

Feature C is in poor condition and excavation potential is considered fair.

Feature D is a pavement located approximately 10.0 m. northwest of Feature B platform. The paving measures approximately 9.0 m. (29.5 ft.) NW/SE by 7.0 m. (23.0 ft.) NE/SW. A collapsed portion of Feature A wall forms Feature D's northeast edge.

No artifacts or midden were observed. Feature D is in fair condition and its excavation potential is good.

Feature E is an enclosure located at the northwest extent of Feature A wall. A low alignment parallel to the wall creates a narrow enclosure off the main wall of Feature A. This enclosure measures 10.0 m. (32.8 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE. A suggested function of this enclosure, due to its long, narrow dimensions, is that of a canoe shed. Proximity to the both the ocean and a suitable canoe landing further support this suggestion.

No artifacts or midden were observed. Feature E is in fair condition and its excavation potential is good.

State Site #:	50-10-47-17204	**CSH Site #: 46**
Site Type:	Platform	
Age:	Prehistoric	
Function:	Possible burial	
Features (#):	1	
Dimension:	6.3 m.² (68.0 ft.²)	
Elevation:	25 ft. a.m.s.l.	

Description: Site 17204 (Figure 48) is a small circular platform located within gently sloping, rough pahoehoe terrain, in a low-lying area between two high points of pahoehoe outcrop. Site 17204 is interpreted as a possible burial because of its small size and elevated height.

The platform measures 2.5 m. (8.2 ft.) in diameter. The southern edge of the platform has a maximum height of 1.0 m. (3.3 ft.). It is constructed of small boulders and cobbles. Vertical facing exists on all sides though the southeast edge is slightly collapsed. The surface is fairly level and is paved predominantly with small cobbles.

No artifacts or midden were observed. Site 17204 is in good condition.

State Site #:	50-10-47-17205	**CSH Site #: 48**
Site Type:	Complex	
Age:	Prehistoric	
Function:	Possible burials; Special	
Features (#):	9	
Dimension:	2275.0 m.² (24,475.4 ft.²)	
Elevation:	23-35 ft. a.m.s.l.	

Description: Site 17205 (Figure 49) is a complex consisting of nine features, designated Features A through I. The site is located in predominantly 'a'ā lava terrain with some pahoehoe flow on the southern edge, all gently sloping toward the coast. There is sparse

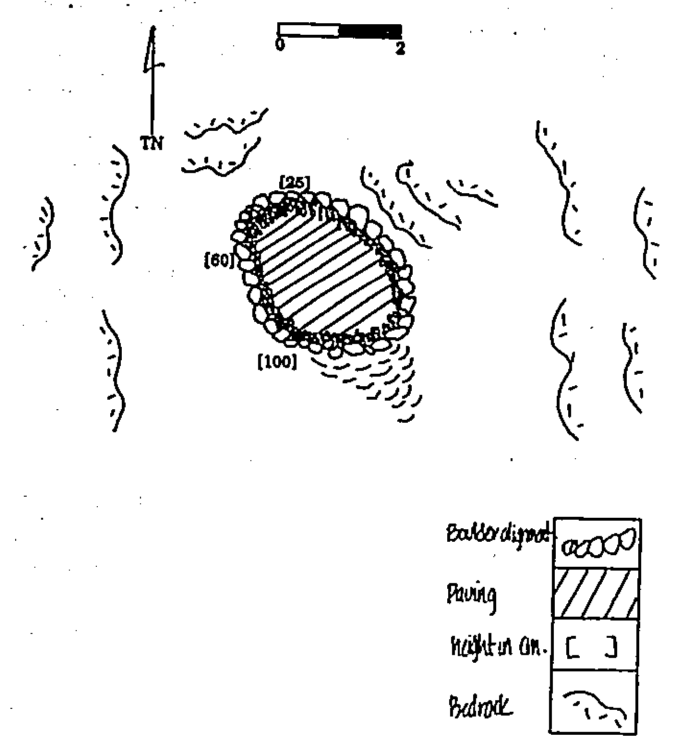

Figure 48 Site 50-10-47-17204 Platform; Plan View

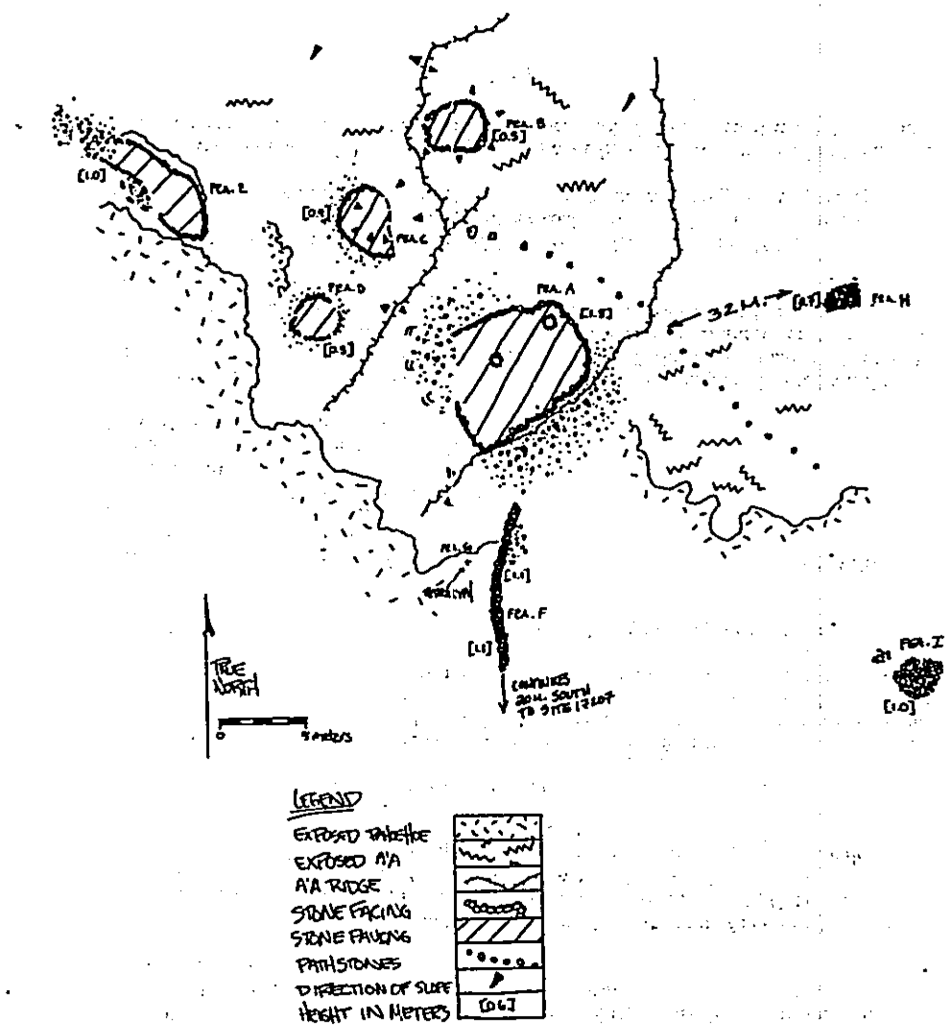

Figure 49 Site 50-10-47-17205 Complex, Feature A through I; Plan View

vegetation of *koa haole* in the area. The site area measures approximately 65.0 m. (213.3 ft.) E/W by 35.0 m. (114.8 ft.) N/S. Site 17205 is interpreted primarily as a possible burial complex (Features A through E, I and J) because of the substantial architecture of most of the features, elevated surfaces - and in the case of Feature E, its association with the other possible burial features. Feature F wall delineates some type of boundary that connects this site with Site 17207 *holua* slide located to the south. Feature G petroglyph is probably affiliated with the burials.

Feature A is a large, trapezoid-shaped platform measuring 9.0 m. (29.7 ft.) NE/SW by 7.0 m. (23.1 ft.) NW/SE with a maximum height of 1.8 m. (5.9 ft.) along the northeast edge. The perimeter is constructed of large boulders and is well-faced, especially on the northeast and southwest sides. The surface of the platform is level and generally paved with cobbles. Two small, boulder-lined circular depressions are present within the platform surface, one near the platform center and the other near the north corner. An associated stepping-stone trail is situated to the northeast of the platform, running roughly east/west.

No artifacts or midden were observed. Feature A is in good condition.

Feature B is a small platform located atop a high point of a jagged 'a'ā ridge, 10.0 m. (32.8 ft.) north of Feature A. The platform is roughly square and measures 4.0 m. (13.2 ft.) E/W by 3.0 m. (10 ft.) N/S with a maximum height of 0.5 m. (1.6 ft.). The construction is mostly of 'a'ā boulders and cobbles with a small number of scattered pahoehoe boulders on the platform surface. The edges are not well-faced and, in some sections, have tumbled downslope. Coral pieces were observed in the southwest and northeast corners.

No midden or artifacts were observed. Feature B is in fair condition.

Feature C is a small terrace located 3.0 to 4.0 m. (9.8 to 13.1 ft.) directly west (*makai*) and downslope of Feature B. The terrace measures roughly 4.0 m. (13.2 ft.) square and 0.9 m. (3.0 ft.) high at the west corner facing. Feature C is faced on the southwest and northwest sides and is flush against the outcrop ('a'ā ridge) to the southeast and northeast. It is constructed of 'a'ā boulders, cobbles, and pebbles. A centrally located depression in the terrace surface measures 1.5 m. (4.9 ft.) in diameter.

No midden or artifacts were observed. Feature C is in fair condition.

Feature D is a circular platform located 3.0 m. (9.8 ft.) west of Feature C. The platform measures 2.5 m. (8.2 ft.) NE/SW by 2.0 m. (6.6 ft.) NW/SE with a maximum height of 0.5 m. (1.6 ft.). The construction is primarily of 'a'ā cobbles and pebbles, with some small pahoehoe and 'a'ā boulders at the edges. One very large boulder or an exposed portion of outcrop lies in the center of the platform. The surrounding pavement is level with the boulder or outcrop surface.

No artifacts or midden were observed. Feature D is in fair condition.

Feature E is a rectangular platform located approximately 7.0 m. (23.1 ft.) northwest of Feature D. The platform measures 8.0 m. (26.4 ft.) NW/SE by 2.5 m. (8.2 ft.) NE/SW and is 1.0 m. (3.3 ft.) high in the northwest corner. Feature E is constructed of small 'a'ā boulders and cobbles, and some pahoehoe cobbles. The facing on the southwest edge is mostly collapsed downslope, but some facing remains.

No artifacts or midden was observed. Feature E is in fair condition.

Feature F is a wall that begins approximately 4.0 m. (13.1 ft.) from the south corner of Feature A. The wall measures 29.3 m. (96.1 ft.) N/S by 1.0 m. (3.3 ft.) wide with a maximum height of 1.1 m. (3.6 ft.). The wall construction is of medium to large pahoehoe boulders. The wall is intermittently preserved and it extends southward as far as the *hōlua* slide (Site 17207).

No midden or artifacts were observed. Feature F is in good to fair condition.

Feature G is a petroglyph of a human figure, lightly pecked into a pahoehoe surface. It is located 3.0 m. (9.8 ft.) west of the north end of Feature F.

Feature G is in fair to poor condition.

Feature H is a small platform located 32.0 m. (105.0 ft.) east of Feature A. Feature H is located on pahoehoe at the edge of the 'a'ā flow (in which Features A, B, C, D, and E are situated). The platform measures 2.3 m. (7.5 ft.) E/W by 1.5 m. (4.9 ft.) N/S with a maximum height of 0.7 m. (2.3 ft.) at the west edge facing. The construction is of pahoehoe boulders (medium to small) and cobbles. The north edge is collapsed.

No artifacts or midden were observed. Feature H is in fair condition.

Feature I is a platform located approximately 30.0 m. (98.4 ft.) southeast of Feature A. The platform measures 3.0 m. (9.8 ft.) NE/SW by 2.6 m. (8.5 ft.) NW/SE with a maximum height of 1.0 m. (3.3 ft.) at the southeast edge facing. The platform is constructed of mounded, not paved, small to large pahoehoe boulders and cobbles and is partially collapsed.

No artifacts or midden were observed. Feature I is in fair to poor condition.

State Site #: 50-10-47-17206 — **CSH Site #: 50**
Site Type: Pavement
Age: Prehistoric
Function: Permanent habitation
Features (#): 1
Dimension: 48.0 m.^{2} (518.4 ft.^{2})
Elevation: 68 ft. a.m.s.l.

Description: Site 17206 is a pavement (see Figure 101) located on pahoehoe terrain that slopes moderately toward the coast. It is located atop a bluff which stands 2.0 to 3.0 m. (6.6 to 9.8 ft.) above the surrounding terrain. The sizable floor area, substantial construction, and internal features (including a possible hearth) suggests that the site functioned as a permanent habitation.

The pavement measures 10.0 m. (32.8 ft.) NE/SW long by 4.8 m. (15.7 ft.) NW/SE. The paving consists of pahoehoe cobble slabs and 'a'ā cobbles and pebbles. The west side consists of remnant pahoehoe boulder facing with many of the boulders having fallen downslope.

At the south end of the pavement, there is a shallow depression measuring 1.0 m. (3.3 ft.) in diameter and 0.3 m. (1.0 ft.) deep. At the north end of the pavement is a 1.0 m. (3.28

ft.) long alignment of four pahoehoe boulders which are set flat into the paving and perpendicular to the pavement edge and the slope. Other set pahoehoe slabs are present within the pavement. Two water-rounded rocks are present in the paving, one set in place and the other sitting on the surface. Bedrock is exposed in the south side of the paving.

Shell midden was observed scattered on the paving. No artifacts were observed. Site 17206 is in good condition and its excavation potential is good.

State Site #: 50-10-47-17207 — **CSH Site #: 52**
Site Type: *Hōlua* slide
Age: Prehistoric
Function: Recreation
Features (#): 1
Dimension: 742.0 m.^{2} (8,013.6 ft.^{2})
Elevation: 16-140 ft. a.m.s.l.

Description: Site 17207 (Figure 50)(see Figure 102) is a *hōlua* slide, a ramp structure used for recreational purposes. The slide measures 265.3 m. (869.9 ft.) in total length and is oriented generally NE/SW. The project area boundary runs basically through the middle of the site, the *makai* half is located within the project area while the *mauka* half is without. The upper 61.0 m. (200.0 ft.) of the slide is located in very steep sloping 'a'ā, on an approximately 25 to 30° slope. As the slide approaches the coast, the degree of the slope decreases.

The *mauka* (NE) portion of the slide measures 4.8 m. (15.7 ft.) wide with vertically faced sides. As the grade of the slope lessens, the slide surface is constructed of pahoehoe slabs and is paved with cobbles and pebbles. The width of the slide decreases to 3.1 m. (10.2 ft.) at the *makai* (SW) terminus.

On the south side of the *makai* (SW) terminus of the slide there is a steeply sloping pavement which terminates at a 5.0 m. (16.4 ft.) wide pahoehoe depression. This area is interpreted as the terminus of the slide where the competitors ended their run. Vegetation would have been placed in the depression to cushion the impact of the descent.

This is an excellent example of a *hōlua* slide. The best preserved section is *makai*, 183.0 m. (600.0 ft.) from the terminus.

Site 17207 is in good condition and excavation potential is poor.

State Site #: 50-10-47-17208 — **CSH Site #: 54**
Site Type: Complex
Age: Prehistoric
Function: Permanent habitation
Features (#): 5
Dimension: 637.9 ft.^{2} (6,889.3 ft.^{2})
Elevation: 12-27 ft. a.m.s.l.

Description: Site 17208 (Figure 51) is a complex consisting of five features, designated Features A to E. The site is located in generally level pahoehoe terrain. Vegetation is dense *koa haole* and *kiawe*.

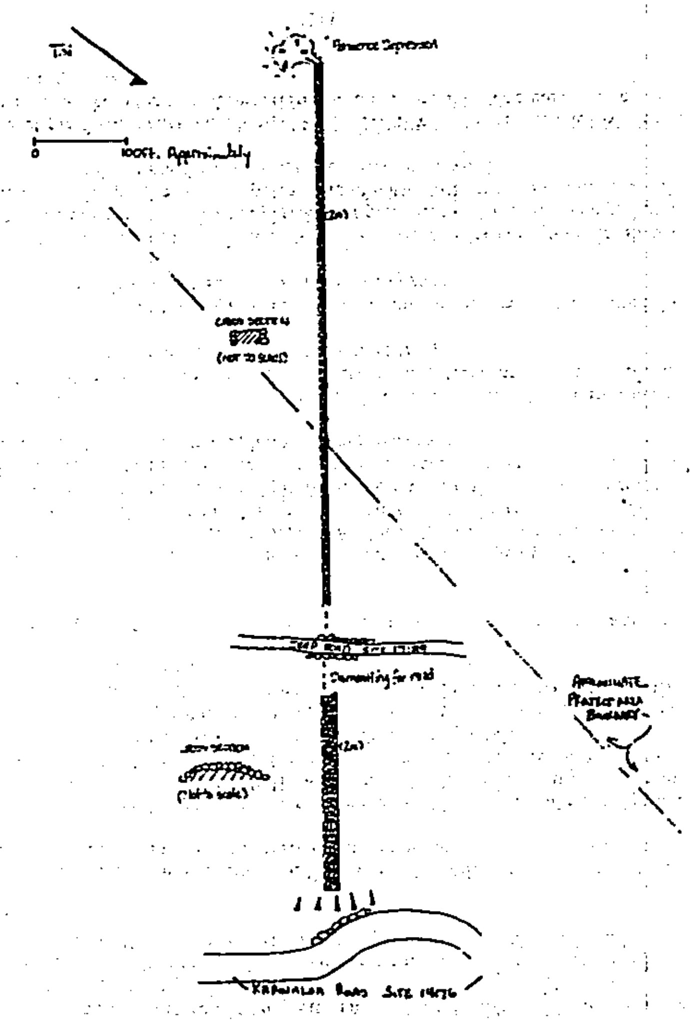

Figure 50 Site 50-10-47-17207 *Holua* Slide; Plan View

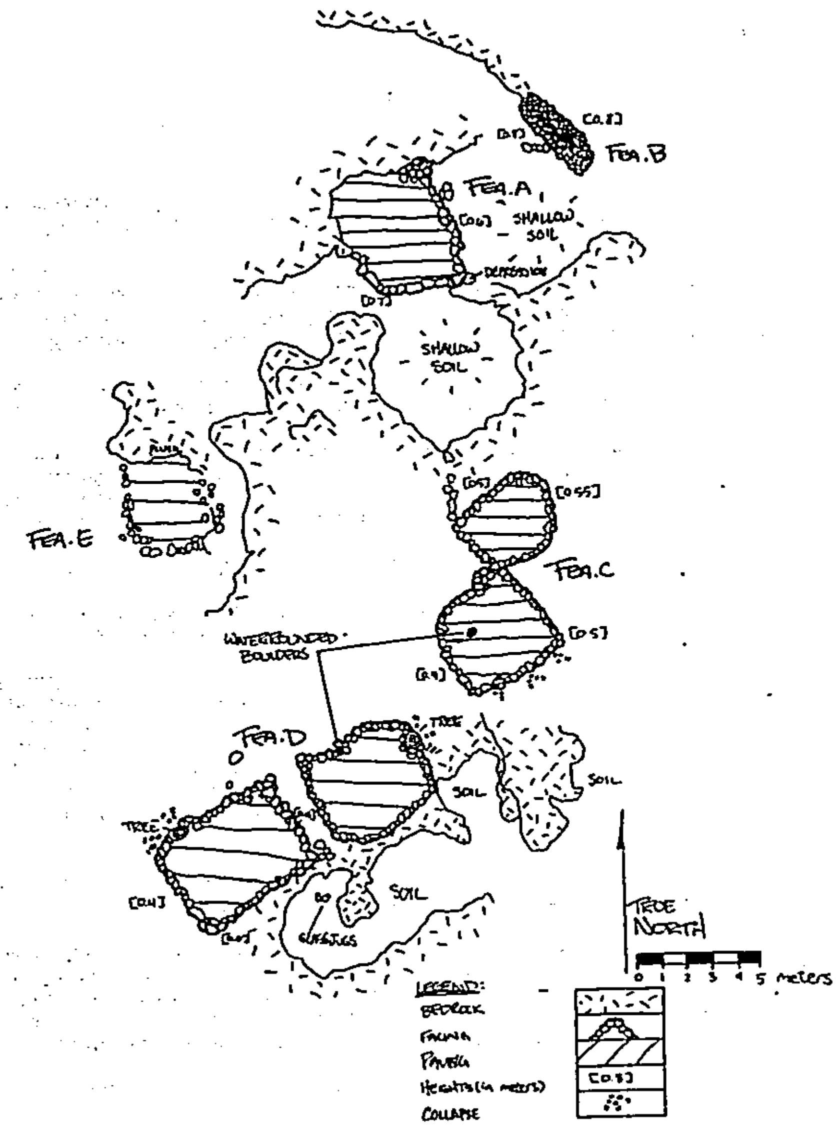

Figure 51 Site 50-10-47-17208 Complex, Feature A through E; Plan View

The site is interpreted as a permanent habitation complex because of the substantial construction exhibited at each of the features, in combination with their low heights (conducive for habitation). The site is also located among a cluster of several other permanent habitation sites on the south coast of Keopuka.

Feature A is a rectangular platform which measures 5.0 m. (16.4 ft.) NW/SE by 3.5 m. (11.5 ft.) NE/SW with a maximum height of 0.7 m. (2.3 ft.). The perimeter is constructed of small boulders and the surface is paved with small to large cobbles. The northwest edge of the platform abuts a pahoehoe ridge; the other three edges are vertically faced.
A small, cupboard-like depression was observed in the pahoehoe outcrop adjacent to the southeast corner of the platform. Within this depression, a coconut shell and a few modern artifacts were observed.

Two pieces of coral were observed on the paving. No indigenous artifacts or midden were observed. Feature A is in good condition and excavation potential is good.

Feature B is a wall located approximately 6.0 m. (19.7 ft.) northeast of Feature A. The wall measures 3.5 m. (11.5 ft.) NW/SE by 1.0 m. (3.28 ft.) NE/SW with a maximum height of 0.8 m. (2.6 ft.). It is constructed of small boulders and large cobbles with vertical facing on all sides. The northwest end of the wall abuts a small pahoehoe ridge. Feature B and the surrounding outcrop ridge serve to create a partially enclosed soil area between Features A and B, with the entrance to this soil area being located between the southeast terminus of Feature B and outcrop.

No midden or artifacts were observed. The feature is in good condition and excavation potential is poor.

Feature C comprises two contiguous, low, rectangular-shaped platforms located approximately 8.0 m. (26.2 ft.) south of Feature A. Both platforms are constructed of small boulder edging and small to large cobble surface paving. Vertical facing was observed along the edges. The south corner of the north platform abuts the north corner of the south platform. The north platform measures 4.0 m. (13.1 ft.) NE/SW by 3.0 m. (9.8 ft.) NW/SE. The platform measures 0.55 m. (1.8 ft.) high above the ground surface.

The southern platform measures 4.0 m. (13.1 ft.) square with a maximum height of 0.5 m. (1.6 ft.). A small, water-rounded boulder was observed in the center of the platform. Collapsed facing was observed on the southeast side of the platform.

No midden or artifacts were observed. A small amount of coral was observed. Feature A is in good to fair condition and excavation potential is good.

Feature D consists of two adjacent, low-level platforms located approximately 2.5 m. (8.2 ft.) southwest of Feature C. A level pathway of pahoehoe bedrock, measuring 1.0 m. (3.3 ft.) wide, separates the platforms. The perimeters of both platforms are constructed of pahoehoe boulders and the platform surfaces are paved with cobbles.

The east platform measures 4.5 m. (14.8 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE. A small water-rounded boulder was observed in the northwest side. The northeast corner is disturbed by a large tree.

The west platform measures 5.5 m. (18.0 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE. The southeast edge measures 0.6 m. (2.0 ft.) high. The northwest edge is disturbed by an opiuma tree.

Coral was observed. Glass jugs were observed southeast of Feature D, in an area of level soil. No midden or indigenous artifacts were observed.

Feature D is in good condition and excavation potential is good.

Feature E is a pavement located approximately 10.0 m. (32.8 ft.) northwest of Feature D. It measures 4.0 m. (13.1 ft.) N/S by 3.0 m. (9.8 ft.) E/W and is flush with the bedrock. The north and east sides of the pavement abut pahoehoe outcrop. The paving consists of small to medium cobbles with a small boulder border along the southern edge. A few small water-rounded cobbles were observed intermixed in the paving.

Coral was observed but no other midden or artifacts were observed. Feature E is in good condition and excavation potential is fair.

CSH Site #: 57

State Site #:	50-10-47-17209
Site Type:	Complex
Age:	Prehistoric
Function:	Transportation; Marker
Features (#):	5
Dimension:	318.0 m.^{2} (3,434.4 ft.^{2})
Elevation:	60-65 ft. a.m.s.l.

Description: Site 17209 (Figure 52) is a complex comprising five features, designated Features A to E. The complex is located across varying terrain of rough pahoehoe, plate-like 'a'ā, and older pahoehoe lava. Vegetation consists of low grasses and creeping vines. Features B through E (*ahu* and C-shape) are likely marking Feature A trail.

Feature A is a trail which is characterized by a trodden linear surface in 'a'ā. It extends across several patches of pahoehoe lava as it meanders seaward. The trail is approximately 150.0 to 180.0 m. (492.0 ft. to 590.4 ft.) in length with minimal modifications. One water-rounded stone was observed, but overall the trail is poorly marked.

No midden or artifacts were observed in association with this feature. Feature A is in poor condition with no excavation potential.

Feature B is an *ahu* located on an outcrop protrusion. The *ahu* measures 0.75 m. (2.5 ft.) high and 1.1 m. (3.6 ft.) in diameter. The feature is constructed of medium to large pahoehoe boulders. The *ahu* probably marks the continuation of the trail across the pahoehoe.

No midden or artifacts were observed. The feature is in good condition with no excavation potential.

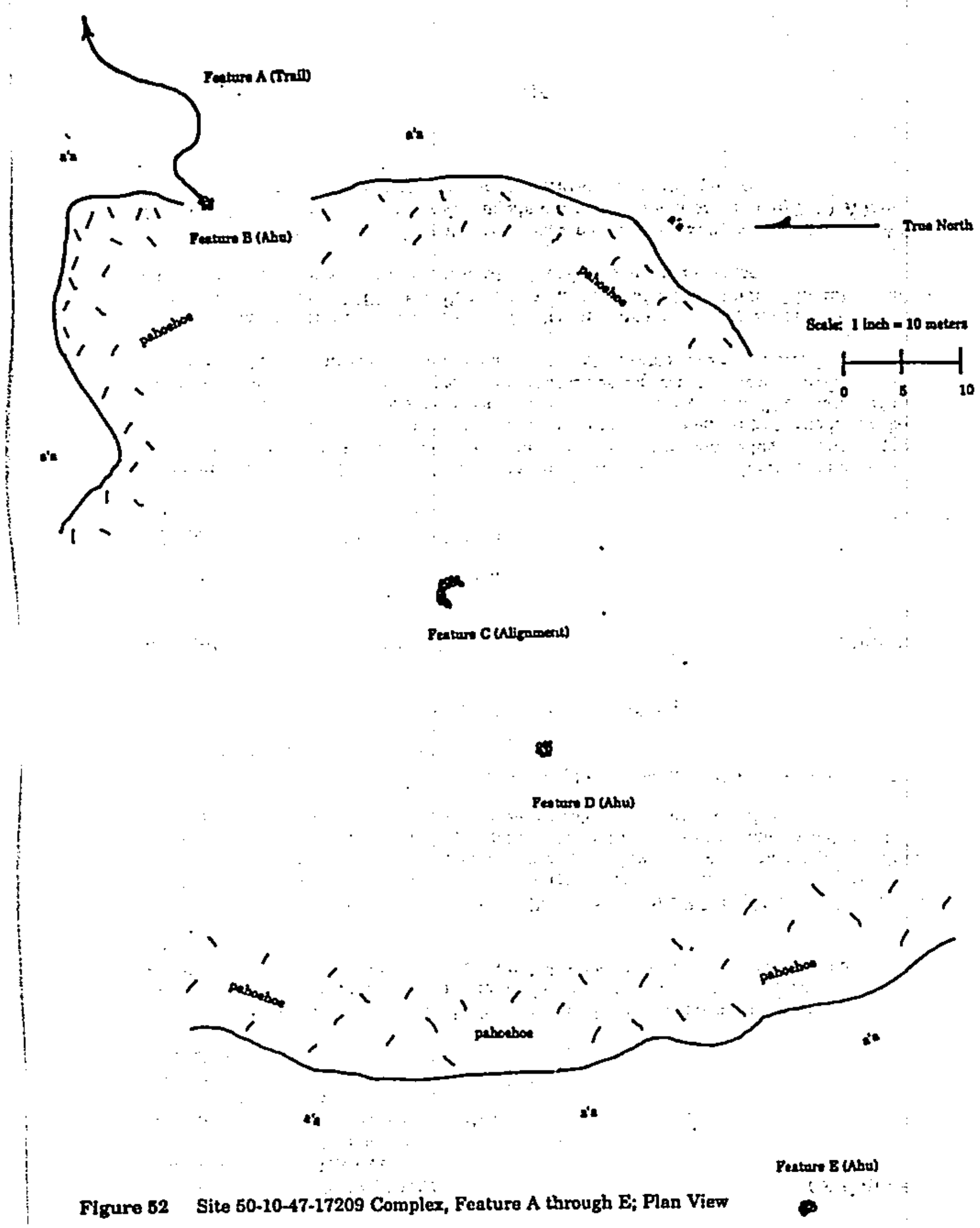

Figure 52 Site 50-10-47-17209 Complex, Feature A through E; Plan View

Feature C is an alignment located 37.0 m. (121.4 ft.) southwest of Feature B. The enclosed semi-circular area measures 1.5 m. (4.9 ft.) in diameter with a maximum height of 0.55 m. (1.8 ft.) and a width of 0.7 m. (2.3 ft.). The alignment consists of flat, small to medium pahoehoe slabs, in some places standing two courses high. Although one upright slab was observed, no formal vertical facing was present.

No midden or artifacts were observed. Feature C is in fair condition with poor excavation potential.

Feature D is an *ahu* located 15.0 m. (49.2 ft.) southwest of Feature C. The feature measures 0.8 m. (2.6 ft.) in height and 1.75 m. (5.7 ft.) in diameter. It is constructed of rough pahoehoe slabs.

No midden or artifacts were observed. Feature D is in fair condition with poor excavation potential.

Feature E is an *ahu* located 41.5 m. (136.2 ft.) southwest of Feature D. It measures 0.9 m. (3.0 ft.) in height and 1.2 m. (3.9 ft.) in diameter. The feature is constructed of 'a'ā boulders and cobbles. One water-rounded boulder was observed 10.0 m. (32.8 ft.) east of Feature E.

No midden or artifacts were observed. Feature E is in fair condition with poor excavation potential.

CSH Site #: 59

State Site #:	50-10-47-17210
Site Type:	Wall segment
Age:	Historic
Function:	Indeterminate
Features (#):	1
Dimension:	12.0 m.^{2} (129.6 ft.^{2})
Elevation:	360 ft. a.m.s.l.

Description: Site 17210 is a wall segment located in rough pahoehoe lava terrain. Vegetation is light, consisting of fountain grass. The function of the wall segment is indeterminable.

The wall segment was constructed perpendicular to and across the King's Trail, in a *mauka/makai* (NE/SW) direction. It measures 15.0 m. (49.2 ft.) NE/SW by 0.8 m. (2.6 ft.) NW/SE with a maximum height of 1.1 m. (3.6 ft.). The wall is constructed of small boulders and large cobbles. No vertical facing was observed.

No midden or artifacts were observed. The wall is in fair condition and excavation potential is poor.

State Site #:	50-10-47-17211	**CSH Site #: 60**
Site Type:	Lava Tube	
Age:	Prehistoric	
Function:	Temporary habitation	
Features (#):	1	
Dimension:	$100.0\ m^2$ $(1080.0\ ft.^2)$	
Elevation:	335 ft. a.m.s.l.	

Description: Site 17211 is a lava tube located in undulating pahoehoe lava terrain. Vegetation includes fountain grass and ferns. Because of the absence of any structural modifications and sparsity of cultural material observed, the site is interpreted as a temporary shelter.

The entrance to the tube is a ceiling collapse, measuring 2.5 m. (8.2 ft.) E/W by 0.9 m. (3.0 ft.) N/S. No modifications to the entrance were observed. The lava tube measures approximately 40.0 m. (131.2 ft.) in length, running roughly E/W, with a maximum width of 2.5 m. (8.2 ft.) and a maximum ceiling height of 2.5 m. (8.2 ft.). Approximately 6.0 m. (19.7 ft.) west (*makai*) of the entrance, a second ceiling collapse opening was observed.

A small water-rounded boulder was observed to the north of the main entrance. No midden or other artifacts were observed.

The site is in fair condition with fair to poor excavation potential.

State Site #:	50-10-47-17212	**CSH Site #: 61**
Site Type:	Lava Tube	
Age:	Prehistoric	
Function:	Temporary habitation	
Features (#):	1	
Dimension:	$22.5\ m^2$ $(243.0\ ft.^2)$	
Elevation:	300 ft. a.m.s.l.	

Description: Site 17212 (Figure 53) is a small lava tube located in undulating pahoehoe terrain immediately west of Site 17211 lava tube. Surface vegetation includes fountain grass and ferns. There is a Christmas-berry tree and a *noni* tree in the entrance to the lava tube. Numerous pahoehoe excavations were observed in the area near the site. The location of the lava tube among the human-made pahoehce excavations suggests that it was used as a temporary habitation shelter, despite the absence of observable cultural material.

The main entrance to the tube is a circular sink area measuring 2.4 m. (7.9 ft.) NE/SW by 2.0 m. (6.6 ft.) NW/SE with a maximum height of 1.4 m. (4.6 ft.). The tube consists of two portions, the west and the south, extending from the main entrance.

The south portion extends southwest from the entrance and measures 5.0 m. (16.4 ft.) NE/SW by 3.0 m. (9.8 ft.) NW/SE with a maximum ceiling height of 2.5 m. (8.2 ft.). A large amount of ceiling collapse was observed in the central area of this portion.

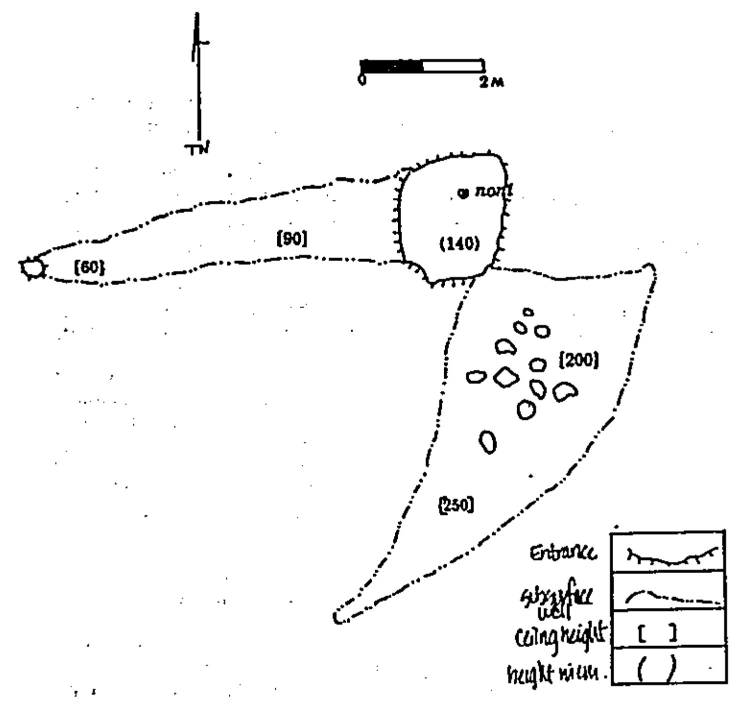

Figure 53 Site 50-10-47-17212 Lava Tube; Plan View

The west portion extends to the west from the entrance and measures 7.5 m. (24.6 ft.) E/W by 1.4 m. (4.6 ft.) N/S at its widest point, with a maximum ceiling height of 0.9 m. (3.0 ft.). A small skylight opening was observed at the end of the west portion.

No midden or artifacts were observed. Site 17212 has no excavation potential.

CSH Site #: 63

State Site #:	50-10-47-17213
Site Type:	Lava tube
Age:	Prehistoric
Function:	Temporary habitation
Features (#):	1
Dimension:	160.0 m.^{2} (1,728.0 ft.^{2})
Elevation:	173 ft. a.m.s.l.

Description: Site 17213 (Figure 54) is a lava tube located in rough, mixed 'a'ā and pahoehoe lava terrain. Vegetation consists of fern and *noni*. The function of this site is interpreted as temporary habitation due to the sparsity of cultural material observed and the presence of only minor modifications.

The entrance to the lava tube is located at the southeast end of a rectangular sink. The tube interior measures 16.0 m. (52.5 ft.) NW/SE by 5.5 m. (18.0 ft.) NE/SW with an entrance height of 1.0 m. (3.28 ft.) and a maximum ceiling height of 0.7 m. (2.3 ft.).

Minor modifications were observed at the northern end of the entrance. The interior walls and floor of the tube is rough pahoehoe. At the back of the tube, a goat skeleton was observed. A small, water-rounded cobble was observed at the south end of the tube.

No midden or artifacts were observed. Site 17213 is in good condition with poor excavation potential.

CSH Site #: 65

State Site #:	50-10-47-17214
Site Type:	Platform
Age:	Prehistoric
Function:	Marker
Features (#):	1
Dimension:	10.5 m.^{2} (113.0 ft.^{2})
Elevation:	105 ft. a.m.s.l.

Description: Site 17214 (Figure 55) (see Figure 103) is a small platform situated on a bluff in rough 'a'ā lava terrain. No vegetation was observed near the site.

This site was originally interpreted as a possible burial and limited subsurface testing was conducted. The excavation results revealed no human remains, nor any other cultural material. Based on the excavation results, the function of this site was re-evaluated. Because of its small size, its elevated location on a prominent bluff, and lack of human remains (see *Excavation Results* section of this report), Site 17214 is interpreted as a marker.

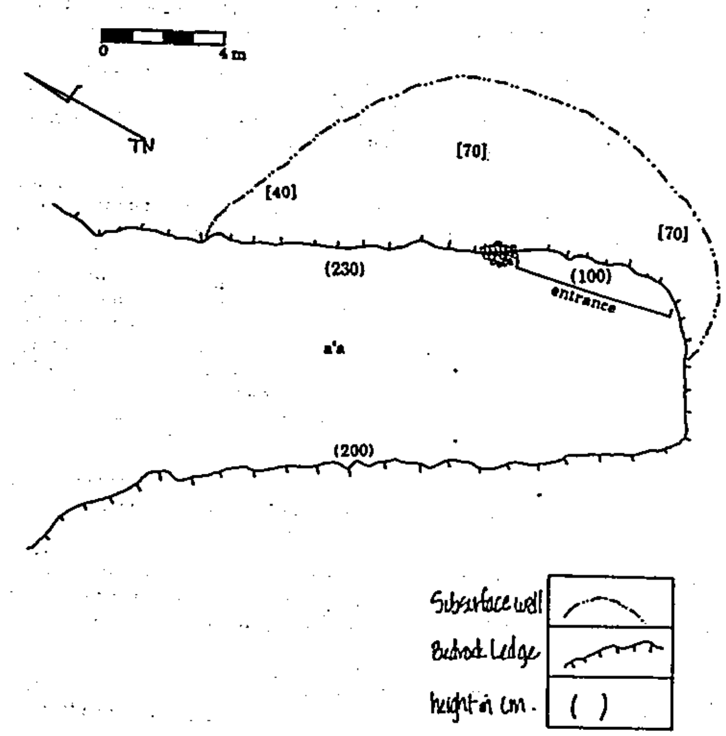

Figure 54 Site 50-10-47-17213 Lava Tube; Plan View

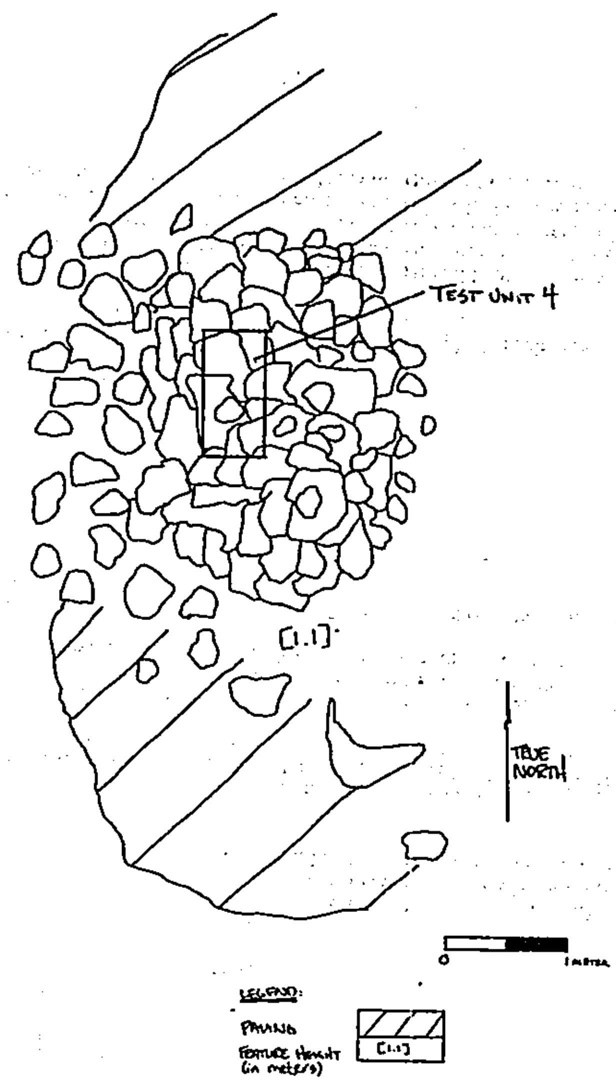

Figure 55 Site 50-10-47-17214 Platform; Plan View

It measures 3.5 m. (11.5 ft.) N/S by 3.0 m. (9.8 ft.) E/W, to a maximum height of 1.1 m. (3.6 ft.). The platform is constructed of large 'a'ā boulders but has mostly collapsed. No midden or artifacts were observed.

Site 17214 is poor condition.

State Site #:	50-10-47-17215	**CSH Site #: 66**
Site Type:	*Ahu*	
Age:	Prehistoric	
Function:	Marker	
Features (#):	1	
Dimension:	4.0 m.^{2} (43.2 ft.^{2})	
Elevation:	250 ft. a.m.s.l.	

Description: Site 17215 is an *ahu* located in steeply sloping 'a'ā terrain. Vegetation includes grass and one *noni* tree. The site is located approximately 30.0 m. (98.4 ft.) south of the main east/west (*mauka/makai*) road in the project area.

The *ahu* is constructed on top of an enormous 'a'ā boulder which measures 2.0 m.(6.6 ft.) in diameter. The *ahu* measures 2.0 m. (6.6 ft.) in diameter and is constructed to a maximum height of 1.7 m. (5.6 ft.). The *ahu* sits atop an 'a'ā ridge and is visible from points downslope.

No midden or artifacts were observed. Site 17215 is in poor condition with no excavation potential.

State Site #:	50-10-47-17216	**CSH Site #: 67**
Site Type:	Complex	
Age:	Prehistoric	
Function:	Recurrent habitation; Transportation	
Features (#):	2	
Dimension:	5.0 m.^{2} (54.0 ft.^{2})	
Elevation:	365 ft. a.m.s.l.	

Description: Site 17216 (Figure 56) is a complex consisting of two features, designated Features A and B. The complex is located in gently sloping pahoehoe terrain. Vegetation consists of sparse shrubs and grass.

Feature A consists of two remnant enclosures. Together, they measure 19.6 m. (64.3 ft.) N/S by 12.7 m. (41.7 ft.) E/W. The north enclosure is a rough C-shape and measures 7.5 m. (24.6 ft.) N/S by 9.6 m. (31.5 ft.) E/W. The enclosure is constructed of pahoehoe boulders. Four depressions were observed along the north and west sides of the feature.

The south enclosure is constructed around a pahoehoe depression and measures 7.0 m. (23.0 ft.) N/S by 5.0 m. (16.4 ft.) E/W. Mounded construction was observed on the southern and eastern sides of the depression. The remaining sides are natural outcrop facing.

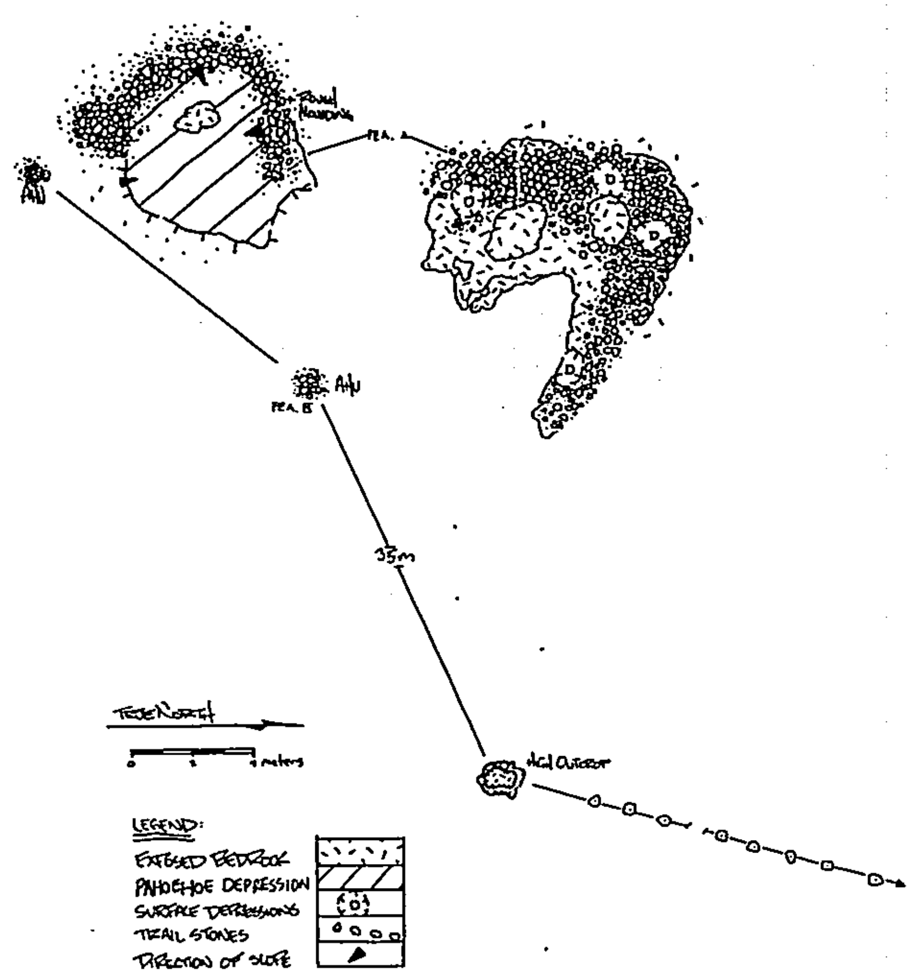

Figure 56 Site 50-10-47-17216 Complex, Feature A and B; Plan View

No midden or artifacts were observed. Feature A is in remnant condition and excavation potential is poor.

Feature B is a remnant trail which is characterized by several *ahu*. While no formal path is present, the *ahu* extend in an east-west direction just *mauka* of Site 7728 trail and appear to delineate a trail leading to Feature A shelter. From this location, moving *mauka*, the trail of *ahu* leads to a stepping-stone trail. The stepping-stone trail also extends *mauka* (eastward) where it terminates at the historic trail, Site 10290. A trail section was identified by PHRI along the same *mauka-makai* orientation of the stepping-stone trail, east of the project area (above 750 ft. a.m.s.l.). It is possible that both of these trail sections once formed a single route that was used to travel *mauka-makai* through Keopuka.

Feature B is in remnant condition with no excavation potential.

CSH Site #: 68

State Site #:	50-10-47-17217
Site Type:	Lava tube
Age:	Prehistoric
Function:	Burial; Recurrent habitation
Features (#):	1
Dimension:	324.0 m.^{2} (3,499.2 ft.^{2})
Elevation:	270 ft. a.m.s.l.

Description: Site 17217 (Figure 57) is a lava tube located in undulating pahoehoe lava. Vegetation consists of grass. The small, recessed entrance to the tube is marked by an *ahu* on the surface. The lava tube was used as a burial cave. Based on the presence of an interior terrace structure and midden deposits, the lava tube was also used as a habitation cave - probably on a recurrent basis because of the substantial construction of the interior terrace.

The entrance or passage measures 2.0 m. (6.6 ft.) NE/SW by 1.0 m. (3.3 ft.) NW/SE. It extends 2.5 m. (8.2 ft.) before the main lava tube is reached. The passageway was purposely narrowed by small boulder stacking along the southwestern edge. The construction reaches the ceiling. Vertical facing was observed along half of its length.

From the entrance, the tube extends both *mauka* and *makai* (northeast and southwest), designated Chambers 1 and 2. The lava tube measures approximately 108.0 m. (354.2 ft.) long, NE/SW, and 3.0 m. (9.8 ft.) at the widest point. The ceiling height reaches a measured maximum of 2.1 m. (6.9 ft.), but averages 1.0 m. (3.3 ft.).

Chamber 1 extends approximately 33.0 m. (108.2 ft.) northeast from the entrance and the floor is sharp, rough 'a'ā. Cultural material, particularly crab claw and some midden, was observed throughout the extent of this chamber. Approximately 3.0 m. (9.8 ft.) from the entrance, a bamboo fishing pole was observed. At 6.5 m. (21.3 ft.) from the entrance, unidentifiable bone fragments were observed. At 14.3 m. (46.9 ft.) from the entrance, a charcoal concentration was observed and a sample (15.0 gms.) was collected for radiocarbon dating (Acc. C-4).

Chamber 2 extends approximately 75.0 m. (246.0 ft.) *makai* (southwest) from the entrance. A constructed terrace extends southwest 10.0 m. (32.8 ft.) from the cave entrance.

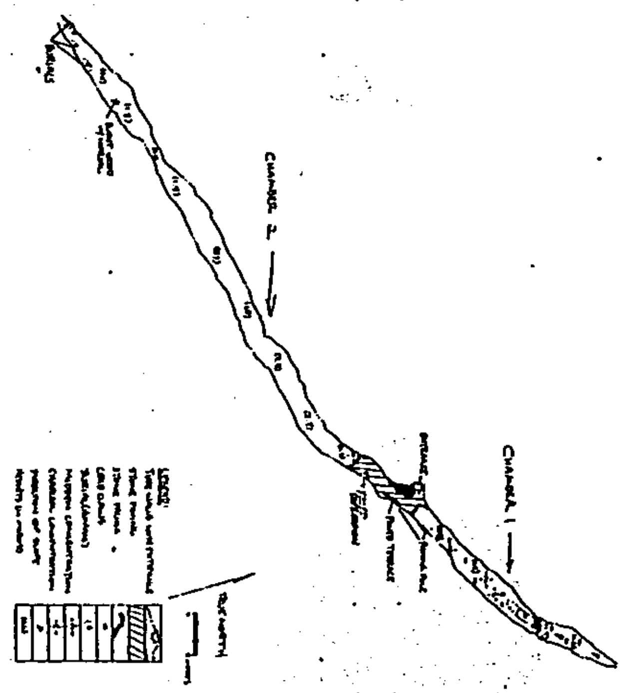

Figure 57 Site 50-10-47-17217 Lava Tube; Plan View

The terrace is constructed of small boulders and the surface is cobble paved. A second bamboo pole was observed 2.5 m. (8.2 ft.) southwest of the entrance.

At the end of Chamber 2, three to four human burials were observed. The burials are located along the edges of the tube where the ceiling height decreases to about 0.4 m. (1.3 ft.). The first burial encountered was in plain view, but otherwise, the burials are difficult to observe because of the low ceiling height. Definitive bone fragments, such as mandibles, and teeth confirm the burials as human. The majority of the skeletal remains have decayed beyond identification. Observed near the burial were decaying wood fragments, some of which were burnt.

State Site #: 50-10-47-17218 **CSH Site #: 72**
Site Type: Lava tube
Age: Prehistoric
Function: Temporary habitation
Features (#): 1
Dimension: 810.0 m.^{2} (8,748.0 ft.^{2})
Elevation: 79 ft. a.m.s.l.

Description: Site 17218 (Figure 58) is a lava tube located in pahoehoe lava terrain. Vegetation on the surface consists of grass and ferns. The lava tube comprises three main chambers, designated Chambers A to C. Each chamber originates from a common sink area. The sink measures 7.4 m. (24.3 ft.) N/S by 6.9 m. (22.6 ft.). No modifications or constructions were observed in the interior or exterior surface of the lava tube. The presence of cultural material in conjunction with the lack of structural modifications observed in the lava tube, suggests that Site 17218 was utilized as a temporary shelter.

Chamber A is accessed through the south end of the sink. From the entrance, Chamber A extends 8.0 m. (26.2 ft.) to the south by 30.0 m. (98.4 ft.) E/W. Ceiling height measures 2.7 m. (8.9 ft.) maximum, at the west end of the chamber.

Midden was observed in the entrance and throughout the chamber. It includes *opihi*, cowrie and shell fragments, *kukui* shell, and coral. At the west end of the tube, approximately 8.0 m. (26.2 ft.) from the entrance, a small water-rounded boulder was observed. To the east, at approximately 10.0 m. (32.8 ft.) from the entrance, two additional water-rounded boulders observed.

Approximately 1.0 m. (3.3 ft.) east of the water-rounded boulders there is a substantial ceiling collapse and a skylight entrance. An additional 12.5 m. (41.0 ft.) east of the skylight, a crab shell and pincher, and a small piece of charcoal were observed.

Chamber A is in fair condition and excavation potential is poor.

Chamber B is accessed through the west side of the sink and measures 15.0 m. (49.2 ft.) long N/S. A maximum width of 5.3 m. (17.4 ft.) E/W is measured. The ceiling height maximum is 1.5 m. (4.9 ft.). A single water-rounded stone was observed 4.7 m. (15.4 ft.) from the entrance. A scattering of marine midden was observed at the entrance to Chamber B.

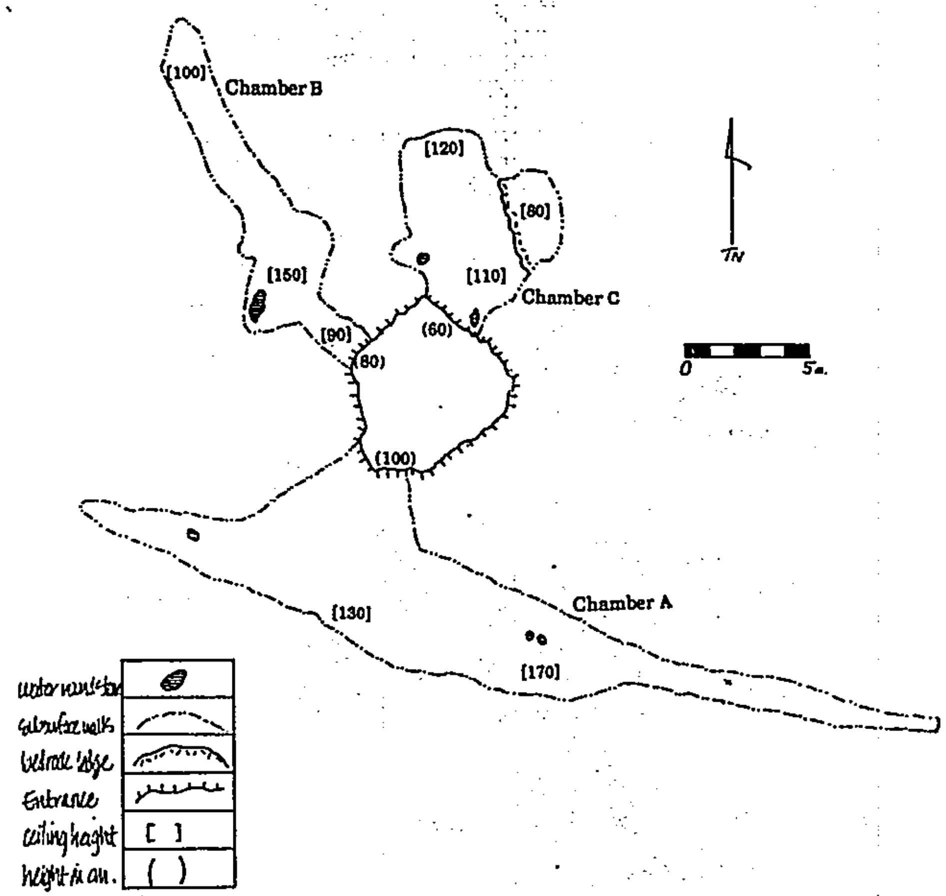

Figure 58 Site 50-10-47-17218 Lava Tube; Plan View

Chamber B is in fair condition and excavation potential is poor.

Chamber C is accessed through the north side of the sink. Chamber C is roughly circular and measures 7.0 m. (23.0 ft.) in diameter, with a maximum ceiling height of 1.2 m. (3.9 ft.). Three water-rounded stones were observed. A basalt flake and a scattering of midden were observed.

Chamber C is in fair condition and excavation potential is poor.

State Site #:	50-10-47-17219	**CSH Site #: 73**
Site Type:	Complex	
Age:	Prehistoric	
Function:	Recurrent habitation	
Features (#):	4	
Dimension:	945.5 m.^{2} (10,211.4 ft.^{2})	
Elevation:	230 ft. a.m.s.l.	

Description: Site 17219 (Figure 59) is a complex including a lava tube (Feature A) and two terraces located on the surface (Feature B). Feature A lava tube has three main extensions or chambers that extend to the north (Chamber A), south (Chamber B) and west (Chamber C) of a common sink area. Feature B comprises two terraces constructed along the northwest edge of the sink. Vegetation on the surface and in the sink includes *koa haole*, *kiawe*, and grass.

Site 17219 complex is interpreted as a recurrent habitation site because of the presence of cultural material observed in the tube, in conjunction with the presence of associated surface structures (Features B) and internal modifications of the tube.

The light zone of Chamber A appears to be the primary living area of Feature A lava tube, based on the presence of internal structures, and abundance of artifacts and midden immediately inside the entrance. This chamber area of the tube measures roughly 5.0 m. (16.5 ft.) in diameter with a 1.1 m. (3.6 ft.) ceiling height. Modifications within the chamber include a bi-faced wall segment measuring 2.5 m. (8.2 ft.) long and 0.5 m. (1.6 ft.) high; paving, measuring 4.5 m. (14.8 ft.) NE/SW by 2.0 m. (6.6 ft.) NW/SE that covers floor of the main chamber; and a wall that partially blocks the entrance into Chamber A. The tube extends to the northeast of the main chamber area for approximately 4.0 m. (13.2 ft.) where another small opening to the tube is located. The tube also extends west of the main chamber for approximately 18 m. (59 ft.). Ceiling heights range from 0.4 m. to 1.3 m. (1.3 ft. to 4.3 ft.). Indigenous artifacts, including coral files, hammerstones, urchin files, a scoria abrader were all observed in the main chamber (Chamber A). A large, oblong, water-worn stone was also observed.

Midden was observed to include: *kukui* nuts, shells and a coconut shell. Coral and goat bones were also present. Chamber A modifications are in good condition and the chamber area itself has good excavation potential.

Chamber B is accessed from the west side of the sink, located 8.0 m. (26.2 ft.) west of the Chamber C entrance. The tube of Chamber B measures 8.0 m. (26.2 ft.) E/W and averages 3.0 m. (9.8 ft.) wide. A maximum ceiling height of 1.3 m. (4.3 ft.) is measured.

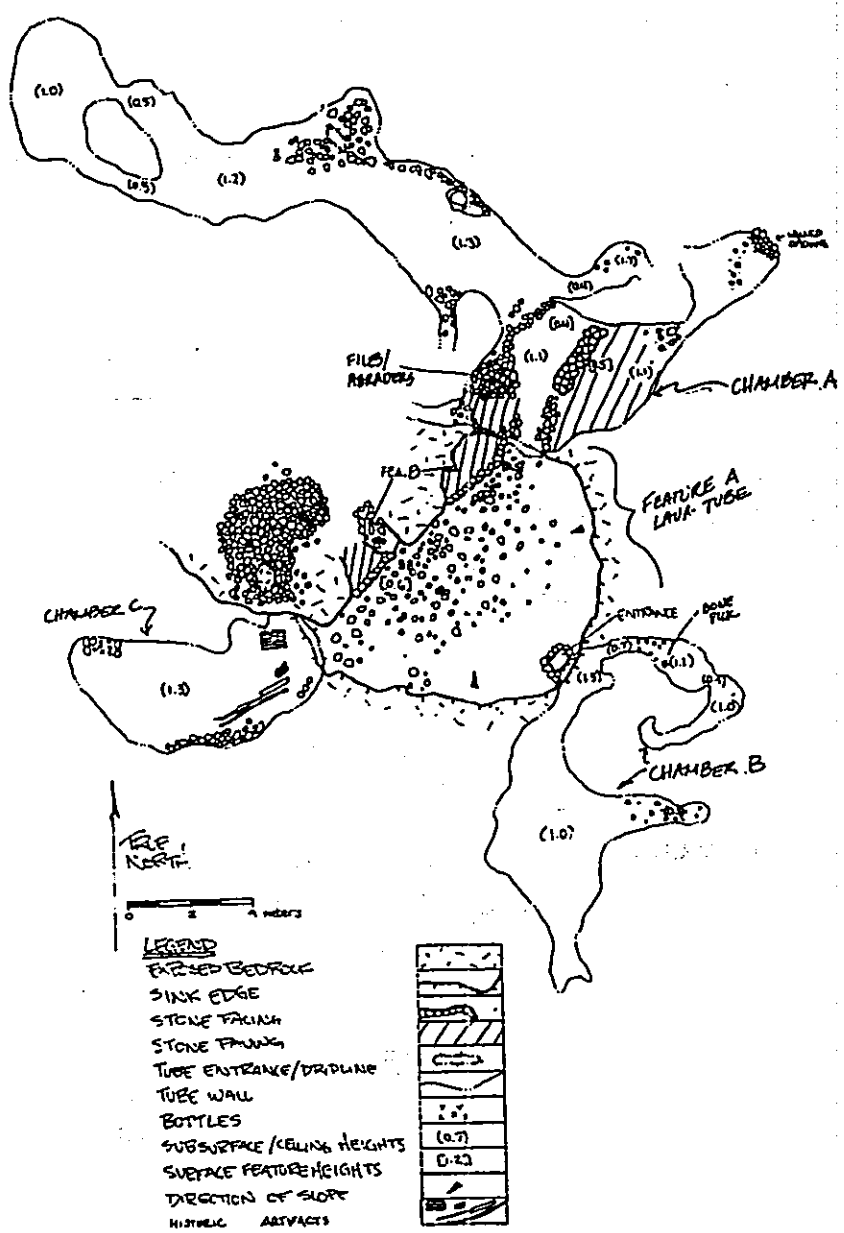

Figure 59 Site 50-10-47-17219 Complex, Feature A and B; Plan View

Historic and modern trash was observed throughout Chamber B and include: bamboo poles, a rolled plastic tarp, a plastic pipe, rotting plywood, numerous glass bottles, nylon string, and a plastic bag.

No midden or indigenous artifacts were observed. Because the floor within Chamber D is bare pahoehoe, there is no excavation potential.

Chamber C of Feature A lava tube is accessed from the south edge of the sink, 7.0 m. (23.0 ft.) south of the entrance to Chamber A. From the entrance, one branch of the tube extends approximately 5.0 m. (16.4 ft.) to the east. This section of tube is very narrow, only 0.5 m. (1.6 ft.) wide, but the ceiling height measures 1.1 m. (3.6 ft.), maximum. A bone pick artifact was observed.

Another tube branch of Chamber C extends 11.0 m. (36.1 ft.) to the south of the entrance. This section of Chamber C measures as wide as 4.0 m. (13.1 ft.) with a maximum ceiling height of 1.0 m. (3.3 ft.).

A Charcoal sample (4.9 gms.) was collected from the light zone area of Chamber C (Acc. C-5). Marine shell midden and *kukui* nuts were observed only along the east wall of the entrance. Chamber C excavation potential appears fair to poor.

Feature B consists of two terraces constructed along the northwest perimeter of the lava tube's (Feature A) sink. The terraces and outcrop together form a straight, wall-like edge of the sink on the northwest side.

The north terrace measures 2.5 m. (8.2 ft.) N/S by 1.5 m. (4.9 ft.) E/W, to a maximum height of 0.5 m. (1.6 ft.). The south terrace measures 2.0 m. (6.6 ft.) N/S by 1.5 m. (4.9 ft.) E/W, to a maximum height of 0.6 m. (2.0 ft.). Both terraces are constructed of medium to large cobbles and are faced along the southeast sides, and flush against outcrop to the northwest. The surface of both terraces is cobble paving. Located approximately 1.0 m. west of the south terrace is an amorphous mound measuring 2.5 m. by 4.0 m. This mound was included on the plan view map but was not assigned a separate feature designation.

No midden or artifacts were observed. Feature B excavation potential appears poor.

CSH Site #: 74

State Site #:	50-10-47-17220
Site Type:	Lava blister
Age:	Prehistoric
Function:	Recurrent habitation
Features (#):	1
Dimension:	11.0 m.^{2} (118.8 ft.^{2})
Elevation:	20 ft. a.m.s.l.

Description: Site 17220 (Figure 60) is a lava blister located in undulating pahoehoe terrain. Vegetation consists of *koa haole*, *kiawe*, and grass.

The lava tube is interpreted as a recurrent use habitation shelter because of the presence of cultural material and minor internal modifications.

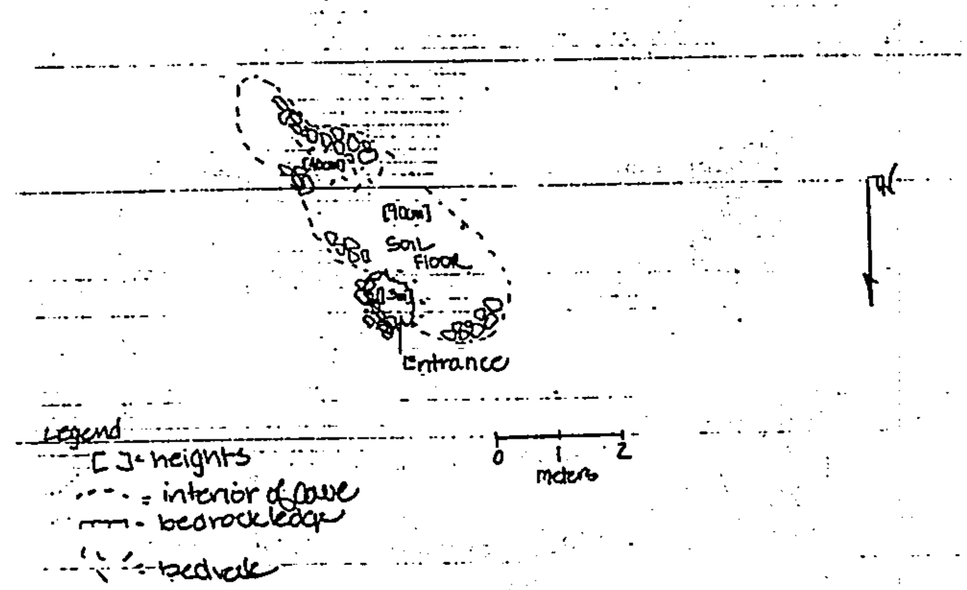

Figure 60 Site 50-10-47-17220 Lava Blister; Plan View

The entrance to the blister measures 2.0 m. (6.6 ft.) N/S wide and it drops vertically to the floor of the blister. The blister interior measures 5.5 m. (18.0 ft.) NW/SE and is 2.0 m. (6.6 ft.) wide, maximum. The ceiling height measures 0.9 m. (3.0 ft.), average. Boulders were cleared from the blister floor and piled against the tube walls. The floor is soil, estimated to be 0.1 m. (0.3 ft.) deep.

Marine shell midden and several artifacts were observed in the blister, including two coral abraders and a *he'e* lure (drilled cowrie shell). A solid steel bar was also present.

The site is in good condition and excavation potential is good.

CSH Site #: 75

State Site #:	50-10-47-17221
Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation
Features (#):	3
Dimension:	1,213.2 m.^{2} (13,102.6 ft.^{2})
Elevation:	20-25 ft. a.m.s.l.

Description: Site 17221 (Figure 61) is a complex located in level pahoehoe terrain, 120 ft. west of the *hōlua* slide (Site 17207). Vegetation consists of *koa haole* and grass. The site consists of three features, designated Features A to C.

The complex is interpreted as a permanent habitation site because of the sizable floor areas of the features and dense cultural layer exposed on the surface of Feature B. Its location on the east portion of the Keopuka coast among other permanent habitation sites also supports this interpretation.

Feature A is a rough rectangular-shaped pavement. The pavement measures 22.0 m. (72.2 ft.) NW/SE by 6.0 m. (19.7 ft.) NE/SW, and is constructed of rough pahoehoe boulders and cobbles. Two large, uprooted *kiawe* trees are partially within this feature and have disturbed the pavement surface. Within the upturned roots of these trees, a rich dark soil with charcoal, coral and shell midden was observed. The feature also seems to have been disturbed by high surf and is surrounded by sand and rubble

Feature A is in remnant condition and excavation potential is fair.

Feature B is a rectangular enclosure remnant located 2.5 m. (8.2 ft.) east of Feature A. It measures 8.0 m. (26.2 ft.) E/W by 5.0 m. (16.4 ft.) N/S, 0.4 m. (1.3 ft.) thick, to a maximum height of 0.4 m. (1.3 ft.). This enclosure is defined by a rough alignment of single boulders, many of which are upright. The enclosure is also divided into two basically equal halves by a rough alignment that runs NW/SE. The eastern interior of the enclosure appears to be roughly paved. A large *kiawe* tree has disturbed much of the southeast part of the paving. The western portion of the enclosure is filled with midden-rich beach sand.

Feature B is in remnant condition and excavation potential is good.

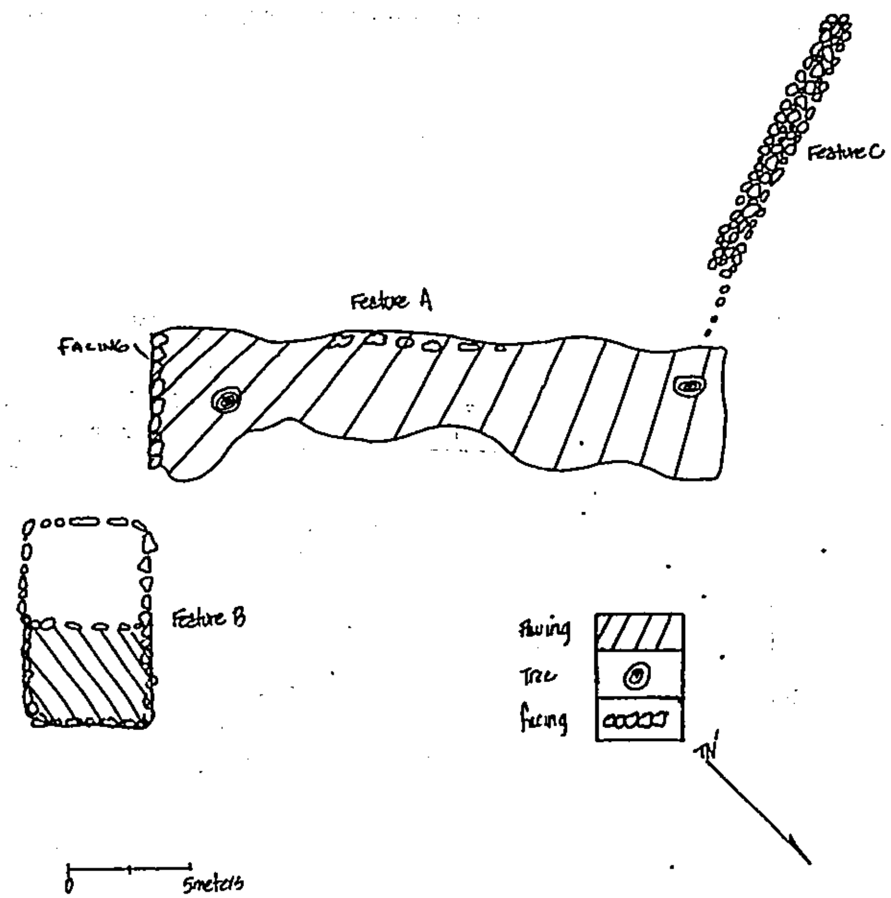

Figure 61 Site 50-10-47-17221 Complex, Feature A through C; Plan View

Feature C is a wall located 2.5 m. (8.2 ft.) northwest of Feature B. It measures 12.0 m. (39.4 ft.) E/W, to a maximum height of 1.2 m. (3.9 ft.). It is constructed of pahoehoe boulders. A portion of the wall functions as a retaining wall on a bluff, but the majority of the wall is free standing.

No midden or artifacts were observed. Feature D is in fair condition and excavation potential is poor.

State Site #:	50-10-47-17222	**CSH Site #: 76**
Site Type:	Rectangular enclosure	
Age:	Prehistoric	
Function:	Permanent habitation	
Features (#):	1	
Dimension:	71.3 m.² (770.0 ft.²)	
Elevation:	25 ft. a.m.s.l.	

Description: Site 17222 (Figure 62) (see Figure 104) is a rectangular enclosure located in a level area of pahoehoe outcrop, at the north edge of a gully. Vegetation near the site consists of *koa haole* and grass.

The site is interpreted as a permanent habitation structure because of its sizable floor area, substantial wall construction, and the presence of a constructed entrance.

The enclosure interior measures 9.5 m. (31.2 ft.) NW/SE by 7.5 m. (24.6 ft.) NE/SW. The enclosing walls measure to a maximum thickness of 1.0 m. (3.3 ft.) and a maximum height of 2.3 m. (7.5 ft.). All sides are well-faced. An entrance at the northwest corner of the enclosure measures roughly 1.0 m. (3.3 ft.) wide. The interior of the enclosure consists of pahoehoe outcrop and shallow, sandy soil.

Shell midden was observed scattered across the interior surface. A collection of modern trash was also present. The site is in good condition and excavation potential is fair.

State Site #:	50-10-47-17224	**CSH Site #: 80**
Site Type:	Complex	
Age:	Prehistoric	
Function:	Recurrent habitation; Burial	
Features (#):	2	
Dimension:	1,617.0 m.² (17,463.6 ft.²)	
Elevation:	480-500 ft. a.m.s.l.	

Description: Site 17224 (Figures 63 and 64) (see Figure 105) is a complex located in mixed pahoehoe and 'a'ā lava terrain. Vegetation consists of ferns, grass, and *opiuma*. The complex comprises a lava tube (Feature B) and the modified sink of the lava tube (Feature A).

Feature A is interpreted as a habitation component of the complex because of the sizable floor areas and substantial construction of modifications (*i.e.*, terraces). Feature B functioned primarily as a burial cave, but based on the presence of midden within, it was

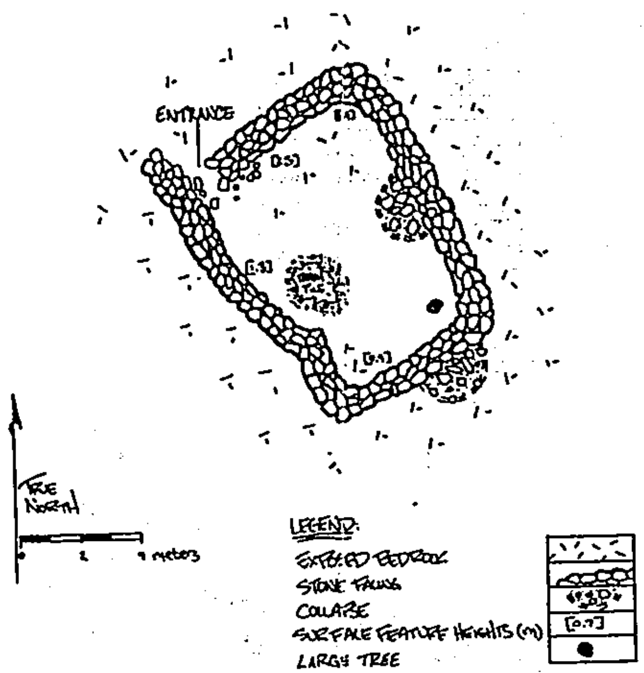

Figure 62 Site 50-10-47-17222 Enclosure; Plan View

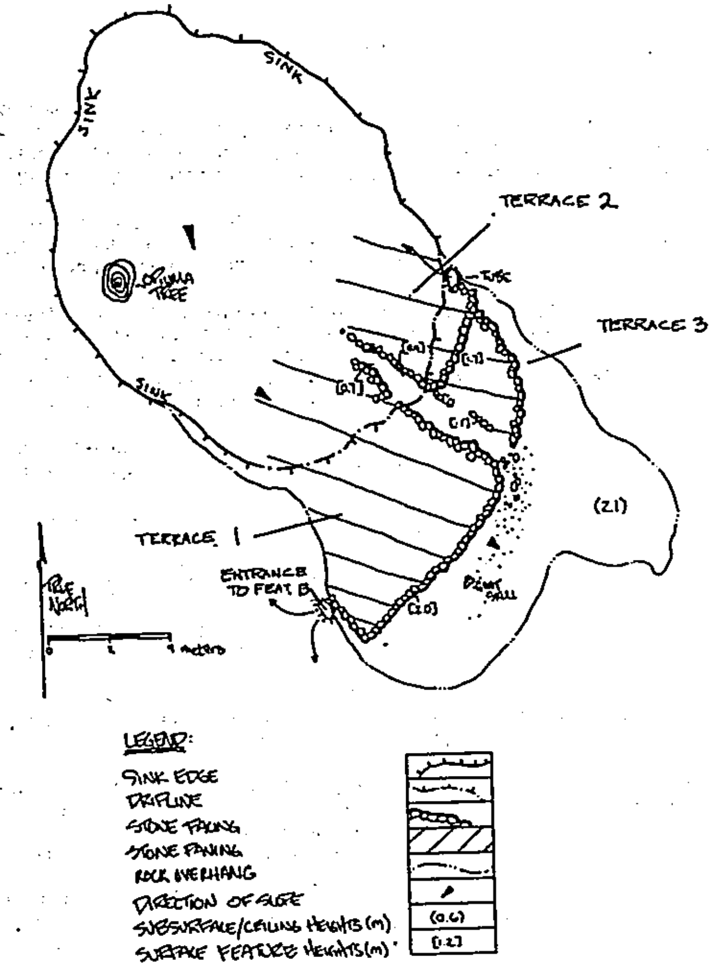

Figure 63 Site 50-10-47-17224 Complex, Feature A and Entrance to Feature B Lava Tube; Plan View

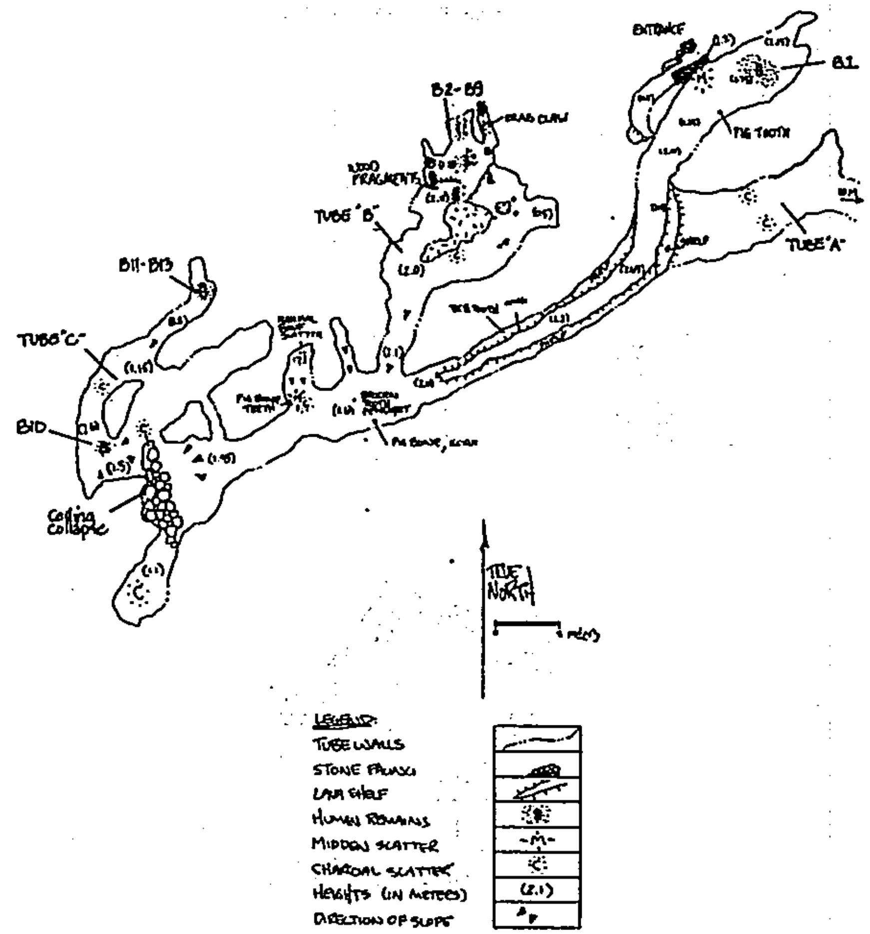

Figure 64 Site 50-10-47-17224, Feature B Lava Tube; Plan View

probably a component of the permanent habitation complex prior to its use as a burial cave. Crab claws observed inside the cave may have had ceremonial affiliations with the burial component of the lava tube.

Feature A is a modified sink and overhang. The sink measures 15.5 m. (50.8 ft.) NW/SE by 11.0 m. (36.1 ft.) NE/SW and the area protected by the overhang measures 10.6 m. (34.8 ft.) NE/SW by 9.0 m. (29.5 ft.). The ceiling height of the overhang measures 2.1 m. (6.9 ft.). Three terrace structures modify the sink and overhang area, designated Terraces 1 to 3. The terraces are constructed of small to large boulders and their surfaces are paved with cobbles.

Terrace 1 is a large terrace located along the southwest side of the sink, lying partly under the overhang. It measures 7.0 m. (23.0 ft.) NE/SW by 5.0 m. (16.4 ft.) NW/SE and reaches a maximum height of 2.0 m. (6.6 ft.), on the southeast side.

Terrace 2 is located along the northeast side of the sink, opposite Terrace 1. A path is created between the two terraces and leads southeast through the sink, into the overhang area, and eventually southwest into Feature B, the lava tube. Terrace 2 measures 4.0 m. (13.1 ft.) NW/SE by 3.5 m. (11.5 ft.) NE/SW and 1.7 m. (5.6 ft.) high, southeast side.

Terrace 3 is contiguous to the southeast side of Terrace 2 and measures 3.5 m. (11.5 ft.) NE/SW by 3.0 m. (9.8 ft.) NW/SE, to a maximum height of 1.1 m. (3.6 ft.), southwest side. Terrace 3 lies completely under the overhang.

A goat skull and gourd fragments were observed. Feature A is in good condition and excavation potential is good.

Feature B is an extensive, multi-chambered lava tube with an entrance located in the south corner of Feature A. The entrance to Feature B lava tube has been constricted by Terrace 1 of Feature A to the north, and by a 1.2 m. (3.9 ft.) high stone wall to the south. The construction extends into the subterranean space on both sides for 2.5 m. (8.2 ft.), southwest.

The lava tube measures approximately 77.0 m. (252.6 ft.) long, NE/SW, from end to end, and a maximum ceiling height of 2.65 m. (8.7 ft.) was measured.

From the entrance, the main tube extends to the northeast and southwest. The northeastern portion extends only 11.0 m. (36.1 ft.). Midden, mammal bones and a shark tooth were observed in the eastern portion of the lava tube in the chamber beyond the entrance. Long bone fragments of a human burial, Burial 1, possibly a juvenile, were observed against the northeast end of the tube, under the uppermost shelf.

The southwestern portion of the lava tube is more extensive. Overall, it measures 55.5 m. (182.0 ft.) from the entrance and consists of a main tube and several lateral tubes, designated Lateral Tubes 1 to 3.

Lateral Tube A extends to the east off of the main tube, roughly 10.0 m. (32.8 ft.) southwest of the entrance. Lateral Tube 1 extends roughly 21.0 m. (68.9 ft.) east then becomes too narrow to explore. Charcoal and shell fragments were observed scattered in Lateral Tube 1.

Lateral Tube B extends off the main tube 38.0 m. (124.6 ft.) southwest of the main entrance. This tube is a "Y"-shape, extending 10.0 m. (32.8 ft.) north and then branching to the east and to the northeast. The east branch measures 11.5 m. (37.7 ft.) in length with a maximum ceiling height of 2.0 m. (6.6 ft.). This fork contains charcoal, *kukui* nuts, bone, and crab claw. A coral abrader was also observed. At the end of this side tube, bone was observed but could not be positively identified as human. The northeast fork measures 13.0 m. (42.6 ft.) long, and 2.5 m. (8.2 ft.) high, maximum. This fork contains Burials 2 to 7. Burial 2 is located on the west edge of a ledge 2.0 m. (6.6 ft.) high. Burial 3 is located beneath the ledge. Burials 3 and 4 are located on a raised ledge to the east. Burial 5 is located within an enclosure consisting of a single course of large cobbles. Burials 6 and 7 are located on the other side of the ledge. The burial at the base of the ledge prevented the exploration of the rest of this fork. Bone, shell, charcoal and ceiling collapse were visible within the west fork.

At the end of the main tube, the ceiling has collapsed. Two openings allow access beyond the collapse into Lateral Tube C.

The entrance to the north reveals a long tube which measures 21.5 m. (70.5 ft.) in length by 7.0 m. (23.0 ft.) width with a ceiling height of 2.6 m. (8.5 ft.). Four human burials were found in this lateral tube. One was located on the other side of the ceiling collapse. The remaining three were located at the north end of the chamber. Crab claw and charcoal were observed in association.

The entrance to the south reveals a small chamber which measures 7.0 m. (23.0 ft.) in length by 3.5 m. (11.5 ft.) in width and a ceiling height of 1.1 m. (3.6 ft.). Charcoal and mammal bone was observed.

At the entrance a shell ornament was collected (Acc. 54). Midden is scattered on all the natural shelves in the tube and on the floor. The midden includes charcoal, marine shell, mammal bone, crab pinchers, pig teeth and wood fragments. Feature B is in good condition with fair excavation potential.

CSH Site #: 81

State Site #:	50-10-47-17225
Site Type:	Complex
Age:	Prehistoric
Function:	Permanent habitation; Burial
Features (#):	4
Dimension:	1,190.0 m.^{2} (12,852.0 ft.^{2})
Elevation:	545-565 ft. a.m.s.l.

Description: Site 17225 (Figures 65 and 66) is a complex located in undulating pahoehoe and shallow soil terrain. Vegetation at the site consists of *koa haole* and grass. The complex consists of four features, designated Features A to D. Feature A is a lava tube and Features B through D are surface features.

The complex is interpreted as a permanent habitation complex because of the extensive and substantial nature of the modifications of Feature A lava tube and the relatively substantial architecture of the associated surface features (Features B through D). Feature A lava tube probably functioned as a special work and storage area (*e.g.*, tapa and

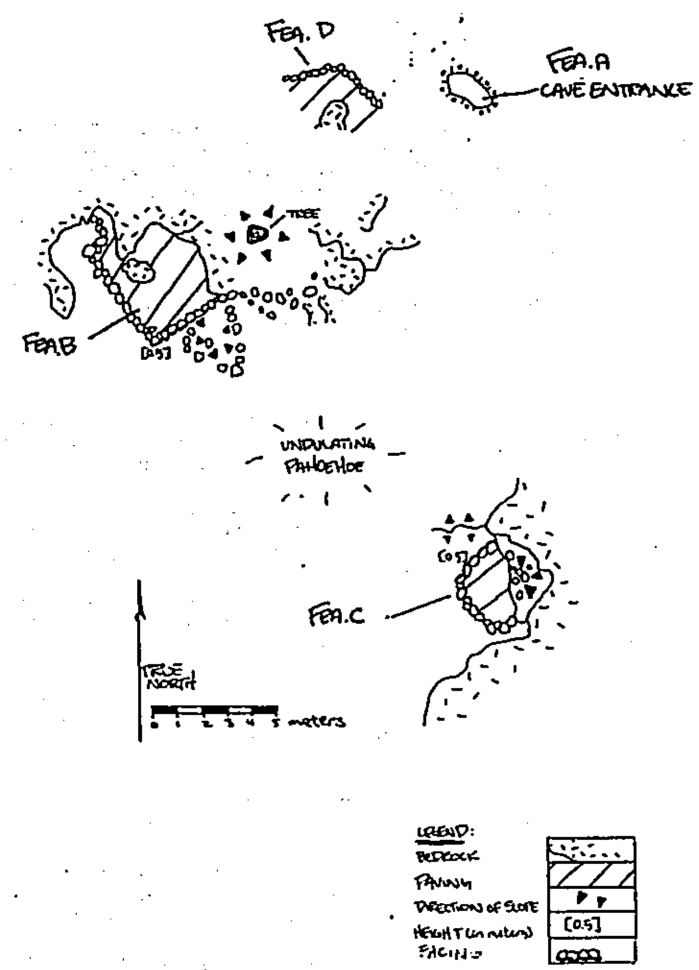

Figure 65 Site 50-10-47-17225 Complex, Feature B through D; Plan View

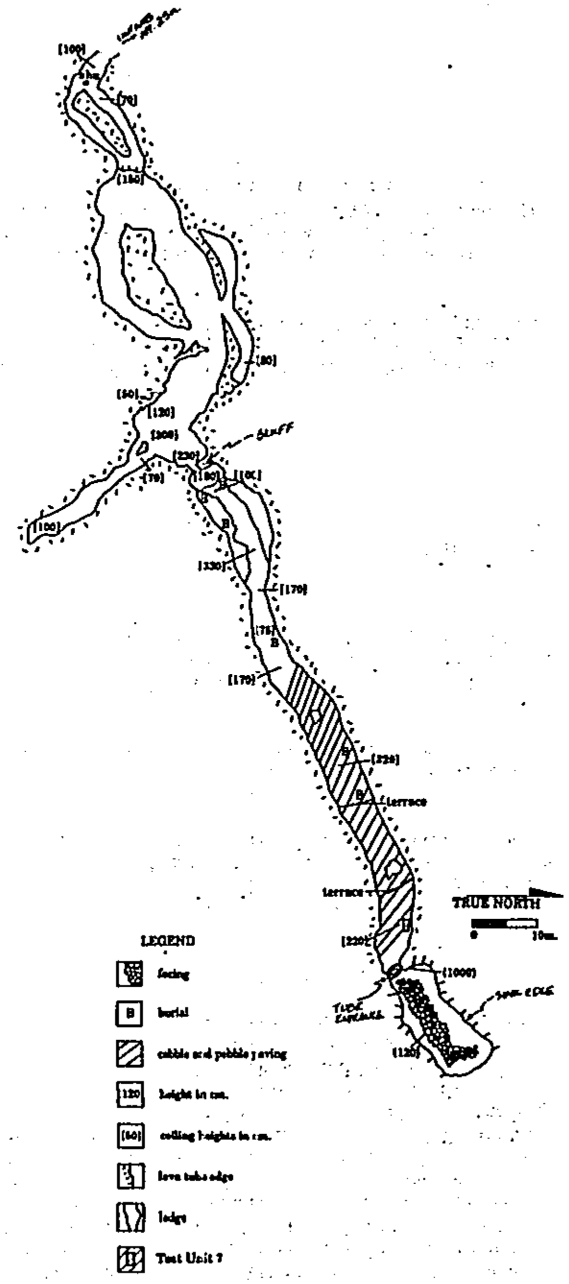

Figure 66 Site 50-10-47-17225, Feature A Lava Tube; Plan View

tool making) of the complex - based on the abundance and types of tools present - and at some point was converted into a burial site. Possible ceremonial items in the lava tube: crab claws and an *ahu*, may be associated with the burial component of the lava tube. Overall, Six concentrations of human bones, possibly representing individual skeletons, were identified within the lava tube.

Feature A is an extensive, branching lava tube that contains internal features, burials, and an abundance of cultural material. The entrance is situated within a sink which measures 15.0 m. (49.2 ft.) N/S by 7.0 m. (23.0 ft.) E/W. The opening into the sink measures 6.0 m. N/S (19.7 ft.) by 4.0 m. (13.1 ft.) E/W with a 10.0 m. (32.8 ft.) drop to reach the tube floor. Overall, the lava tube measures 170.0 m. (557.6 ft.) E/W by 21.0 m. (68.9 ft.) N/S with a maximum ceiling height of 3.3 m. (10.8 ft.).

Within the sink there is a shelter area protected by a deep overhang. The shelter area measures approximately 25.0 m. (82.0 ft.) E/W by 10.0 m. (32.8 ft.) N/S. A wide wall divides the sink into two sections. It measures roughly 7.0 m. (23.0 ft.) long and stands to a maximum height of 1.2 m. (3.9 ft.). The wall is constructed of small to medium boulders and cobbles. The south end and east side are well faced. The west side is partially collapsed. A passage-way between the wall and the south side of the overhang averages 2.5 m. (8.2 ft.) wide. This passage reaches the main entrance of the lava tube.

Deposits of ash were observed in the eastern portion of the sink. There is a family of large white barn owls (*Tyto alba pratincola*) living in the entrance. Two owl nests were observed.

Several structural modifications enhance the entrance area of the tube for approximately 60 m. (198 ft.). Four step-like terraces lead into the lava tube from the entrance for a distance of 25.0 m. (82.0 ft.). The ceiling height in this area ranges from 2.0 m. to 4.0 m. (6.6 ft. to 13.1 ft.) and the width is approximately 4.0 m. (13.1 ft.). A large mounded wall is located 10.0 m. (32.8 ft.) from the entrance. It measures 0.9 m. (3.0 ft.) E/W. Three burials (or concentrations of human bones) were observed in this portion of the tube, two burials roughly 30 m. (99 ft.) from the entrance and one burial 50 m. east of the entrance.

Numerous artifacts were recovered from the terraces nearing the entrance to the tube (see last paragraph of this feature description). Also observed in the entrance area were scattered *kukui* nut and marine shell midden, charcoal, bird and small animal bones, as well as a goat skull.

The tube floor is paved for approximately 60.0 m. (196.8 ft.) to where the tube narrows. The tube extends then 79.5 m. (262.4 ft.) to a high bluff that interrupts the passage. The bluff is 2.7 m. (8.9 ft.) high and almost reaches the tube ceiling. On the west side of the bluff three concentrations of human bones were observed. Two of these burials were visible in the cracks of the ledge on the south side of the tube. Crab claws were also present.

Behind the bluff the tube extends roughly 43 m. (142 ft) to the east until terminating. Four lateral tubes branch from the main tube beyond the bluff. The lateral tube closest to the bluff extends roughly 20.0 m. (65.6 ft.) to the south. No midden or artifacts were observed in this tube. Two lateral tubes branch to the north and south of the main tube approximately 20 m. (66 ft.) east of the bluff. Crab pinchers were observed in both side tubes. About 45 m. east of the bluff, the main tube narrows into two parallel passages (formed by a central lava island) that converge again 15 m. (49 ft.) to the east. An *ahu* is located at this point and the ceiling height constricts the passage of the main tube at 1.0 m. (.3 ft.) high. The tube continues approximately 25 m. (82 ft.) east until terminating.

A total of 24 indigenous artifacts were recovered from site 17225 Feature A. Twenty two of these artifacts were recovered from the ground surface of the feature; one of which was on the surface of Test Unit 7. These surface artifacts include: basalt adzes (Accs. 55-57, 69); a bone fish hook shaft and preform (Accs. 58, 59); a shell fish hook preform (Acc. 60); a bone ornament (Acc.61); a coral abrader (Acc. 61); cut bones (Accs. 74, 78); a coral sinker (Acc. 63); a shell scraper (Acc.64); pieces of worked wood, including a possible *pahe'e* and a *tapa* beater (Accs. 65, 66, 75); coral files (Accs. 67, 70, 73); a basalt saw and manuport (Accs. 71, 72); and some twined fiber (Acc. 68).

Feature A lava tube modifications are considered to be in good condition.

Feature B is a terrace located 12.0 m. (39.4 ft.) southwest of the entrance to Feature A. The terrace measures 5.0 m. (16.4 ft.) NE/SW by 4.0 m. (13.1 ft.) NW/SE, to a maximum faced height of 0.5 m. (1.6 ft.) on the south side. The surface is paved with cobbles and pebbles. The north side abuts the surrounding outcrop.

No midden or artifacts were observed. Feature B is in fair condition and excavation potential is poor.

Feature C is a platform located 17.0 m. (55.3 ft.) southeast of the entrance to Feature A. It measures 3.0 m. (9.8 ft.) NE/SE by 2.0 m. (6.6 ft.) NW/SE. A maximum faced height of 0.5 m. (1.6 ft.) is measured on the north side. The surface is paved with small cobbles and pebbles.

No midden or artifacts were observed. Feature C is in poor condition and excavation potential is poor.

Feature D is a terrace located 3.0 m. (9.8 ft.) west of the entrance to Feature A. The terrace measures 3.0 m. (9.8 ft.) N/S by 2.5 m. (8.2 ft.) E/W and 0.5 m. (1.6 ft.) high. The surface is paved with cobbles and pebbles. No facing was observed. The west and south sides are flush with the surrounding outcrop.

No midden or artifacts were observed. Feature D is in poor condition and excavation potential is poor.

CSH Site #: 88

State Site #:	50-10-47-17228
Site Type:	Complex
Age:	Prehistoric
Function:	Agriculture
Features (#):	4
Dimension:	460.0 m.^{2} (4,968.0 ft.^{2})
Elevation:	600 ft. a.m.s.l.

Description: Site 17228 (Figure 67) consists of a complex that includes a large terrace (Feature A), and three smaller terraces (Features B through D). The site is located in a gully of older 'a'ā flow deposits. Soil is built-up behind the terraces. Vegetation includes *kukui*, grass, and vines.

The complex is interpreted as an agricultural site because the terrace features appear to have been constructed to retain soil as planting areas. The location of this site, within a moist gully, also supports an agricultural functional interpretation. This site is the only upland agricultural site in the project area, probably because it is located in one of only a few small *kipuka* (comprising older 'a'ā flow deposits) that could probably support limited agriculture in the project area. The surrounding upland terrain in the project area consists of uneroded lava flow.

Feature A terrace is constructed along the western edge of the gully. The terrace is long and linear and measures 29.3 m. (96.1 ft.) N/S by 2.5 m. (8.2 ft.) E/W, with a maximum height of 1.5 m. (4.9 ft.). The terrace is constructed of small to medium boulders. It stands four courses high. The east wall is well-faced; the west wall is flush with the adjacent outcrop. A step-like feature lies approximately 12.0 m. (39.4 ft.) south of the north side of the terrace. It may have served as an entrance to a planting area or it could be the result of natural collapse.

Features B and C are two terraces that modify the eastern side of the gully. The eastern side of the gully is steeper and somewhat more eroded than the west side. Each terrace retains a large level soil area probably used for planting. Feature B terrace is located 9.0 m. (29.5 ft.) east of Feature A terrace. It measures 4.3 m. (14.1 ft.) N/S by 0.6 m. (1.97 ft.) E/W. It stands four to six courses high and is constructed of large cobbles. Feature C terrace is located 10.5 m. (34.4 ft.) east of Feature A terrace. It measures 2.3 m. (7.5 ft.) N/S by 1.0 m. (3.3 ft.) E/W. It also is constructed of large cobbles and stands four to six courses high. All visible sides are faced.

Feature D is an L-shaped terrace located between Feature A to the west and Features B and C to the east. The terrace measures 5.3 m. (17.4 ft.) N/S by 3.0 m. (9.8 ft.) E/W with a maximum height of 1.0 m. (3.3 ft.). It is constructed of large cobbles and small boulders. The terrace sides are well-faced and stand five courses high. A large area of level soil lies northeast of the terrace.

Modern trash was observed at the southwest side of the site. No indigenous midden or artifacts were observed.

Site 17228 is in good condition and offers good excavation potential.

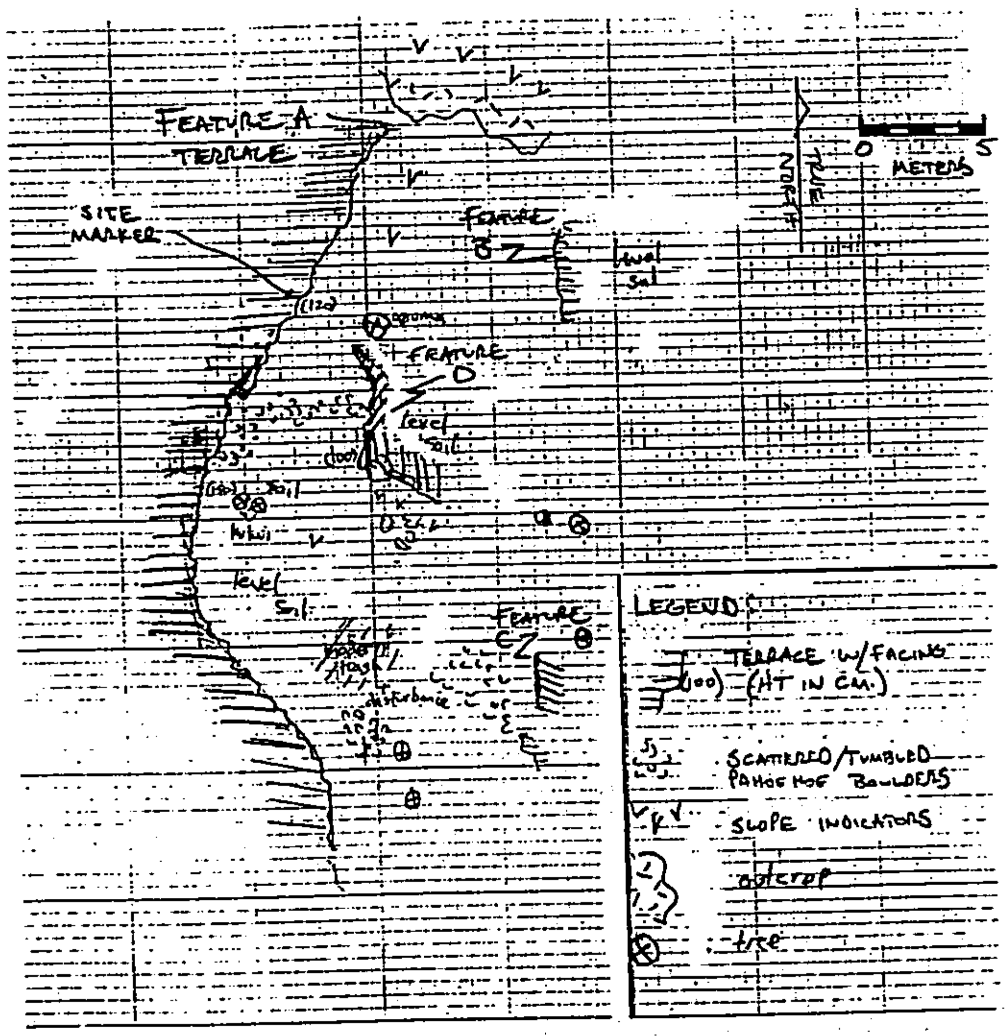

Figure 67 Site 50-10-47-17228 Complex, Feature A through D; Plan View

State Site #:	50-10-47-17229
Site Type:	Lava tube
Age:	Prehistoric
Function:	Burial
Features (#):	1
Dimension:	442.8 m.^{2} (4,782.2 ft.^{2})
Elevation:	445 ft. a.m.s.l.

Description: Site 17229 (Figure 68) is an east-west trending lava tube located in gently sloping, undulating 'a'ā and pahoehoe lava terrain (an 'a'ā flow encroached upon an older pahoehoe flow). The vegetation surrounding the site consists of *koa haole*, grass and ferns.

Site 17229 is a lava tube that appears to have been used primarily for the interment of at least one human burial, and possibly as a temporary habitation shelter in the light zone of the tube's entrance. Crab claws were also observed within the lava tube and were probably a ceremonial item affiliated with the burial.

A small entrance provides access into the tube. The lava tube extends 135.0 m. (442.8 ft.) to the west of the entrance. The tube has a width of 3.0 m. (9.8 ft.) on average and a maximum ceiling height of 1.9 m. (6.2 ft.). *Opihi* was observed within 2.0 m. (6.6 ft.) of the tube entrance, suggesting that the light zone may have been used as a temporary shelter.

At 30.0 m. (98.4 ft.) west of the entrance, a small concentration of crab claw was observed. A small amount of charcoal was also observed in the same area.

Continuing west, at 46.0 m. (150.9 ft.) from the entrance, a human burial was observed. The skeletal remains were poorly preserved. A portion of the cranium was positively identified, along with other bones. Charcoal and wood fragments were found in association with the burial. Crab claws were observed approximately 2.0 m. (6.6 ft.) beyond the burial.

At 115.0 m. (377.2 ft.) west of the entrance, the tube constricts to 1.0 m. (3.3 ft.) wide. The tube continues past the constriction for 9.0 m. (29.5 ft.), widens to 5.0 m. (16.4 ft.) N/S, and terminates. A fairly heavy concentration of crab claws was observed, but no burials were present at the rear of the tube.

Site 17229 is in fair condition.

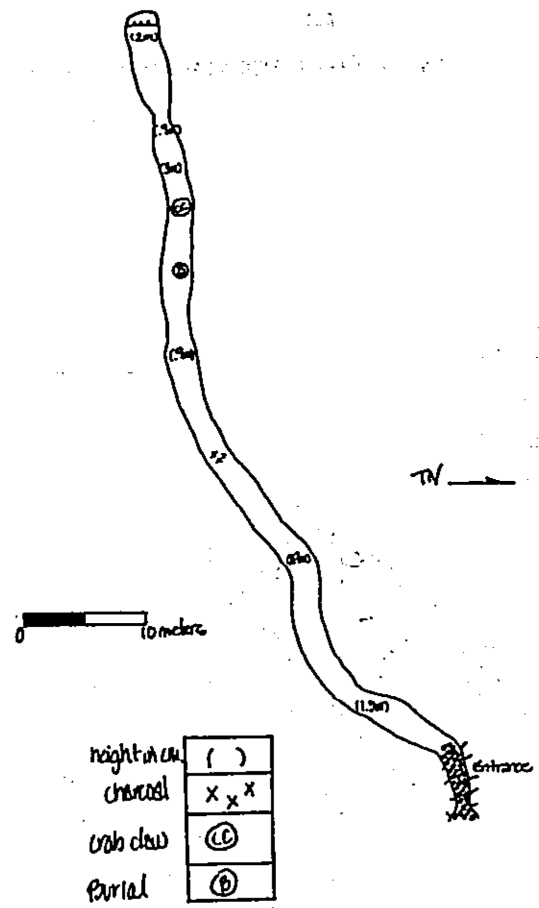

Figure 68 Site 50-10-47-17229 Lava Tube; Plan View

State Site #:	50-10-47-17234	**CSH Site #: 85**
Site Type:	Modified outcrop	
Age:	Prehistoric	
Function:	Temporary habitation	
Features (#):	1	
Dimension:	29.6 m.² (319.7 ft.²)	
Elevation:	638-649 ft. a.m.s.l.	

Description: Site 17234 (Figure 69) is a modified outcrop located on gently sloping pahoehoe lava terrain. Vegetation includes *koa haole*, Christmas-berry, lantana, morning glory, and grass. The site is interpreted as a temporary habitation site because of its minor amount of construction.

The modified pahoehoe outcrop resembles a terrace or platform but is less formally constructed. The modification is roughly defined by large boulder alignments. It measures 6.5 m. (21.3 ft.) NW/SE by 5.0 m. (16.4 ft.) NE/SW and 0.5 m. (1.6 ft.) high. Some of the material used is tabular pahoehoe boulders which may have been placed on edge but not necessarily upright. The surface is roughly paved (or roughly levelled off) and a depression is present in the southwest corner.

No midden or artifacts were observed. The site is in poor to remnant condition with poor excavation potential.

State Site #:	50-10-47-17235	**CSH Site #: 64**
Site Type:	Complex	
Age:	Prehistoric	
Function:	Recurrent habitation; burial	
Features (#):	2	
Dimension:	2,520.0 m.² (27,216.0 ft.²)	
Elevation:	255-295 ft. a.m.s.l.	

Description: Site 17235 (Figure 70) consists of two sections of a lava tube located on a mixture of 'a'ā and pahoehoe which is gently sloping *makai*. The area has scattered pockets of soil which supports grasses and ferns. The lava tube sections include an extensive lava tube system (Feature A) and an inaccessible lava tube (Feature B).

Feature A lava tube was likely used as a recurrent habitation site - as opposed to a temporary habitation - because of the relative substantial architecture of structures in the tube. A human burial was identified in Feature A tube near the light zone. This burial was probably placed within the lava tube after it had been abandoned as a shelter. Because Feature B lava tube was inaccessible, its function remains undetermined.

Feature A is lava tube accessed through a large sink. The sink is approximately 4.0 m. (13.1 ft.) E/W by 10.0 m. (33 ft.) N/S. The sink is approximately 10.0 m. (32.8 ft.) deep. The lava tube extends to the northeast and southwest of the tube entrance. The entrance is a 4.0 m. (13.1 ft.) drop from the floor of the sink to the floor of the tube. Immediately upon entering the tube there is a paved terrace which measures 5.0 m. (16.4 ft.) E/W by 8.0 m. (26.2 ft.) N/S.

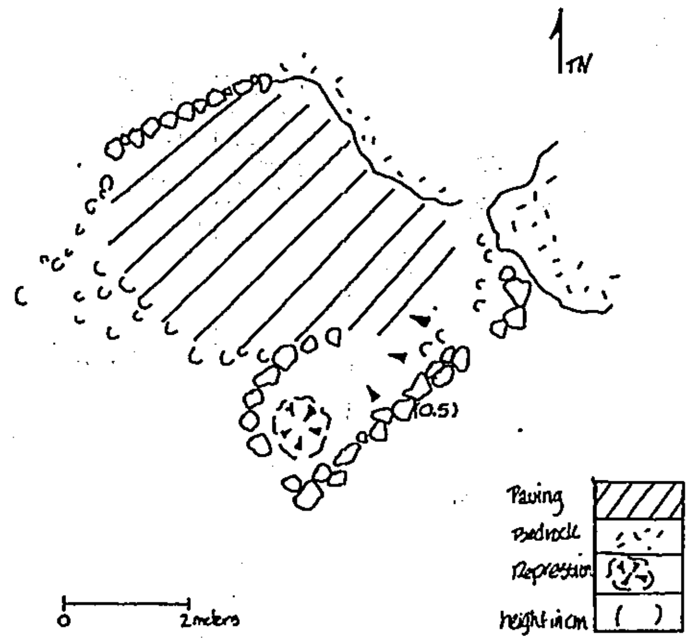

Figure 69 Site 50-10-47-17234 Modified Outcrop; Plan View

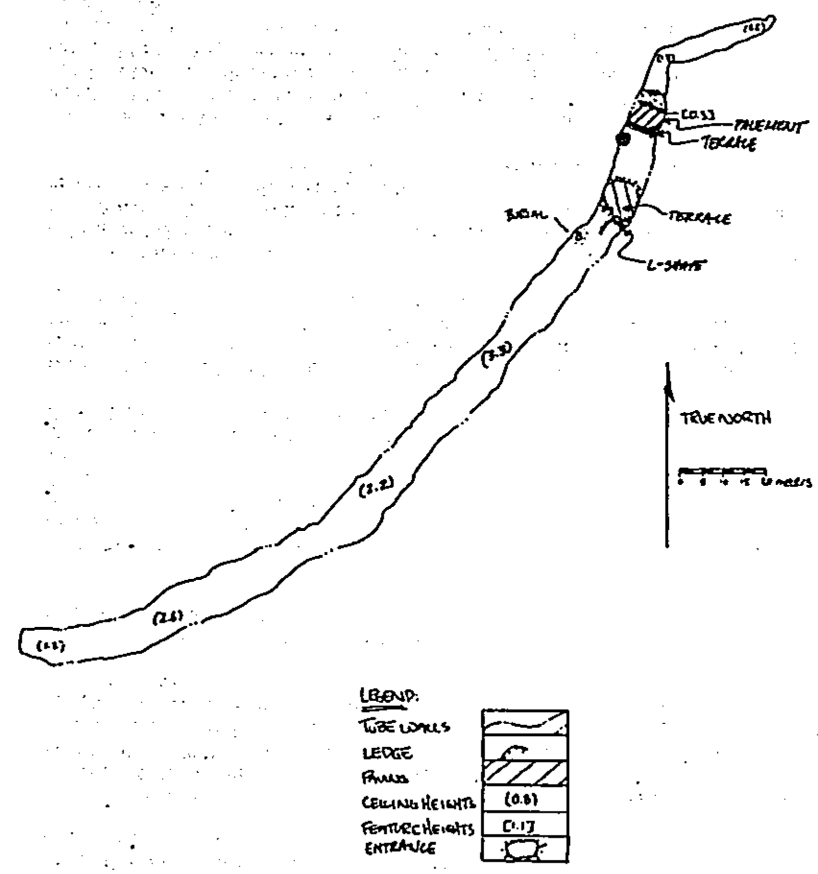

Figure 70 Site 50-10-47-17235, Feature A Lava Tube; Plan View

The northeast portion of the lava tube extends for 60.0 m. (196.9 ft.) NE with a maximum width of 9.5 m. (31.2 ft.) and a maximum ceiling height of 2.5 m. (8.2 ft.). At 13.0 m. (42.7 ft.) from the entrance a terrace is present. It extends across the width of the chamber and is constructed of large cobbles (including one water rounded stone) and reaches a maximum height of 0.3 m. (0.98 ft.). A pavement extends 5.0 m. (16.4 ft.) behind or northeast of the terrace. A dog or goat skeleton was observed 34.0 m. (111.5 ft.) from the entrance.

The southwest portion of the lava tube extends for 192.0 m. (629.9 ft.) and is up to 10.0 m. (32.8 ft.) wide with a maximum ceiling height of 3.3 m. (6.6 ft.). An L-shaped terrace is present at 2.0 m. (6.6 ft.) from the entrance. Approximately 6.0 m. (19.7 ft.) from the entrance, a human burial was identified located against the west wall of the tube. Crab claws and charcoal were observed lightly scattered on the floor for the entire length of the lava tube.

Feature B consists of a lava tube with two inaccessible vertical entrances which were recorded from surface observations only. The western-most entrance measures approximately 1.0 m. by 1.0 m. (3.3 ft. by 3.3 ft.) and has a drop of approximately 7.0 m. (23.0 ft.). The eastern entrance is located 7.0 m. (23.0 ft.) northeast. From the surface, mammal bones, probably goat, could be seen on the lava tube floor. An *opihi* shell was also observed resting at the bottom of the entrance. No modifications were observed within the entrances.

No other midden or artifacts were observed associated with Feature B.

V. SURVEY RESULTS

During the inventory survey, 165 structural and nonstructural (lava tubes and blisters) features were identified within the project area. These features were subsequently organized into 70 distinct sites or complexes (*i.e.*, groupings of features). Feature associations were based on proximity, similarity in construction technique and state of preservation, functional interrelationships, and inclusion within a larger enclosure wall.

The survey was designed for 100% coverage of the project area. It is our belief that all sites in the project area have been recorded and are included in this report.

A. Formal Feature and Site Types

Formal feature and site type designations are descriptive - based on physical characteristics - and commonly refer to structural elements of a site. Whereas some sites consist of single features, other sites are composites of several different feature types. Examination of these single feature sites and the individual components of complexes revealed seventeen (17) distinct formal feature and site types. These type categories are defined below and individual feature types are listed in Tables 3 and 4, below.

Ahu: A cairn of stacked or piled stones.

Alignment: A linear, curvilinear, circular, or rectangular formation comprised of single course of boulders.

Enclosure: A wide range of walled structures which enclose or partially enclose an area. Enclosures are further categorized by their configurations which are referred to as: rectangular, circular, irregularly shaped, C-shaped, U-shaped, L-shaped enclosures, and enclosing walls (see Table 4).

***Holua* Slide:**
A constructed stone ramp used as a sled course for recreation.

Lava tube/blister:
Modified or utilized subterranean lava formations characteristically found in pahoehoe flows.

Modified depression/outcrop/sink:
Natural outcrop that has been altered by the placement or removal of stones. This structure usually lacks any type of formal construction techniques such as vertical facing and surface paving.

Mound: Linear, circular or amorphous stone pile which typically lack a vertical face and level surface.

Lava excavation:
Rough basins in the pahoehoe and a'a lava that has been excavated for use as agricultural pits. Water rounded boulder hammerstones are sometimes found in association with these features.

Pavement: A stone-filled floor, or a surface that has been cleared and leveled by removing and redistributing the natural stone.

Petroglyph: A figure or inscription pecked or carved into a rock surface.

Platform: A raised stone construction with three or more vertical faces; it also refers to circular structures with vertical facing.

Rockshelter:
An outcrop overhang that exhibits human modification or use. These site/feature types are usually formed by subterranean lava tubes or blisters.

Complex: A formal site type category consisting of an associated group of features (2+). A complex can include a full range of feature types.

Feature remnant:
A destroyed or partially destroyed structure whose remnants exhibit qualities of other recognizable formal feature or site types.

Terrace: A raised stone construction partially built against or level to a ground or outcrop surface. These structures commonly have one or two vertical faces.

Trail: A linear worn, cleared, and/or paved surface: also includes alignments of stepping stones.

Wall/wall segment:
A linear construction of stacked or piled boulders and cobbles, sometimes exhibiting vertical facing on one or both sides. They vary greatly in their size, length, and formality of construction.

Table 3 - Occurrences of Formal Feature Types

Formal Site Type	Number of Features	% of Total Features
Ahu	5	3
Alignment	2	1.2
Enclosure	26	15.7
Cart Road	1	0.6
Holua slide	1	0.6
Feature remnant	1	0.6
Lava tube/blister	11/19	18.1
Modified depression/outcrop/sink	4	2.4
*Mound	1	0.6
*Lava excavation	1	0.6
Pavement	13	7.8
Petroglyph	2	1.2
Platform	36	21.8
Rockshelter	2	1.2
Terrace	24	14.5
Trail	8	4.8
Wall/wall segment	8	4.8

** Refers to clustered occurrence and does not reflect the total number present in the project area.*

Table 4 - Occurrences of Specific Enclosure Types

Enclosure Type	Number of Occurrences	% of Total Features
C-shaped	7	26.9
Circular	1	3.8
Irregular	4	15.3
L-shaped	1	3.8
Rectangular	9	34.6
U-shaped	1	3.8
Remnant	3	11.5

In those instances where groups of structural and/or nonstructural features were observed to be clearly interrelated, such groups are designated as sites and are in the formal site type category of complex.

B. Functional Categories and Land Use

Functional interpretation of a site or feature is determined by criteria such as: site construction and complexity; locational context (association with other sites and/or geological determinants); analysis of cultural remains (surface and subsurface); and correlations with other archaeological sites in Hawai'i.

Ten (10) primary functional categories were identified among the sites within the present project area: agriculture, habitation, human burial, marker, mining, recreation, ritual (*heiau*), special (petroglyph), and transportation. An indeterminate function was assigned to remnant features or sites. Table 5 tallies the occurrences of these functional categories identified among the individual features and sites.

Table 5 - Functional Classification of Recorded Features and Sites

Function	Number of Features	% of Total Features	Number of Sites	% of Total Sites
Agriculture	+5	2.4	2	2.8
Habitation	107	64.2	47	66.6
Confirmed Burial (Poss. Burial)	8 (21)	4.8 (13)	10 (6)	14.4 (10.1)
Heiau	2	1.2	1	1.4
Marker	7	4.2	3	4.3
Modern hearth	1	0.6	1	1.4
Quarry	1	0.6	1	1.4
Recreation	1	0.6	1	1.4
Special	2	1.2	2	2.9
Transportation	9	5.4	8	11.6
Indeterminate	1 *	1.2	1	1.4

**includes multiple-function sites*
+Refers to clustered occurrence and does not reflect the total number present in the project area.

Fifty-seven of the sites in the project area exhibit single functions and 12 sites exhibit multiple functions. The multiple-function sites include a lava tube (Site 17217) and 10 complexes or multiple-feature sites. Table 6 lists these 12 multiple function sites.

Table 6 - Sites with Multiple Functions

Site Number	Multiple Functions
50-10-47-17205	Possible Burial - Special (petroglyph)
50-10-47-17225	Permanent habitation - Burial
50-10-47-17233	Permanent habitation - Burial
50-10-47-1952	Permanent habitation - Possible burial
50-10-47-17216	Recurrent habitation - Transportation
50-10-47-17217	Recurrent habitation - Burial
50-10-47-17224	Recurrent habitation - Burial
50-10-47-17235	Recurrent habitation - Burial
50-10-47-17198	Recurrent habitation - Possible burial - Marker
50-10-47-1958	Recurrent habitation - Possible burial
50-10-47-17194	Recurrent habitation - Possible burial
50-10-47-17209	Transportation - Marker

Agriculture

Only two sites (Site 17172 and 17228) within the project area are interpreted as agricultural in function. These two sites include an isolated terrace complex (Site 17228) located at 600 ft. a.m.s.l. and an extensive complex of lava excavations (Site 17228) generally concentrated adjacent to the coast.

Gulch Modification

Site 17228 consists of a complex of terrace features which essentially retain the opposite slopes of a gulch formation within a limited expanse of an older a'a flow or *kipuka*. The site's isolation is probably explained by its location in one of only a few older lava surfaces and moist gulch environments that would have been conducive for methods of agriculture.

Lava Excavations

The excavations of Site 17172 occur in both pahoehoe and a'a flows, and are most densely concentrated between the coast (especially in proximity to habitation sites and trails) and roughly the 75 foot elevation contour. The excavations in pahoehoe lava are characterized by pits that have been formed by fracturing the pahoehoe surface. The pahoehoe rubble created by the fracturing was either completely or partially removed from the excavated pits, and some of the rubble was piled around the perimeter of the excavations -- seemingly to shelter the excavated pit. The initial fractures of the pahoehoe excavations were likely created with water-worn boulders, as several such manuports were observed in association pahoehoe excavations. The excavations in a'a lava are less well-defined because the excavated rubble typically blends in with the surrounding a'a lava surface.

Much discussion has arisen regarding the functional interpretations of lava excavations, since it is a common archaeological feature found among predominant lava landscapes of the Island of Hawai'i. Some of the larger expanses of lava excavations have been recorded in the Ka'u District (*e.g.*, McDermott *et. al.* 1993), and the Kekaha region of North Kona (*e.g.*, Robins *et. al.* 1993; Pantaleo *et. al.* 1992; Carter 1985; Bevacqua and Moore 1972, among others) and South Kohala (Rosendahl 1972; and Kirch 1979). The analysis presented in these particular reports identify agriculture and mining as being the primary functions assigned to the excavations.

Lava excavations likely associated with quarrying activities have been recorded specifically in South Kohala. Here the features are interpreted as scoria quarry areas (*e.g.*, Rosendahl 1972 and Kirch 1979) because of the presence of grinding surfaces adjacent to the quarried pits and the abundance of scoria raw material in the immediate area of the pits. The Bevacqua and Moore Report (1972:18) suggest that pahoehoe excavations in Waikoloa (S. Kohala) were, in addition to scoria mining, the result of mining for basalt material for the construction of nearby shelters and the Kiholo-Puako trail. Likewise, the Robins *et. al.* Report (1992) proposes that pahoehoe excavations in the *makai*, "barren" region of Honokōhau Ahupua'a (N. Kona) were the result of extracting stone material for the construction of the nearby Mamalahoa Trail or subsequent jeep road.

Most of the lava excavations in other locations of Hawai'i, including North Kona (Carter 1985; Pantaleo 1992; McDermott *et. al.* 1993; and Robins *et. al.* 1993) and Ka'ū (McDermott *et. al.* 1993) are classified as agricultural features. Numerous reputable historic and ethnographic accounts attest to their agricultural function. Henry J. Lyman, the son of a missionary couple who first arrived in Hilo in 1831, provides a vivid observation that sweet potatoes were planted in lava excavations:

> Wherever the lava could be pounded into scoria, a plantation of sweet potatoes was laboriously formed by digging among the stones and filling the holes with dried grass brought from the mountainside. Placed in the nests, the tuberous buds were covered with gravel, and there grew with astonishing luxuriance, yielding the largest and finest potatoes on the island (Lyman in Frierson 1991:167).

During the mid 1800's, Captain Charles Wilkes of the American Exploring Team commented on the agricultural use of lava excavations which he observed specifically in the Kona region:

> Cultivation is carried on in many places where it would be deemed almost impracticable in any other country...The natives, during the rainy season, also plant, in excavations among the lava rocks, sweet potatoes, melons, and pine-apples, all of which produce a crop. (Wilkes 1845:91)

E.S Craighill Handy and Elizabeth Green Handy (1972:129) also contend that the Hawai'ian farmers often cultivated sweet potatoes in less favorable environments, such as in

"small pockets of semi-disintegrated lava" where potatoes were grown by "fertilizing with rubbish and by heaping up fine gravel and stones around the vine" (*ibid.*). Contrary to Lyman's account, this type of growing method produced an inferior quality of sweet potatoes (*ibid.*).

Archaeologically, the agricultural excavations have been distinguished from quarrying excavations because of the absence of associated grinding areas and observable raw material (*e.g.*, Pantaleo 1992:113). However, a few of these features may lack evidence of quarrying, but the nature of the excavation - such as, if it intrudes into a accretionary boulder (*ibid.*) or into vertical faces of outcrop - suggest a quarrying function. In Honokōhau Ahupua'a, the excavations are apparently affiliated with a prehistoric, inland settlement situated along the *makai* fringe of the upland agricultural fields of the *ahupua'a*. The excavations are considered to have been an intensive agriculture component of the upland, Honokōhau field system.

The lava excavations in Keopuka (Site 17172) are interpreted primarily as agricultural pits as they lack grinding areas and associated raw materials. Because these features are more concentrated in proximity to the coast and permanent habitation sites, it is likely that the excavations were the principal garden areas that provided sweet potatoes and other subsidiary crops to the coastal residents.

Because of the absence of soil along the coast and immediate inland region of Keopuka (up to the *mauka* boundary of the project area), it is feasible that most of the cultivation at these lower elevations of Keopuka occurred in the lava excavations of Site 17172. However, we would expect that the main surplus of agricultural goods in Keopuka were cultivated in more upland localities where rainfall was consistent and the landscape had a more expansive soil base. This is supported by the identification of intensive agriculture (adapted to an a'a lava landscape) features in Keopuka *mauka* of the project area (Rosendahl and Jensen 1989).

Habitation

Of the total 70 sites in the project area, 46 (67.1%) sites are interpreted as habitation sites; 35 of these sites are classified solely as habitation in function and 11 are multiple function sites that contain habitation components. Three types of habitation were identified among the sites, including: temporary, recurrent, and permanent habitation. These habitation types can be correlated with Jeffrey Todd Clark's habitation model (Clark 1987) with one major exception: the present study does not differentiate between Clark's "extended domestic units" and "permanent domestic units." Instead, all permanent habitation sites in the project area correlate with Clark's "permanent domestic unit" classification.

These three habitation modes are represented somewhat proportionately in the project area: 37% of the sites are recurrent, 33% are permanent and 30% are interpreted as temporary in use (Table 7)

Table 7 - Types of Habitation Sites

Habitation Type	Number of Sites	Percentage of Total
Temporary	15	30
Recurrent	16	37
Permanent	16	33

Temporary Habitation

In general, the term temporary habitation has been used for sites which are small (most between 5 and 8 m.2) and minimally modified or appear to be constructed with little effort and used merely as a wind break or protective overhang (Table 8). In the case of lava tubes, temporary usage is defined by minimal structural modification - if any - of the lava tube and lack of associated habitation structures on the surface (agricultural pits [Site 17172] commonly exist). The amount of midden and artifact types is typically minimal, but in caves, midden may be more abundant (but less than recurrent habitation cultural deposits) because of their often repeated use as temporary shelters.

The 15 temporary habitation sites consist mostly of lava tubes or blister shelters (71%) and the remaining sites were surface structures. The surface structures included a platform, a C-shaped and rectangular enclosure, and a modified outcrop. Four of the lava tubes and blisters exhibit minor modifications, such as shelter walls, and midden or artifacts are present in all of the tubes and blisters. The surface sites comprise single features which are generally characterized as rough constructions without vertical facing (except Site 1951) or that comprise uneven surface areas. The floor areas of three of the surface sites range between 5.5 and 8.4, and one site, a less-defined modified outcrop, measures 32.5 in floor area.

Table 8 - Characteristics of Temporary Habitation Sites

Site	CSH Site #	Feature Type	Floor Size (m2)	Nature of Construction	Associations with other Sites	Cultural Material Present	Location
1951	12	Platform	8.4	facing	temporary hab. sites	hammer-stone	coast
1953	19	Lava blister	N/A	shelter wall	temp. hab. sites; lava excavations	midden; glass	coast
17175	4	C-shaped enclosure	5.5	rough wall	lava excavations	none	near coast
17178	10	Lava blister	N/A	minor modifications	temporary hab. sites	manuport; midden	coast
17181	21	Lava blister	N/A	minor modifications	temporary hab. sites	midden; bottle	near coast
17182	15	Rectangular enclosure	7.3	rough wall	isolated perm. hab. site	none	coast

Table 8 - (Continued)

Site	CSH Site #	Feature Type	Floor Size (m2)	Nature of Construction	Associations with other Sites	Cultural Material Present	Location
17186	28	Lava blister	N/A	minor modifications	temp. hab; possibly a trail	midden	near coast
17188	30	Lava blister	N/A	none	temporary hab. site; trail	midden; hist. artifacts	near coast and road
17191	33	Lava tube	N/A	minor modifications	burial site	midden; manuports	near coast
17211	60	Lava tube	N/A	none	temporary hab. site; lava excavations	manuport	inland
17212	61	Lava tube	N/A	none	temporary hab. site; lava excavations	none	inland
17213	63	Lava tube	N/A	minor modifications	isolated	none	inland
17218	72	Lava tube	N/A	none	lava excavations	midden; lithic flakes; manuports	inland
17220	74	lava tube	N/A	minor modifications	holua slide; permanent hab.	midden; coral	near coast
17234	85	Modified outcrop	32.5	rough surface	burial caves; permanent hab. site	none	inland

N/A Not Applicable because they are non-constructed features

The temporary habitation sites are distributed in areas where permanent habitation is mostly absent (Figure 71): (1) along the north half of the coast, (2); immediately inland of the northern and central and southern portion of the coast; and (3) in upland lava tubes surrounded by the barren landscape of the a'a flow. These locations suggest that the temporary habitation sites were utilized in association with fishing along the more remote regions of the coast, tending to the agricultural gardens of Site 17172 complex (lava excavations), and while traveling between coastal localities, as well as between coastal and *maukā* localities of Keopuka.

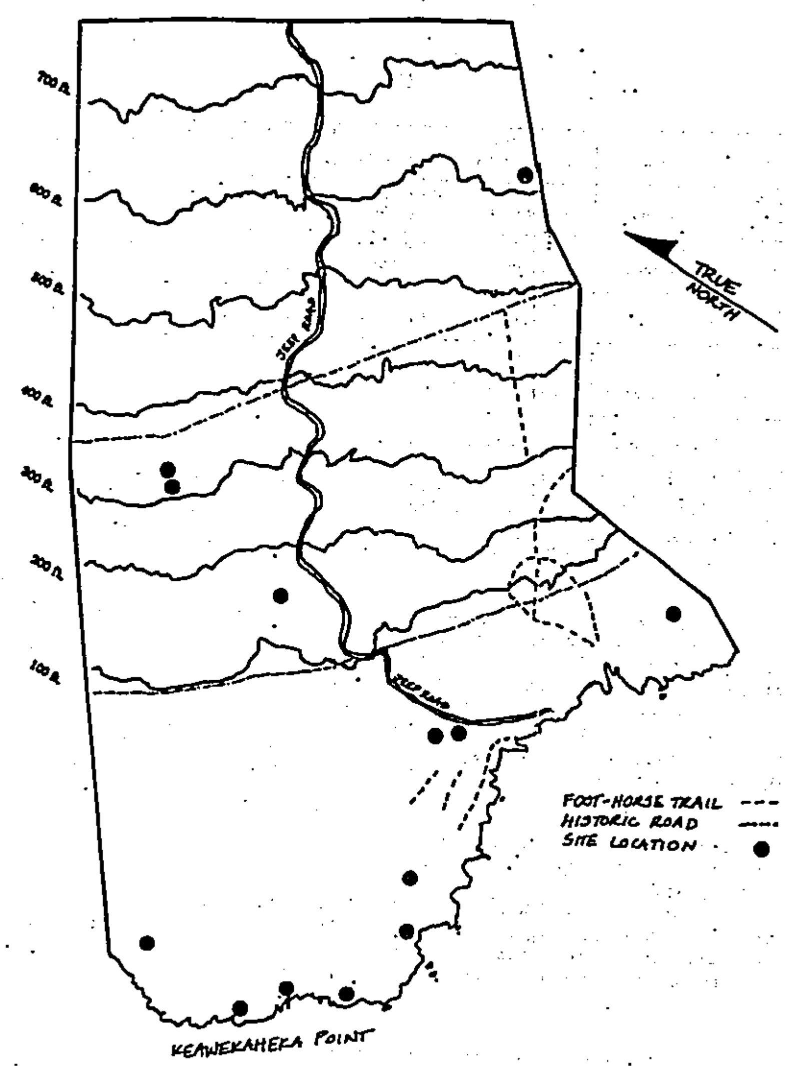

Figure 71 Distribution of Temporary Habitation Sites

The temporary habitation sites of Keopuka appear to correlate well with Jeffrey Clark's model of "Single-Use Shelters" (Clark 1986:197):

Shape: C, U, Box C, L, linear enclosures, irregular, caves (lava tubes) (see Table 11).

Construction: Generally crude, usually stacked rocks, or unmodified to slightly modified caves.

Size: Small, generally less than 10 m.^{2} and most from 3 to 7 m.^{2}.

Associations: Variable but no clear associations other than, perhaps, other shelters (and agricultural features).

Geographical Context: Can be found anywhere but generally along trails (and agricultural features) not in areas with heavy occupation.

Cultural Deposit: Very little or, more likely, no artifacts and midden, and charcoal and ash, if present, in single fireplace.

Recurrent Habitation

A recurrent habitation feature or site is considered to be more substantially constructed than a temporary habitation feature, and commonly exhibits formal construction elements similar to permanent habitation sites, however, on a smaller scale (*i.e.*, vertical facing, bifacial walls, and pavements). There is considerable variation in size, which in itself is not a diagnostic characteristic Lava tubes which exhibit structural modifications or other evidences of habitation, which are not associated with permanent habitation features on the surface, are also considered to be recurrent habitation sites

Fifteen sites in the project area are interpreted as recurrent habitation sites (Table 9), including 12 complexes of multiple features and three single feature sites. Nine of the sites are classified primarily as recurrent habitation and seven sites contain complexes of features with multiple functions. The associated feature functions include burial caves, possible burial monuments, trails, and a marker (*ahu*).

Of the 25 recurrent habitation features identified among the sites, nine (36%) are lava tubes and blisters (including a modified sink and two rockshelters), and the remaining 16 features (64%) are surface structures. The surface structures consist of five C-shaped enclosures and one U-shaped enclosure; four irregular-shaped enclosures and a rectangular enclosure; three terraces; two platforms; and one pavement and a modified outcrop.

Table 9 - Characteristics of Recurrent Habitation Sites or Features

Site Number	CSH Site/Feature	Formal Feature/Site Type	Floor Size (m²)	Structural Elements	Associations w/ other Features/Sites	Cultural Material Observed	Location
1950	11/A	Rockshelter	N/A	rough wall	temporary hab. sites	midden	coast
1950	11/B	C-shaped enclosures	15.4	core-fill wall	temporary hab. sites	midden	coast
1950	11/C	C-shaped enclosure	14	rough wall	temporary hab. sites	none	coast
1955	20/A	Rectangular enclosure	20.2	bifaced wall, entry	temp./recur. hab. sites	coral	coast
1955	20/B	Lava blister	N/A	walls	temp./recur. hab. sites	midden; artifacts	coast
1955	20/C	Lava blister	N/A	pavement	temp./recur. hab. sites	midden; fishing poles	coast
1956	22	Platform	22	pavement	temp./recur. hab. sites	midden; coral	coast
1957	23	U-shaped enclosure	10.5	bifaced wall	temp./recur. hab. sites	midden	coast
1958	24/A	Irregular enclosure	16	rough wall	poss. burial feature; trail sites	modern	near coast
1958	24/C	C-shaped enclosures	52	bifaced walls	poss. burial feature	midden	near coast
1959	29	C-shaped enc./pavement	88	pavement	trail	midden; artifact	coast
1961	31/A	Irregular enclosure	66	rough walls	rec. and perm. hab. sites	none	coast
17194	36/A	Platform	14.8	facing	poss. burial feature; lava excavations	none	near coast
17194	36/B	Terrace	5	pavement	poss. burial feature; lava excavations	none	near coast
17194	36/C	Modified outcrop	10.5	facing	poss. burial feature; lava excavations	coral	near coast
17194	36/E	Rockshelter	N/A	C-shape; pavement	poss. burial feature; lava excavations	midden; bottle; tin	near coast

Table 9 - (Continued)

Site Number	CSH Site/Feature	Formal Feature/Site Type	Floor Size (m²)	Structural Elements	Associations w/ other Features/Sites	Cultural Material Observed	Location
1950	11/A	Rockshelter	N/A	rough wall	temporary hab. sites	midden	coast
17198	40B	Pavement	60	pavement	poss. burial feature; trail	midden; volc. glass	near coast
17199	41/A	Terrace	40	pavement	perm. hab. and burial sites	midden	near coast
17199	41/B	Lava tube	N/A	minor modifications	perm. hab. and burial sites	midden	near coast
17216	67/A	Irregular enclosure	94	rough walls	trail feature - isolated site	none	inland
17217	68	Lava tube	N/A	terrace	burials in tube; trail site	midden	inland
17219	73/A	Lava tube	N/A	bifaced wall; pavement	perm. hab. sites	midden; artifacts	coast
17219	73/B	Terrace	6.7	facing; pavement	perm. hab. sites	none	coast
17224	80/A	Modified sink-overhang	59.5	terraces	burial feature	gourd	inland
17235	A	Lava tube	N/A	terrace	burial in tube	none	inland

N/A = Not Applicable because they are non-constructed features

Four of the recurrent habitation sites (Sites 17216, 17217, 17224, and 17235) are located inland, above the 275 foot contour – among the relatively barren landscape of the a'a flow (Figure 72). Three of these sites (17217, 17224, and 17235) are associated with burials in lava tubes. In the case of Sites 17217 and 17235, being exclusively lava tubes, the burials were probably placed inside the tube after all habitation activities had ceased. Sites 17216 and 17217 are situated along two sections of a *mauka-makai* trail identified in Keopuka.

The remaining twelve sites are distributed between the northern portion of the Keopuka coast - among temporary habitation sites - and immediately inland of the cluster of permanent habitation sites in the southern portion of the Keopuka coast. Most of these coastal sites occur along trails and in close proximity to lava excavation features.

The distribution of the recurrent habitation sites and their spatial associations with trails, lava excavations, as well permanent habitation sites, suggests differing explanations for the occurrence of these more substantial and complex shelter-type sites in Keopuka: (1) frequent stays along the main trails to and from the coast and upland localities; (2) extended stays near the agricultural pit features of Site 17172 during times of harvest, or near

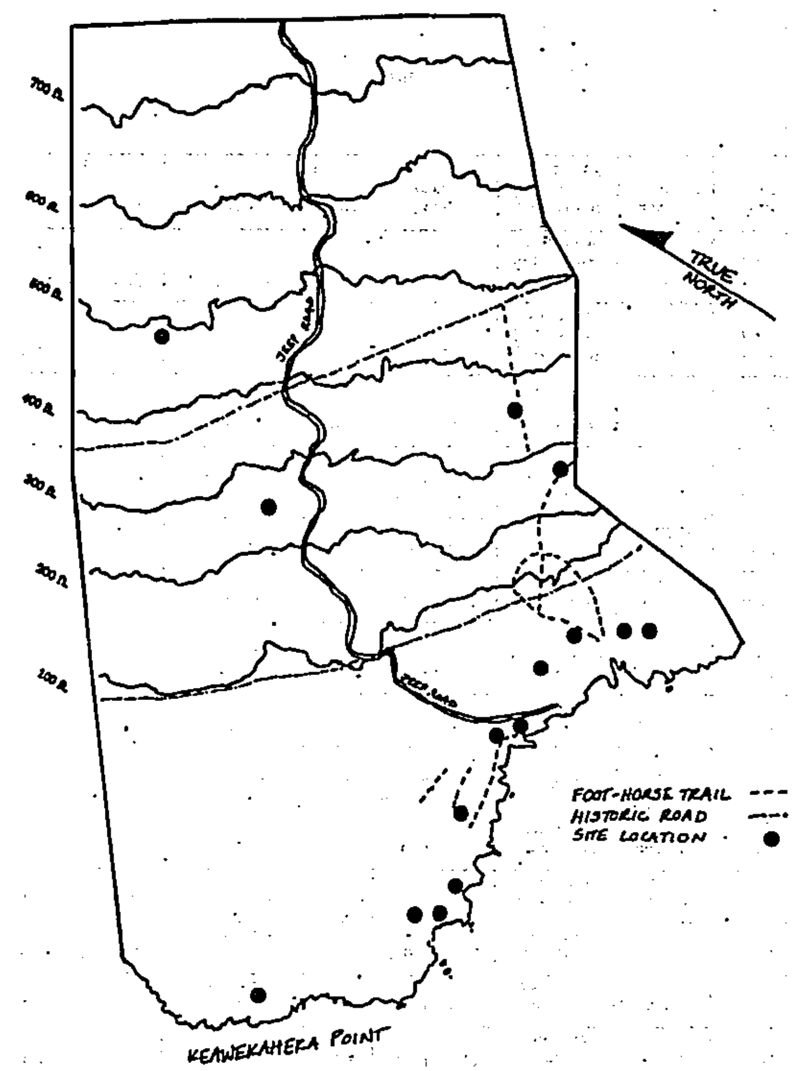

Figure 72 Distribution of Recurrent Habitation Sites

favorable fishing grounds during seasonal fish migrations; and (3) extended stays near permanent habitation sites by visiting relatives or friends.

The recurrent habitation sites of Keopuka appear to correlate well with Jeffrey Clark's model of "Recurrent-Use Shelters" (Clark 1986:198), with the exception that many of the Keopuka sites are associated with burial caves or possible burial monuments:

Shape: C, U, Box-C, Linear, enclosures, irregular, cave (lava tubes).

Construction: Similar to single-use shelters, although the larger and more frequently used features may be somewhat more formalized or modified - *e.g.*, perhaps distinguishable living areas.

Size: A good deal of variation but generally small; less than 30 m.^{2}, but most from 7 to 12 m.^{2}.

Associations: Usually found in association with agricultural features or specialized resource areas. Generally not associated with other structural features such as burial monuments.

Geographic Context: Predominantly in leeward areas, and most commonly in agricultural zones, along trails, and scattered along the coast.

Cultural Deposit: Midden and artifacts likely to be present but in small quantities and relatively limited in range. Clear cultural deposit, although evidence of sequential abandonment and reoccupation may not be obvious. Multiple short-use fireplaces at different horizontal and vertical locations and/or charcoal flecks and possibly ash scattered through deposit.

Permanent Habitation

In general, permanent habitation sites in Keopuka exhibit more substantial architectural elements and are usually considerably larger than the temporary habitation sites, and contain a greater abundance of internal components than exhibited in recurrent habitation sites.

Sixteen sites, including 67 individual features, are interpreted as permanent habitation in function (Table 10). Fourteen of the 16 sites are complexes of multiple features and two (Site 17206 pavement and 17222 enclosure) is a single feature site. Two of these habitation sites (Site 17225 and 17233) contain burial components in lava tubes and one site includes a possible burial monument.

The permanent habitation sites are distributed in three specific localities in the project area (Figure 73). The majority of the sites (66%) are located along the southern coast, two sites (Site 1948 and 1952) are located on Keawekaheka Point on the northern coast; and (3) three sites (Site 17225, 17232, and 17233) occur near upland lava tubes above the 525 foot contour.

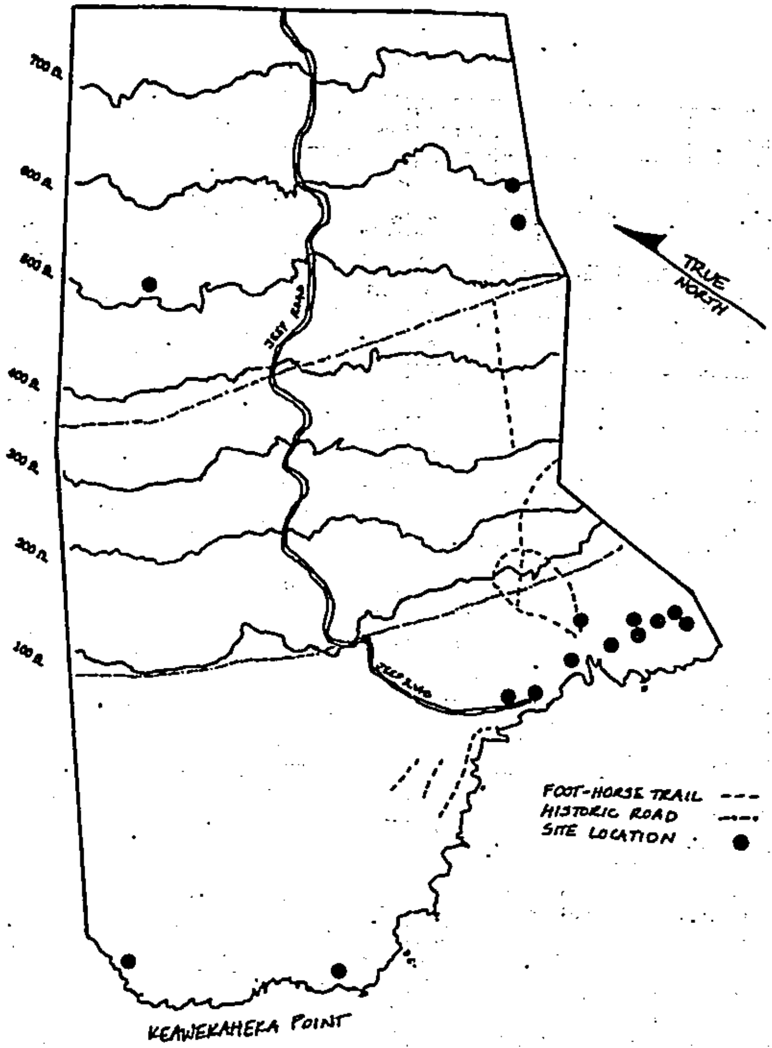

Figure 73 Distribution of Permanent Habitation Sites

The permanent habitation features associated with the 16 sites comprise platforms (24%), enclosures (22%), pavements (15%), terraces (15%), lava tubes and blisters (12%), complex or feature boundary walls (7.5%), a modified depression and a midden scatter. The floor areas of the permanent habitation features (excluding lava tubes, blisters and complex boundary walls) range between 6 m.² and 300 m.², with the majority of the floor areas (92%) measuring below 48 m.².

Table 10 - Characteristics of Permanent Habitation Sites or Complex Features

Site Number	Site/Feature	Formal Type/Site Type	Floor Area (m²)	Structural Elements	Locational Context/Associations	Cultural Material Observed
1948	A	Irregular enclosure	26	bifaced wall	coastal - perm. hab. and excav. features; heiau site	salt pan; midden
1948	B	Terrace	8	part of Fea. A	-	
1948	C	Platform	24	pavement	-	midden
1948	D	Platform	12.2	incorporates outcrop	-	midden
1948	E	Rectang. enclosure	30	bifaced wall; entry	-	midden
1948	F	Terrace	18	pavement; facing	-	midden
1952	B	Platform	22	pavement; facing	coastal - temp. hab. site; excav. features	none
1952	C	Pavement	13	pavement	-	none
1952	D	Lava blister	N/A	bifaced wall; auxiliary feature	-	none
1952	E	Enclosure remnant	27	remnant	-	midden
1952	F	Pavement	20	pavement	-	none
1952	G	Lava blister	N/A	auxiliary feature of complex	-	midden; lithics
17192	A	Terrace	24.7	pavement; facing	coastal - perm. hab. and rec. hab. sites	modern
17192	B	Platform	15.7	pavement; facing	-	midden; salt pan
17192	C	Rectang. enclosure	N/A	bifaced wall - complex boundary	-	midden
17192	D	Lava blister	N/A	minor modific. auxiliary feat.	-	midden
17193	A	Platform	160	pavement; facing	-	midden; bottles; hist artifacts
						lithic flake; modern

Table 10 - (Continued)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17193	B	Feature remnant	25	midden scatter	•	midden
17195	A	Rectang. enclosure	112	bifaced wall; pavement	coastal - recurrent hab. site	midden; bottles
17195	B	Pavement	30	pavement; auxiliary feature	•	midden bottles
17195	C	Modified depression	9	faced wall; auxiliary feature	•	bottles
17197	A	Platform	99	pavement; facing; hearth?; entry	coastal - perm and rec. hab. sites	midden; pestle; bottle
17197	B	Platform	31.5	pavement; facing	•	midden; modern
17197	C	Circular enclosure	138	bifaced wall; entry	•	midden
17197	D	Rectang. enclosures	38	bifaced wall; entry	•	midden; salt pan
17197	E	Platform	35	pavement; facing	•	midden; lithic flake
17197	F	Platform	33	pavement; facing	•	midden; hammerstone
17201	A	Platform	22	pavement; facing	coastal - holua slide; rec. and perm. hab. sites	none
17201	B	Lava blister	N/A	none	•	midden
17201	C	Wall	N/A	bifaced wall-complex boundary	•	none
17201	D	Wall segment	N/A	bifaced wall-boundary?	•	none
17201	E	Pavement	15	pavement	•	coral
17202	A	Rectang. enclosure	24	bifaced wall; pavement	coastal - trail and rec. hab. site	midden
17202	B	C-shaped enclosure	7.5	bifaced-auxiliary feature	•	midden
17202	C	Platform	48	pavement; depression	•	none
17202	D	Terrace	42	pavement; facing; ahu	•	none

Table 10 - (Continued)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17202	F	C-shaped enclosure	25	bifaced wall; pavement	•	modern
17202	H	Pavement	300	pavement	•	midden
17202	I	L-shaped enclosure	10.6	facing-auxiliary feature	•	midden
17203	A	Wall	N/A	bifaced-complex boundary wall	coastal - trail and rec. hab. site	midden
17203	B	Platform	60	pavement; facing; entry	•	midden; modern
17203	C	Enclosure remnant	120	bifaced-remnant	•	midden; glass
17203	D	Pavement	63	pavement	•	none
17203	E	Rectang. enclosure	40	bifaced wall-canoe shed?	•	none
17208	A	Platform	17.5	pavement; facing	coastal - rec. and perm. hab.; holua slide	coral
17208	B	Wall	N/A	bifaced wall-auxiliary	•	none
17208	C	Platform	28	pavement; facing	•	coral
17208	D	Platform	40	pavement; facing	•	coral
17208	E	Pavement	12	pavement	•	
17221	A	Pavement	132	pavement remnant	coastal - rec. and perm. hab.	none
17221	B	Enclosure remnant	35	upright alignment	•	midden
17221	C	Wall	N/A	bifaced-complex boundary?	•	none
17222	76	Rectang. enclosure	80	bifaced wall; entry	coastal - permanent hab. sites	midden
17225	A	Lava tube	N/A	entrance and interior modifications	inland - recurrent hab. site; burials present	midden; abraders; adzes; preforms
17225	B	Terrace	20	pavement; facing	•	none
17225	C	Platform	6	pavement; facing -auxiliary feature	•	none
17225	D	Terrace	7.5	rough construction -auxiliary feature	•	none

Table 10 - (Continued)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17232	A	Terrace	75	pavement; facing	inland - perm. hab. site; trail	none
17232	B	Lava tube	N/A	minor modifications	•	midden
17232	C	Lava tube	N/A	minor modifications	•	midden
17232	D	Terrace	48	pavement; facing	•	none
17232	E	Pavement	72	pavement	•	none
17232	F	Terrace	70	pavement	•	none
17233	A	Terrace	80	pavement; facing	inland - temp and perm. hab; trail	none
17233	B	Pavement	8	pavement-auxiliary feature	•	none
17233	C	Lava tube	N/A	minor modifications in tri-level tube	•	midden; lithics

N/A = Not Applicable because they are non-constructed features

Twelve (80%) of the permanent habitation sites are a group of separate or contiguous structures and four of the sites comprise single or primary house structures (Sites 17195, 17201, 17206, and 17222). The five permanent habitation sites located on Keawekaheka Point and inland are exclusively multiple-house residences. The remaining sites (66%), both multiple and single house residences, occur in a clustered setting along the southern coast of Keopuka.

The multiple-house permanent residences are characteristic of *kauhale* or multiple structured Hawaiian households described by E.S Craighill Handy and Mary Kawena Pukui in *The Polynesian Family System in Ka-'u Hawai'i* (Handy and Pukui 1991). A *kauhale*-style residence does not necessarily denote that each residence contains the full range of functionally-specific structures described by Handy and Pukui, but rather that it contains multiple structures that suggest differential functions related to permanent habitation. Handy and Pukui describe *kauhale* as including: 1) *hale mua*: a men's eating house and place to meet "with the family gods"; 2) *hale 'aina*: an eating house for women and young boys and girls; 3) *hale noa*: a common sleeping house for all household or family members; 4) *hale pe'a*: a women's house during menstruation; 5) *hale papa'a*: a storage house for crops and related tools; 6) *hale kuku*: a house to prepare *tapa* cloth; 5) *hale ulana*: a house to prepare and store mats; and 6) *hale kahuma*: a covered house for cooking during bad weather conditions (both men and women had one until the *kapu* on eating was abolished) (*ibid.*: 7-12). An additional house component or activity area of a *kauhale* may be a *hale ho'olu'u*, a house for dying tapa

cloth (Kamakau 1976:111) and/or a tapa drying pen or *pa kaula'i*; the *hale ho'olu'u* was constructed to protect the material from animal disturbance (Handy and Pukui 1991:12).

Clearly the more substantially constructed permanent habitation sites (Site 17192, 17193, 17197, and 17203) are located along the southern coast of Keopuka. The largest complexes, Site 17197 and 17203, cover areas between 1500 m.^{2} and 2400 m.^{2}, respectively. These sites are characterized by a multitude of contiguous and well-constructed enclosures and platforms. Both of these sites are situated in what appears to be advantageous locations where access to the ocean would have been easily gained; one of the sites (Site 17203) may contain a canoe shed. Two other large and substantially constructed permanent habitation complexes (Site 17192 and 17193) are located in close proximity to each other and may actually represent two components of a single residence. These sites themselves also have separate house structures or internal components characteristic of functionally-specific house structures.

The multiple-house permanent residences along the more remote localities of Keawekaheka Point (Site 1948 and 1952) and inland above the 525 foot contour (Site 17232, 17233, and 17225) have much more simple architectural elements (less substantial) and their floor areas are generally smaller than the sites along the southern coast of Keopuka.

The distribution of the permanent habitation sites in the project area indicate that the preferred location of permanent settlement was along the south portion of the Keopuka coast with its less rugged coastline and more level coastal terrain. Within this relatively small settlement the permanent habitation sites generally encompass a larger area, comprise larger floor areas, and are more substantially constructed than the other permanent habitation sites in the project area. The southern portion of the Keopuka coast also provides easier access to the ocean.

The permanent habitation sites in Keopuka correlate well with Jeffrey Clark's model of *Permanent Domestic Units* (Clark 1986:208-209):

> *Shape*: Various forms, most commonly terraces, platforms, quadrangular enclosures, pavings, 3-sided walled structures, and, less frequently C-shapes, L-shapes and caves (lava tubes).
>
> *Construction*: Wall structures are well built with thick, high walls (not uncommonly as much as 1 m. or more), and bifacial or interior surface wall facing likely. Wall cupboard may be present.
>
> *Size*: A very wide range, from 10 m.^{2} to well over 200 m.^{2} with commoner's houses smaller than chiefs'. Most range between 20 and 50 m.^{2}. Some perhaps as small as 5 m.^{2}.
>
> *Associations*: Chiefs, high-status families and/or religiously devout have multiple structures for each household (huts for various activities, earth ovens, burial monuments, etc.). Houses may occur singly or in neighborhoods with other domestic units, extended or permanent.

Geographic Context: Along the coast, up valleys, and in leeward agricultural zones but seldom, if ever, in Intermediate or Wilderness Zones. That is, they are located wherever people can reasonably secure a living year round.

Cultural Deposit: Cultural deposit with highly varied and comparatively abundant midden and artifact assemblages, although quantities may not be large. Multiple abandonment phases absent or separated by long occupation periods. Fireplaces few in number and formal in construction.

Human Burial

Nine burial sites were identified in the project area. Two of the burial sites are lava tube (cave) features of permanent habitation complexes (Site 17225 and 17233) and three are lava tube features of recurrent habitation sites (Site 17217, 17224, and 17235). Of the remaining four burial sites, three are lava tubes that were used exclusively for burial placement (Site 17226, 17227, and 17229) and one site is a complex of monument burials (*i.e.*, platforms and terraces). The confirmed burial sites in the project area are situated just inland of the coast between the 50 foot and 670 foot contours (Figure 74). Site 1960 complex is the only confirmed burial site located immediately inland of the main permanent settlement in Keopuka (along the southern coast line).

As many as 45 individuals were interred among the eight lava tubes, with the largest quantity of individuals interred within Site 17226 lava tube. The cave burials were exposed on the floor and wall shelves of the lava tubes, and most were associated with crab claw and charcoal. Crab claws were probably a ceremonial item associated with the burials and (or) with the lava tube itself.

Of the lava tubes that contain burials and evidences of habitation, it is probable that the burials were placed within the lava tubes after habitation there was abandoned. E.S. Handy and Mary Kawena Pukui emphasize that "burial caves were not used as dwellings or for storage; they were only for the dead and their processions" (Handy and Pukui 1991:14).

Site 1960 burial site consists of a complex of seven features (platforms and terraces) closely concentrated along the edge of an a'a flow. Limited subsurface testing at one of the larger terraces in the complex (Feature E) indicated that at least one individual was interred among the a'a fill of the terrace, approximately 40 cm. below the surface. Because of the confirmed burial at Feature E and similar architectural styles and close proximity of the other companion features, the entire complex is likely a group of burial monuments. Its location near the primary settlement at the coast suggests that the site was a burial ground used by coastal residents.

Possible (Unconfirmed) Burials

Eight sites in the project area are interpreted as possible burials (Table 11). These sites contain platforms, terraces, and pavements that comprise one or more of the following elements: (1) an elevated height and small surface area (not conducive for habitation); (2) internal components that indicate underlying crypts (depressions, collapsed surfaces, and

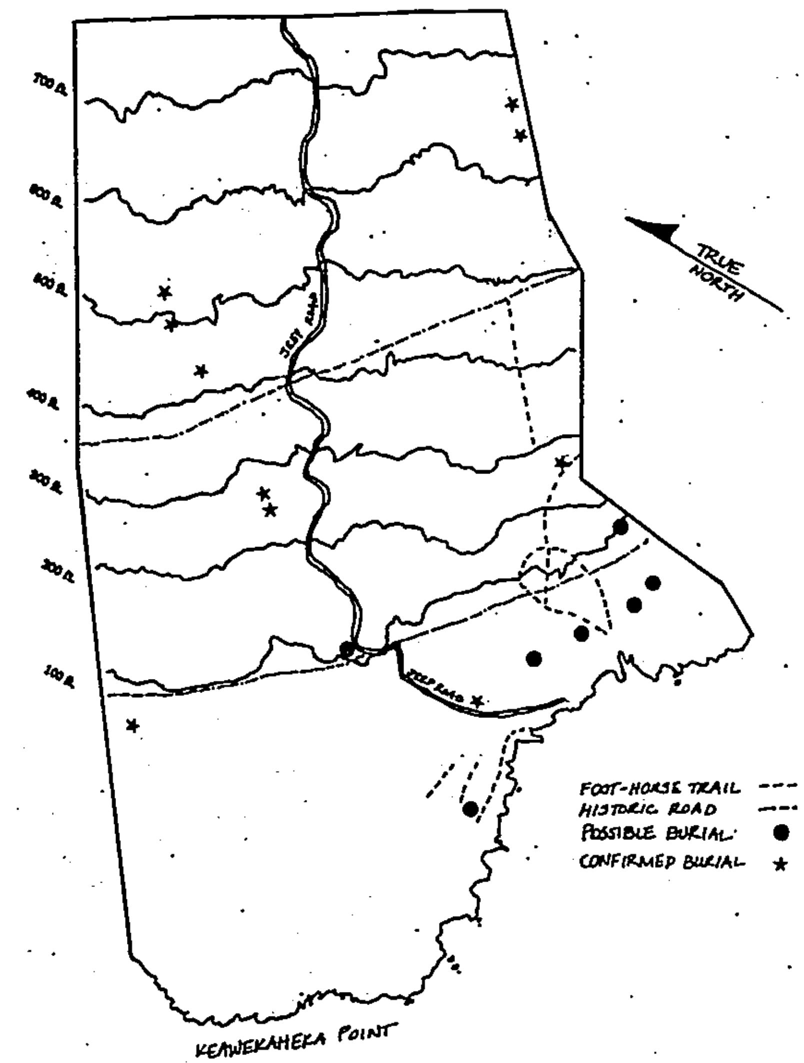

Figure 74 Distribution of Confirmed and Possible Burial Sites

internal alignments); and (3) similarities with confirmed burials in the project area (*i.e.*, Site 1960).

Three of the sites (Site 1958, 17194, and 17198) are associated with recurrent habitation features. All seven of the possible burial sites occur immediately inland of the permanent settlement along the south coast, along trails (Site 7727, 7728, and 17183), near

Table 11 - Characteristics of Possible Burial Sites

Site Number	# of Features	Formal Site/ Feature Type	Height (m.)	Size (m.²)	Structural Elements	Association's
1958	1	platform	1.0	35.7	3 tiered platforms	recurrent habitation
17194	2	platform; blocked lava tube	0.7	5	circular shape	recurrent habitation
17198	2	platforms	1.7 1.0	49 20	depressions; internal alignment	recurrent habitation
17204	1	platform	1.0	7.5	circular; collapsed surface	solitary
17205	7	platforms and terraces	0.5-1.8	2-24	circular; depressions	petroglyph; on a'a

lava excavations (Site 17172), and next to the *Hāuu* slide (Site 17207). The only clear pattern of distribution is that the sites are set back behind the permanent settlement, generally in barren landscapes of a'a lava.

Utilization of lava Tubes

In addition to habitation and burial use, some lava tubes provided potable water and an appropriate environment for storing perishable materials. E.S. Craighill Handy and Elizabeth Green Handy account that lava tubes in the Wai'ohinu area were used to collect water:

> At various places in this general are there were caves in which local Hawai'ians were able to collect in gourds enough water, which dripped from the cave ceilings, for drinking and watering sweet potatoes and gourds during the dry season. The water came from dew-fall, caused by the cold breeze flowing down from Mauna Loa's forest meeting the damp air blown in from the ocean by the tradewinds across the coastal lands
> (Handy and Handy 1972: 583-584).

Possible gourd-holder alignments of stones were observed in Site 17233 lava tube.

The consistent temperature of the lava tubes also provided an ideal environment for preparing and storing perishable items. E.S. Craighill Handy and Mary Kawena Pukui note:

The consistent temperature of the lava tubes also provided an ideal environment for preparing and storing perishable items. E.S. Craighill Handy and Mary Kawena Pukui note:

> Some caves that were always cool through summer and winter were never used as dwellings but as places in which to prepare *hala* leaves for plaiting. These leaves are best prepared in the early morning, on a cool night or rainy day. The warmth of the sun has a tendency to make them brittle and hard. Women used to take their *lauhala* into these cool caves to prepare and to store. Very dry caves were good places to store the surplus salt in thick *lauhala* baskets
> (Handy and Pukui 1958: 14).

Ahu/Marker

Four *ahu* sites were identified in the project area (Site 17173, 17209, 17214, and 17215) and interpreted as trail or road markers. One of the sites contains a row of four *ahu* that probably delineates an indistinct trail extending *mauka-makai* through a pahoehoe *kipuka* in the a'a lava terrain. Two of the *ahu* sites (Site 17214 and 17215) appear to mark the main *mauka-makai* access road, one of which (Site 17214) occurs on a high bluff at the intersection between Site 17189 Cart Road and the access road. The last *ahu* is situated among the lava excavations of Site 17172. Like Site 17209, Site 17173 *ahu* probably marks an indistinct trail.

Recreation

One site in the project area, a *holua* slide (Site 17207), is recreational in function. The site is characterized by a stone-constructed ramp that descends steeply *makai* from approximately the 125 foot contour line (outside the southwest corner of the project area) to the 25 foot contour line, 400 feet from the coast. The slide terminates in a soil-filled sink or pit, in close proximity to the concentration of permanent habitation sites along the southern coast of Keopuka.

Holua sledding was a popular sport among the Hawaiian *ali'i*. The sport was competitive and bets were often made to see who could make the longest run. David Malo (1951) describes the construction elements of a *holua* slide: "Rocks were first laid down, then earth was put on and beaten hard; lastly the whole was layered with grass, and this was the track for the *holua* sled to run on (Malo 1951: 224).

Ritual/*Heiau*

Only one site in the project area (Site 1949) exhibits characteristics of a *heiau*. The site is located on a high point along the northern coast of Keopuka and consists of two features. Feature A, representing the primary *heiau* component of Site 1949, is a two-tiered platform that is substantially constructed with high vertical facing and a level surface pavement. The upper tier of the platform is centrally located on the lower platform (closer to the *makai* side) and probably functioned as an altar. Two small enclosures form depressions in the *makai* corners of Feature A; these depression features may have functioned as idol holders.

Site 1949 was probably a fishing shrine or *koa* that may have also been utilized as a marker for marine navigation.

Special

The "special" function category is utilized in this report to categorize sites or features that did not fit into the standard categories; the "special" function in this case refers to petroglyphs. Two individual petroglyphs were identified in the project area: a human figure motif within a possible burial complex (Site 17205) and a person's name and date (Site 17179).

The traditional, human image motif in Site 17205 may depict an individual who was buried at the site. However, the human image may also represent a supernatural being of either an *'aumakua* ("ancestral guardian") or an *akua*: a major deity (Cox and Stasack 1988:18).

The post-contact petroglyph of Site 17179 transcribes "J.S. Kainoa, Feb. 6, 1891" and a five-pointed star motif. It may be posited that J.S. Kainoa was a land surveyor since in 1891 the island of Hawaii was being extensively surveyed to create maps and ensure boundaries.

Transportation

A total of eight transportation routes are located in the project area, including traditional foot trails and historic cart roads – one of which was developed into a late historic jeep road (Site 17189).

The traditional Hawaiian trails in the project area - characterized by trodden lava surfaces or steppingstone alignments - include three *mauka-makai* trail sections (Site 14186, 7728 and 17216), four coastal trails (Site 7727, 17173, 17183, and 17185); Site 7727, 17183, and 18185 parallel each other.

One of the *mauka-makai* trails (Site 7728) forms a network of travel routes that extend from the permanent settlement along the south portion of the coast (in a circular nature) to the base of the cliffs of Keopuka, at roughly 125 ft. a.m.s.l. From this intersection, the trail converges into a single route and ascends the cliff formation in a switchback manner. The lower trail network of Site 7728 essentially provides three alternative routes between the coast and the switchback portion of the trail that steeply ascends the cliff. It may be speculated that the alternative routes were utilized when travel became slow or backed up on the steep cliff portion of the trail. (This type of "traffic control" would allow *makai*-destined travelers swifter access to the coast while the *mauka*-destined travelers may have tarried on one of the alternative trails until the cliff trail became accessible.) Beyond the cliff, Site 7728 trail continues in an easterly direction until crossing the south boundary of Keopuka (at approximately 300 ft. a.m.s.l.) into Ka'awaloa *Ahupua'a*.

The second *mauka-makai* trail (Site 17216) branches off of Site 7728 to the east and parallels the southern boundary of Keopuka until terminating at the Old Government Road

(Site 10290). The third trail (Site 14186) - which is probably a *mauka* extension of Site 17216 trail - runs along the southern boundary of the project area between about 575 ft. and 650 ft. a.m.s.l. through several habitation and burial cave sites.

All three of these trail sites (Site 7728, 14186, and 17216) were probably sections that once constituted the main *mauka-makai* trail of Keopuka. The fact that these trails are located in the southern portion of the *ahupua'a* attests that the main course of travel probably occurred between the permanent settlement along the south coast and the upland fields and probably a *mauka*-upland settlement. The importance of communication during prehistory, and early history with the larger villages in Ka'awaloa and Kealakekua is also suggested by the diverted course of Site 7728 trail into Ka'awaloa *Ahupua'a* to the south.

The three paralleling sections of coastal trails (Site 7727, 17183, and 17185) are most visible where they cross a finger of a'a lava at the center of the Keopuka coast. The three trails are approximately 200 ft. apart, with the longest stretch of trail being the closest to the coast (Site 17183) and extending between two habitation sites (Site 1956 and 17189) at a distance of roughly 700 ft. The fourth coastal trail observed near the north boundary of the project area is probably an extension of Site 17185 - the more *mauka* of the coastal trails - because both are located at the same orientation and distance from the coast.

Two historic roads were identified in the project area and represent 19th Century transportation routes designed for horse and cart travel between major Kona villages. Site 17189, historically referred to as the Old Cart Road, was apparently built in 1836 under the direction of Governor Kuakini (Alvarez 1990:3.34). This road, apparently constructed over an older "ancient road to Kailua" (*ibid.*) extended between the village at Ka'awaloa and Kailua. Sometime during the mid 20th Century, the Old Cart Road was mechanically widened and maintained as a jeep road, which is its current status.

A second road (Site 10290), historically referred to as the Old Government Road, was probably constructed sometime during the 1850's, when other more *mauka* roads were being established between historic upland, villages of Ka'u and Kona. The Old Government Road (Site 10293), also sometimes termed the "King's Trail" was built above the *pali* or cliff of Keopuka, at approximately the 500 foot elevation.

Indeterminate Function

One of the recorded sites (Site 17210), a wall segment, was deemed indeterminate in function, based on a lack of distinguishing characteristics.

C. Excavation Results

Limited subsurface testing was conducted at seven sites within the present study area and a total of eight test units were excavated (Test Units 1 to 8). The sites tested include two probable permanent habitation sites (sites 1948 and 17197), one probable temporary habitation site (site 17199), three possible burial sites (sites 1960, 17194, and 17214), and one lava tube (site 17225).

Controlled excavation was extended to bedrock or sterile soil layers or, in the case of testing for human burials, until any human remains were uncovered. Contents were screened through 1/8-inch wire mesh and cultural material recovered from the excavations were measured and analyzed at the Cultural Surveys Hawaii laboratory. Each test unit was backfilled and the sites were reconstructed to their original form.

Testing Results

Site 50-10-47-1948 Feature A

Site 50-10-47-1948 Feature A, irregular-shaped enclosure, was tested with a single 1.0 m. by 0.5 m. (3.3 ft. by 1.64 ft.) test unit, designated Test Unit 8, placed in the northeast corner of the feature (see Plan View - Figure 9). A total of four stratigraphic units were revealed during the excavation of Test Unit 8, designated Stratum I, II, IIIA and IIIB (Figure 75).

The surface of Test Unit 8 consisted of a coral and basalt sand with scattered small cobbles. Eight historic and one indigenous artifacts were recovered. The historic artifacts were all bottle glass fragments (Accs. H-1, H-2), and the indigenous artifact consisted of one volcanic glass flake (Acc. 1).

Stratum I (0 to 10 cmbs.) consisted of a mixture of coral and basalt sand, alternating between very pale brown (10YR 8/3) and very dark gray (10YR 3/1), intermixed with 10% large cobbles. Stratum I produced a total of 44.1 grams of marine midden. The midden inventory includes 13.5 gms. of *Opihi* (*Cellana* sp.), 11.6 gms. of *Thaididae* sp., 11.0 gms. of unidentified shell, 5.1 gms. of Reticulated Cowrie (*Cypraea maculifera*), 1.5 gms. of Crustacean, 0.6 gms. of *Pipipi* (*Nerita picea*), 0.4 gms. of Periwinkle (*Littorina* sp.), and 0.4 gms. of Sea Urchin (Echinoderm). No indigenous artifacts were recovered from Stratum I. Historic artifacts recovered from Stratum I consisted of three historic bottle glass fragments (Accs. H3, H4, and H5).

Stratum II (10 to 30 cmbs.) consisted of a mixture of coral and basalt sand (same color values as Stratum I) and brown (10YR 4/3) silt loam intermixed with 10-20% cobbles. Stratum II produced a total of 233.9 grams of marine midden and 0.1 grams of charcoal. The midden inventory from the 10 to 20 cmbs. level includes 32.7 gms. of *Opihi* (*Cellana* sp.), 28.5 gms. of *Thaididae* sp., 8.8 gms. of Reticulated Cowrie (*Cypraea maculifera*), 6.4 gms. of unidentified shell, 4.1 gms. of *Pipipi* (*Nerita picea*), 3.7 gms. of Sea urchin (Echinoderm), 2.5 gms. of undetermined fish, 0.6 gms. of Periwinkle (*Littorina* sp.), and 0.5 gms. of Parrotfish (Scarid). The midden inventory from the 20 to 30 cmbs. level includes 57.5 gms. of *Thaididae* sp., 31.9 gms. of *Opihi* (*Cellana* sp.), 12.7 gms. of *Pipipi* (*Nerita picea*), 10.5 gms. of

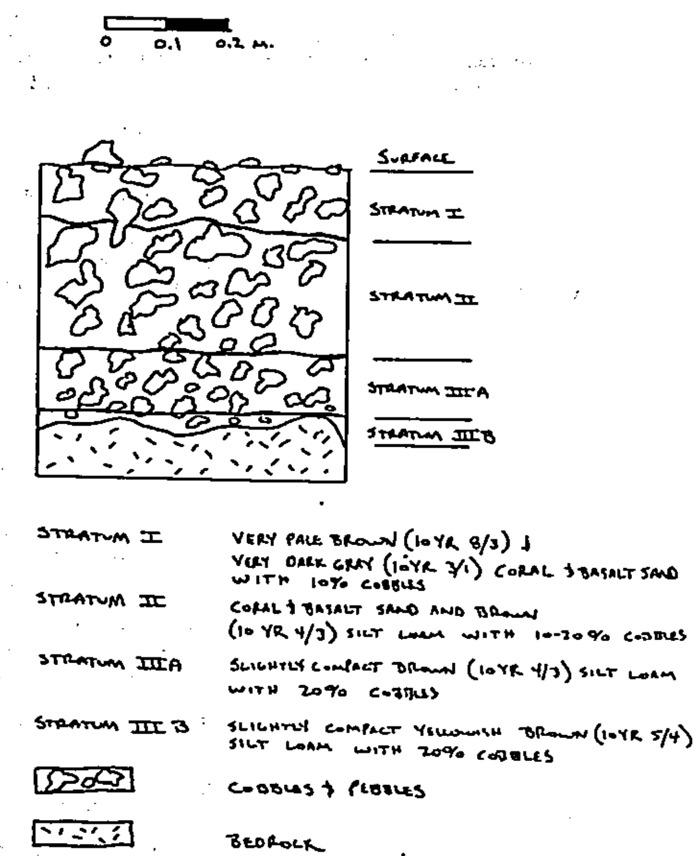

Figure 75 Site 50-10-47-1948, Test Unit 8 Profile: East Face

Snakehead Cowrie (*Cypraea caputserpentis*), 7.6 gms. of unidentified shell, 6.7 gms. of Periwinkle (*Littorina* sp.), 6.5 gms. of Sea Urchin (Echinoderm), 3.9 gms. of Reticulated Cowrie (*Cypraea maculifera*), 1.1 gms. of unidentified fish, 0.1 gm. of Parrotfish (Scarid), and 0.1 gm. of Triggerfish (Balistid). Both historic and indigenous artifacts were collected during the excavation of Test Unit 8. Artifacts collected include six historic bottle-glass fragments (Accs. H6 to H9), all from the 20 to 30 cmbs. level, and a volcanic glass flake (Acc. 2), also from the 20 to 30 cmbs. level.

Stratum IIIA (30 to 40 cmbs.) consisted of a slightly compact brown (10YR 4/3) silt loam with 20% cobbles intermixed. Stratum IIIA produced a total of 192.9 grams of total midden which includes 189.0 grams of marine midden and 3.9 grams of terrestrial midden. The midden inventory includes 77.8 gms. of *Thaididae* sp., 40.4 gms. of Snakehead Cowrie (*Cypraea caputserpentis*), 32.9 gms. of unidentified shell, 9.3 gms. of Sea urchin (Echinoderm), 8.9 gms. of *Pipipi* (*Nerita picea*), 7.6 gms. of *Opihi* (*Cellana* sp.), 7.3 gms. of Periwinkle (*Littorina* sp.), 4.4 gms. of Reticulated Cowrie (*Cypraea maculifera*), 3.5 gms. of medium mammal, 0.4 gms. of indeterminate fish, and 0.4 gms. of medium bird. One indigenous artifact (Acc. 3), a volcanic glass flake, and three historic artifacts (Accs. 10-11), a glass fragment and two metal fragments, were recovered from this stratum.

Stratum IIIB (40 to 50 cmbs.) consisted of a slightly compact yellowish brown (10YR 5/4) silt loam with 20% cobbles intermixed and directly overlying bedrock. Stratum IIIB was located mostly in the west half of the test unit. A total of 45.4 grams of marine midden was collected from the Stratum IIIB level. The midden inventory includes 16.2 gms. of *Thaididae* sp., 15.1 gms. of Snakehead Cowrie (*Cypraea caputserpentis*), 7.2 gms. of Sea urchin (Echinoderm), 2.1 gms. of *Pipipi* (*Nerita picea*), 1.7 gms. of Reticulated Cowrie (*Cypraea maculifera*), 1.7 gms. of Periwinkle (*Littorina* sp.), 1.1 gms. of unidentified shell, and 0.3 gms. of undetermined fish. One indigenous artifact, a volcanic glass flake (Acc. 4), and one historic artifact, a glass fragment (Acc. H-12), were recovered from the stratum.

Interpretation: Information gathered from Test Unit 8 indicates that both Strata II and IIIA are directly associated with the occupation of Site 1948 Feature A irregular-shaped enclosure. The historic artifact component throughout the strata is indicative of utilization during historic times. However, the primary function appears to have been associated with prehistoric habitation. The amount of marine midden and the proximity of this multi-featured site to the coast are indicative of traditional Hawaiian marine resource exploitation and habitation.

The historic artifacts, mainly bottle glass fragments, appear to represent post traditional utilization by 20th century fishermen. The loose sandy matrix within the feature has allowed progressively smaller glass fragments to be "worked into" the underlying strata. Thus, Stratum I represents post-traditional use of the structure, probably historic use as a fisherman's camp. Stratum II and Stratum IIIA correlate to the construction and traditional utilization of the structure, with Stratum II being the main cultural layer (*i.e.*, the stratum with the greatest midden and traditional artifact content). Stratum IIIB represents a thin discontinuous soil horizon resting directly on bedrock; the stratum predates the structure and the cultural material present had likely filtered down into the soil matrix.

Site 50-10-47-1960 Feature E

Site 50-10-47-1960 Feature E, multi-level terrace, was tested with a single test unit (Test Unit 3). Feature E comprises four levels, designated Levels 1 to 4. A 0.75 m.² test unit was excavated in the center of the highest level, Level 4 (see Plan View - Figure 21). Excavation began with the removal of the terrace rock-fill which consisted of 'a'ā cobbles. The rock-fill was excavated to depth of 40 cm. below the terrace surface. Human remains consisting of two human long bones were encountered within the fill at 37 cm. below terrace surface (Figure 76). No artifacts or midden were observed on the surface or within the rock-fill. The excavation was halted and the test unit was backfilled.

Interpretation: The testing confirmed the burial function specifically for Feature E, thus raising the probability that the remaining six features of the site complex are also burials. The features are similar to each other in a construction style associated with burials. No artifacts or midden were observed on the surface or within the rock-fill.

Site 50-10-47-17194 Features A and B

Site 50-10-47-17194 Features A and B were tested to determine the presence or absence of human remains. Features A is a small, roughly square platform and Feature B is a small terrace. Feature B is located approximately 4.0 m. (13.1 ft.) northwest of Feature A.

Test Unit 1 was excavated roughly in the northwest corner of Feature A (see Plan View - Figure 39) and measured 0.5 m.² Excavation began with the removal of the platform fill which consisted of small, medium and large 'a'ā cobbles and small boulders. One water-rounded boulder was observed within the platform. The fill extended to a depth of 20 cm. to 30 cm. below the platform surface until bedrock was encountered (Figure 77). No midden or artifacts were observed within Test Unit 1.

Test Unit 2 was excavated in the center of Feature B (see Plan View - Figure 39) and measured 0.75 m.² Excavation began with the removal of the terrace fill which consisted of 'a'ā pebbles and small cobbles. The fill extended to a depth of 15 cm. to 20 cm. below surface where bedrock was encountered (Figure 78). No midden or artifacts were observed within Test unit 2.

Interpretation: The absence of human remains at Site 17194 Features A and B indicates an alternative function from what was initially posited. Although neither midden nor artifacts were observed during excavation, these features have been redesignated as recurrent habitation features based on structural similarities with other recurrent habitation features of the complex, and with other recurrent habitation sites in the project area.

Site 50-10-47-17197 Feature A

Site 50-10-47-17197 Feature A platform was tested with a single 1.0 m.² unit (Test Unit 5). The unit was excavated in the northwest portion of the platform near a rock-lined depression (see Plan View - Figure 41). Two stratigraphic units were revealed during the excavation of Test Unit 5 and were designated Stratum IA and IB (Figure 79).

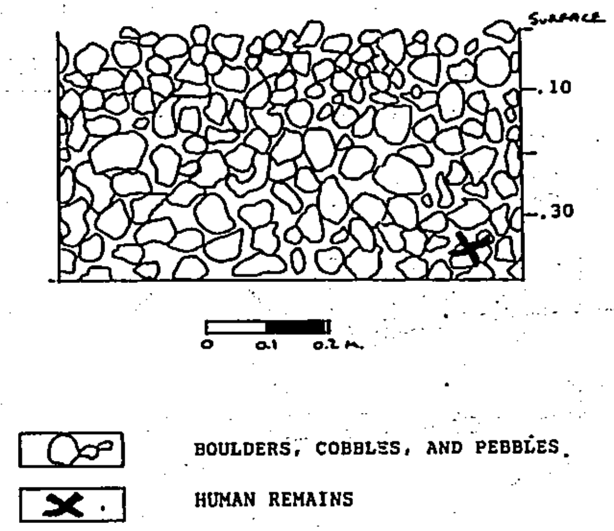

Figure 76 Site 50-10-47-1960 Feature E, Test Unit 3 Profile: East Face.

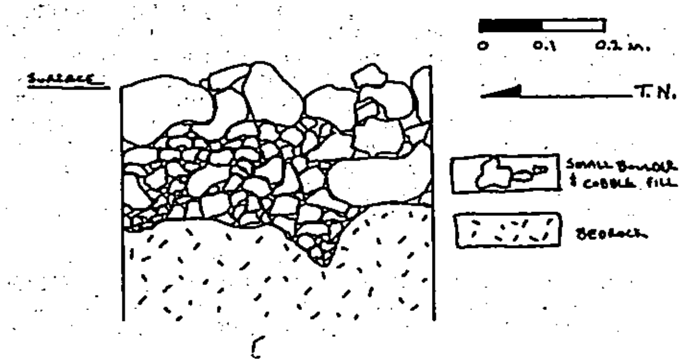

Figure 77 Site 50-10-47-17194 Feature A, Test Unit 1 Profile: East Face

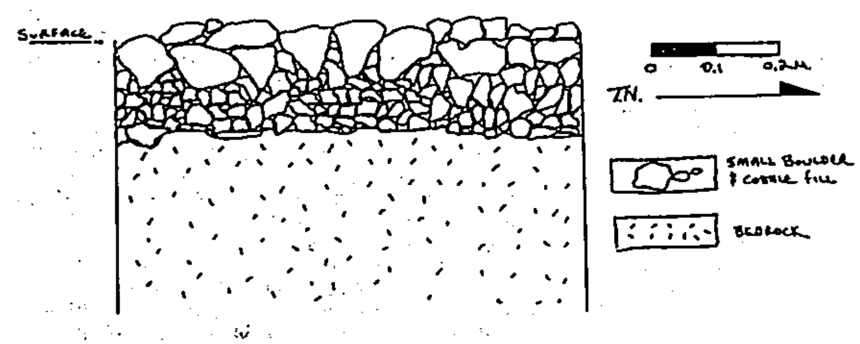

Figure 78 Site 50-10-47-17194 Feature B, Test Unit 2 Profile: West Face

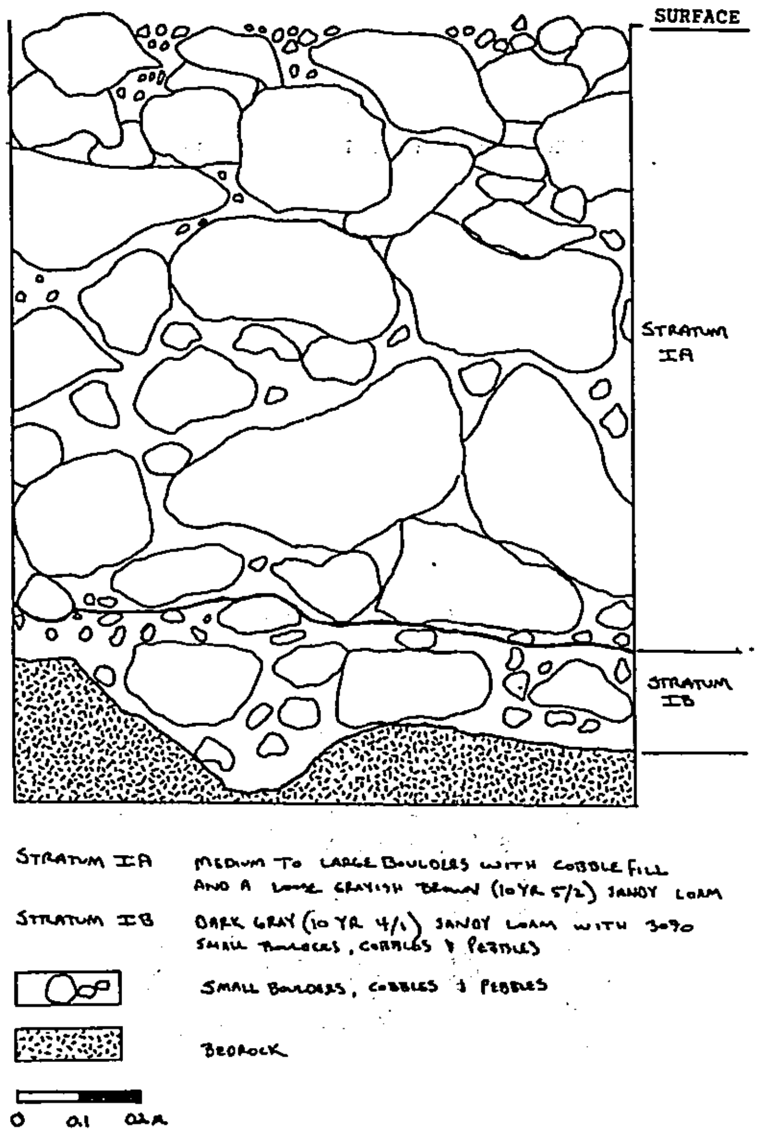

Figure 79 Site 50-10-47-17197 Feature A, Test Unit 5 Profile: West Face

Stratum IA (0 to 100 cm. below platform surface) consisted of medium to large boulders with cobble fill and a loose grayish brown (10YR 5/2) sandy loam matrix. Strata IA produced a total of 52.2 grams of marine midden (scattered throughout the stratum), but no artifacts were observed. The midden inventory includes 37.6 gms. of Snakehead cowrie (*Cypraea caputserpentis*), 10.4 gms. of *Thaididae* sp., 3.8 gms. of unidentified shell, and 0.4 gms. of *Pipipi* (*Nerita picea*).

Stratum IB (100 to 120 cm. below platform surface) consisted of very fine loose, dark grey (10YR 4/1) sandy loam with 30 % small boulders, cobbles and pebbles intermixed. This stratum overlies bedrock. Stratum IB produced a total of 284.1 grams of marine midden and 11.7 grams of terrestrial midden.The midden inventory includes 137.4 gms. of Snakehead cowrie (*Cypraea caputserpentis*), 58.1 gms. of *Thaididae* sp., 17.1 gms. of *Opihi* (*Cellana* sp.), 16.5 gms. of unidentified shell, 16.3 gms. of *Pipipi* (*Nerita picea*), 15.6 gms. of Sea urchin (Echinoderm), 8.0 gms. of *Kukui* endocarps, 6.1 gms. of Reticulated cowrie (*Cypraea maculifera*), 4.8 gms. of Periwinkle (*Littorina* sp.), 2.8 gms. of Pearl shell (*Isognomon*sp.), 1.7 gms. of *Trochus intextus*, 1.4 gms. of indeterminate fish bone, 0.8 gms. of Triggerfish (Balistid), 0.5 gms. of small to medium mammal bone, 0.3 gms. of Filefish (Monacanthid), 0.2 gms. of pig (*Sus scrofa*), 0.2 gms. of small Indian mongoose (*Herpestes auropunctatus*), 0.2 gms. of domestic dog (*Canis familiaris*), and 0.1 gms. of Shark. Both historic and indigenous artifacts were recovered from Stratum IB including twelve volcanic glass flakes (Acc. 12); a pig bone ornament (Acc. 13); a cut shell (Acc. 10) and one historic ceramic fragment (Acc. H13).

Interpretation: The stratigraphic information gathered during the testing indicates that Feature A platform (Site 17197) was constructed directly on bedrock and that cultural material had filtered down through the structure. The bulk of the filtered matrix, including midden and artifacts, had accumulated at the base of the structure (*i.e.*, Stratum IB), while Stratum IA represents the filtered and trapped matrix within the feature structure itself. The excavation results, together with other criteria, support the interpretation of this feature as a permanent habitation component.

Site 50-10-47-17199 Feature B

Site 50-10-47-17199 Feature B lava tube was tested with a 1.0 m. by 0.5 m. test unit (Test Unit 6) located within an area of soil and scattered midden near the main entrance (see Plan View - Figure 44). Two stratigraphic units, designated Stratum I and II, were revealed during the excavation of Test Unit 6 (Figure 80).

The surface consisted of scattered cobbles, coral, artifacts and midden. A total of 9.5 grams of midden was collected from the surface, including 1.1 grams of marine midden and 8.4 grams of terrestrial midden. The midden inventory consists of 4.2 gms. medium mammal, 3.0 gms. pig (*Sus scrofa*), 0.2 gms. small to medium mammal, 0.8 gms. medium *procellariid*, 0.2 gms. medium bird, and 1.1 gms unidentified marine midden. A total of 16 indigenous artifacts and one historic artifact were collected from the surface and close proximity of Test Unit 6 (Acc. 14 to 29 and H-14), including: urchin files (Accs. 14, 19, 27); basalt files (Accs. 15, 20,); basalt adzes (Accs.18, 21, 26); coral abraders (Accs. 17, 22); coral files (Accs. 23, 25); a coral sinker (Acc. 16); a basalt core (Acc. 28); a basalt manuport (Acc. 24); a bone pick (Acc. 29); and a historic bottle glass fragment (Acc. H14).

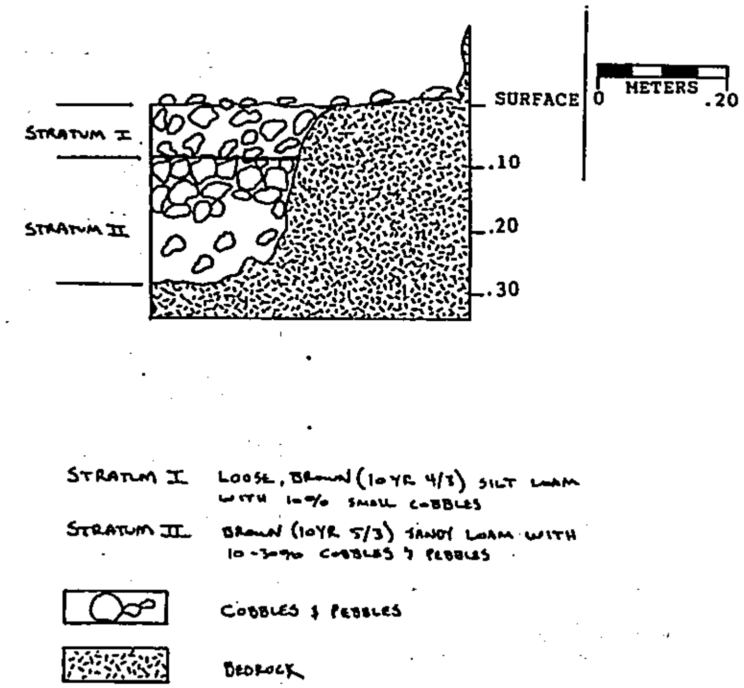

Figure 80 Site 50-10-47-17199, Feature B, Test Unit 6 Profile: South Face

Stratum I (0 to 10 cm.) consisted of a loose, brown (10YR 4/3) silt loam with 10% intermixed small cobbles. Stratum I produced a total of 284.6 grams of midden which includes 12.6 grams of terrestrial midden and 272.6 grams of marine midden. The midden inventory includes 139.5 gms. of Snakehead cowrie (*Cypraea caputserpentis*), 38.5 gms. of *Thaididae* sp., 43.1 gms. of unidentified shell, 23.1 gms. of *Pipipi* (*Nerita picea*), 14.3 gms. of Sea urchin (Echinoderm), 6.6 gms. of *Opihi* (*Cellana* sp.), 6.3 gms. of *Kukui* endocarps, 4.6 gms. of Reticulated cowrie (*Cypraea maculifera*), 3.5 gms. unspecified hooved mammals (Medium *Artiodacyl*) 2.0 gms. of Periwinkle (*Littorina* sp.), 1.5 gms. cf small to medium mammal bone, 0.7 gms. medium mammal, 0.6 jungle fowl (*Gallus*), 0.3 gms. Auger shells (*Terebre* sp.), 0.2 gms. Porcupine fish (Deodontid), 0.1 gms. Filefish (Monacanthid), 0.1 gms. of Shark, 0.1 gms. barracuda (Sphraenid), and 0.1 gms. of indeterminate fish bone. Fourteen indigenous artifacts were collected from Stratum I and include: 11 volcanic glass flakes (Acc. 33); two coral file fragments (Accs. 31 and 32); and one bone pick (Acc. 30).

Stratum II (10 to 30 cm.) consists of a brown (10YR 5/3) sandy loam with 30% cobbles within the top 10 cm. of this stratum and 10% cobbles intermixed throughout the remainder.

Stratum II (10 to 20 cm. level) produced a total of 344.1 grams of marine midden and 39 indigenous artifacts. The midden inventory includes 123.2 gms. of *Thaididae* sp., 78.4 gms. of unidentified shell, 50.2 gms. of Snakehead cowrie (*Cypraea caputserpentis*), 46.8 gms. of Sea urchin (Echinoderm), 21.4 gms. of *Pipipi* (*Nerita picea*), 14.5 gms. of *Opihi* (*Cellana* sp.), 3.7 gms *Isognomon* sp., 2.7 gms. Turbo (*Turbo sandwicensis*), 1.6 gms. cone shells (*Conus* sp.), and 1.6 gms. periwinkle (*Littorina* sp.). The artifacts collected include 23 volcanic glass flakes (Acc. 45); four coral files (Accs. 34, 41, 42 and 44); six basalt flakes (Acc. 39); three basalt cores (Accs. 37, 40 and 43); a coral sinker (Acc. 38); a bone pick (Acc. 36); and a piece of cut bone (Acc. 35).

Stratum II (20 to 30 cm. level) produced a total of 431.1 grams of total midden which includes 426.2 grams of marine midden and 4.9 grams of terrestrial midden. The midden inventory includes 136.9 gms. of Snakehead cowrie (*Cypraea caputserpentis*), 109.2 gms. of *Thaididae* sp., 80.5 gms. of unidentified shell, 26.4 gms. of Sea urchin (Echinoderm), 19.0 gms of Reticulated cowrie (*Cypraea maculifera*), 18.9 gms. of *Pipipi* (*Nerita picea*), 9.2 gms. cone shells (*Conus* sp.), 7.9 gms. of *Opihi* (*Cellana* sp.), 7.5 gms. of Periwinkle (*Littorina* sp.), 5.2 gms. unspecified fish bone, 3.3 gms. small to medium mammal, 2.3 gms. oyster (*Pinctada*), 1.7 gms *Isognomon* sp., 1.3 gms unspecified medium vertebrate, 0.5 gms of Filefish (Monacanthid), 0.3 gms. medium bird, 0.3 gms. of Turbo (*Turbo sandwicensis*), 0.2 gms parrot fish (Scarid), 0.2 gms. squirrel fish (Holocentrid), 0.1 gms. of goat fish (Mullid), 0.1 gms. of wrasse (Labrid), and 0.1 gms. of tuna (Scombrid). Stratum II, 20 to 30 cm. level, also produced a total of 19 indigenous artifacts including: seven volcanic glass flakes (Acc. 50); five basalt flakes (Acc. 49); two basalt files (Accs. 47 and 53); two basalt manuports (Accs. 46 and 52); and a coral file (Acc. 51).

Interpretation: The excavation results for Site 17199 Feature B suggest that Stratum II was contemporaneous with the occupation of this feature. Though Stratum I contained midden and artifacts, it is our interpretation that Stratum II is the cultural layer of the site and Stratum I, which is high in organic debris, had developed since abandonment of the feature. Thus, the cultural material that was recovered from Stratum I does not represent a depositional event, but rather cultural material that had been absorbed into the developing Stratum I from the underlying older "ground surface" of Stratum II.

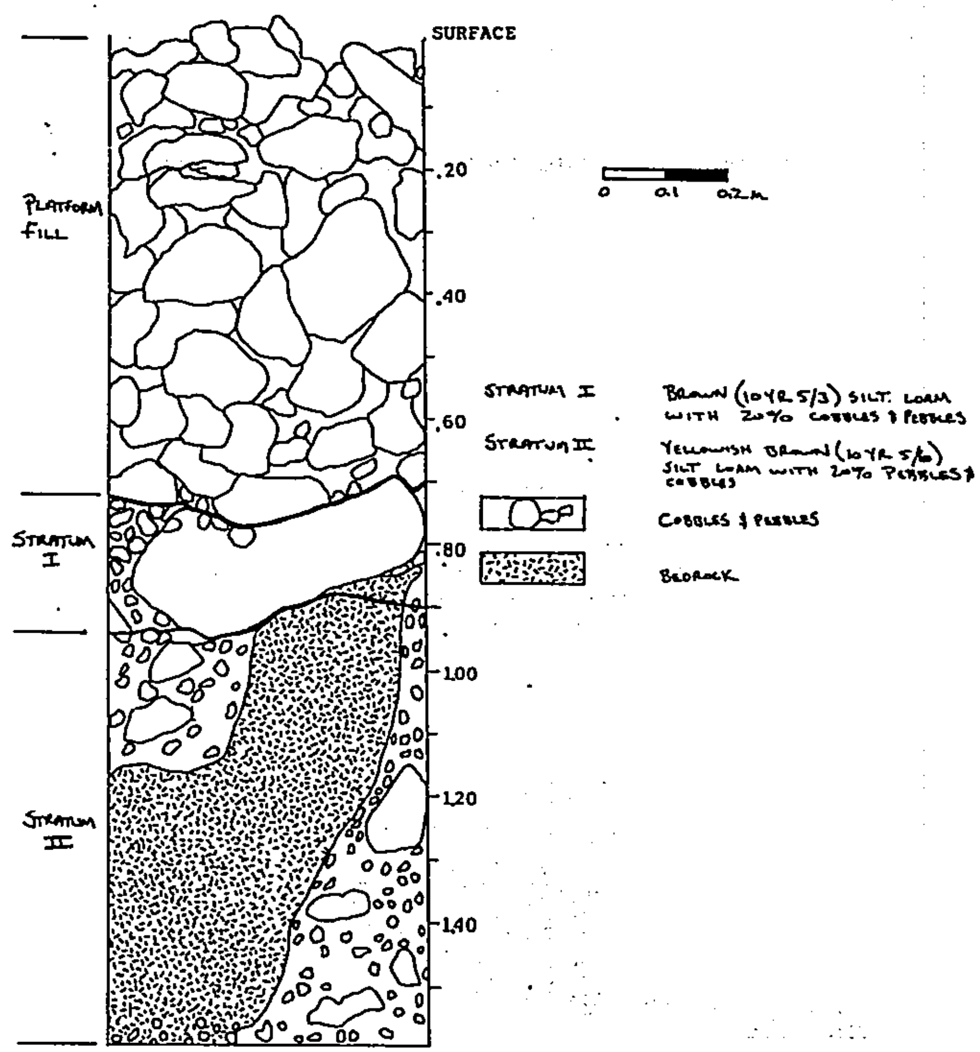

Figure 81 Site 50-10-47-17214 Test Unit 4 Profile: East Face

The abundance of midden and artifacts recovered from the lava tube suggests that the feature was utilized as a recurrent habitation shelter, as opposed to a temporary habitation shelter. The type of midden and the artifacts suggest marine resource exploitation and the processing of materials for marine exploitation.

Site 50-10-47-17214

Site 50-10-47-17214, possible burial platform, was tested with a single test unit (Test Unit 4) measuring 0.5 m. by 1.0 m. The test unit was excavated in the central portion of the platform (see Plan View - Figure 55). Excavations began by removing the platform fill which was 70 cm. thick. A single water-rounded boulder was observed at 60 cm. below the platform surface. Two soil strata were encountered and were designated Stratum I and II (Figure 81).

Stratum I (70 to 90 cmbs.) consisted of brown (10YR 5/3) silt loam intermixed with 20% small to large 'a'ā cobbles and pebbles. A few land snail shells were observed, but not collected. No cultural material was observed.

Stratum II (90 to 160 cmbs.) consisted of yellowish brown (10YR 5/6) silt loam mixed with 20% 'a'ā cobbles. This stratum overlies natural bedrock. No cultural material was observed.

Interpretation: As excavation of this site revealed no human remains, the initial burial function was changed to that of a marker. Site 17214 is located near the intersection of the main *mauka/makai* jeep road in the project area and the historic Cart Road and its visual prominence suggests the marker function.

Site 50-10-47-17225 Feature A

Site 50-10-47-17225 Feature A lava tube was tested with a single 1.0 m. by 0.5 m. test unit (Test Unit 7). Test Unit 7 was excavated in the first terrace located within the interior of the lava tube (see Plan View - Figure 66). This test unit extended to a maximum depth of 45 cm. below surface where bedrock was encountered. One stratigraphic unit was revealed during the excavation and designated Stratum I (Figure 82).

One artifact, a piece of cut mammal bone (Acc. 78) was collected from the surface to Test Unit 7. Two pieces of mammal bone and one *kukui* nut were also observed on the surface of the test unit, but not collected.

Stratum I (0 to 40 cm.) consisted of grayish brown (10YR 5/2) silt loam between 'a'ā boulders and cobbles that directly overlies bedrock. Artifacts and midden were encountered and collected from the 0 to 20 cm. level only. The artifacts collected included a piece of cut bone (Acc. 76) and a basalt abrader (Acc. 77). The midden recovered included a total of 46.0 grams of terrestrial midden and 1.5 grams of marine midden. The midden inventory includes 28.2 gms. kukui endocarp, 8.7 gms. *Canis familiaris*, 6.7 gms. unspecified medium mammal, 2.4 gms. medium *Procellariid*, 1.2 gms. of *Terebra* sp., 0.2 gms. of sea urchin (Echinoderm), and 0.1 gm. of crustacean. A 19.1 gram charcoal sample was also collected from Stratum I and was one of two charcoal samples submitted to Beta Analytic, of Miami Florida, for radiocarbon analysis. The testing of this sample yielded a modern date.

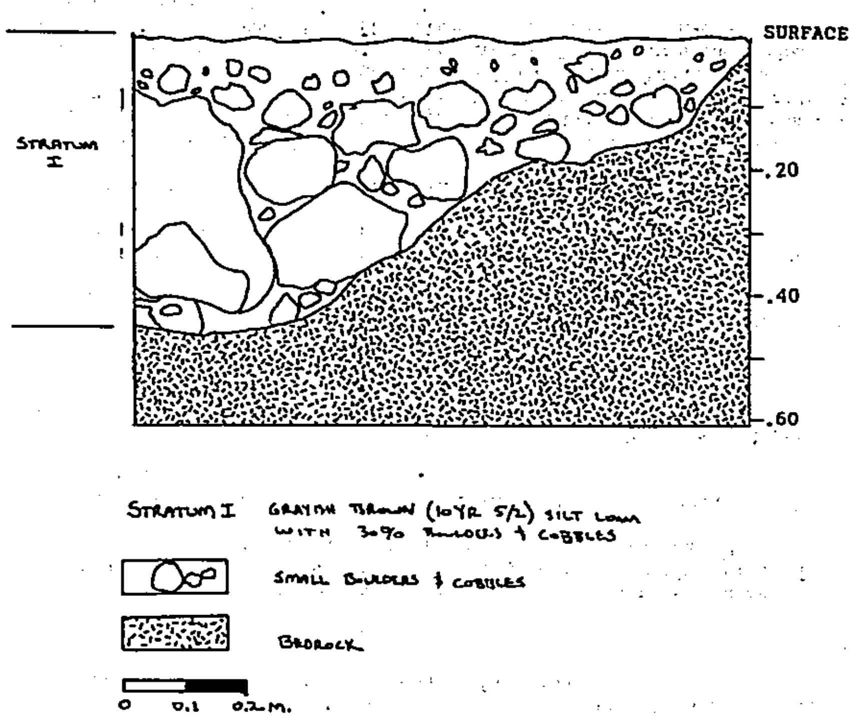

Figure 82 Site 50-10-47-17225 Feature A, Test Unit 7 Profile: West Face

Interpretation: Site 17225 is interpreted as a permanent habitation complex, with Feature A (lava tube) functioning as an auxiliary feature to the main habitation components. The amount of midden and artifacts recovered during the testing do not indicate that the terrace tested was utilized as a primary habitation structure.

Based on survey data and the excavation results, Feature A lava tube appears to have served a variety of functions including special work areas (*e.g.*, tool manufacturing and possibly tapa making) and later, burial placement.

Summary

In general, the data collected during the limited subsurface testing at seven sites in the project area was helpful in site function interpretation. In certain instances, excavation led to a re-evaluation of site function. In particular, Site 17194 and 17214, at first thought to be possible burials, have now been designated alternate functions. Also, one site (Site 17199) that was initially suspected to be temporary habitation site, was redesignated as a recurrent habitation because of the large quantity of cultural material collected during the testing.

Site 1960 tested positive for human burials and, as a result of the discovery of human remains at Feature E, the remaining features of the complex were redesignated as probable burials.

Site 17225 complex contains one of the more complex and extensive lava tubes (Feature A) in the project area. The excavation results in combination with the lava tube's association with permanent habitation surface features, suggests that the tested terrace in the lava tube was an auxiliary component of its primary function as a permanent habitation complex.

D. Cultural Material Analysis

Artifacts

A total of 161 artifacts were recovered from surface and subsurface contexts of sites within the project area (Table 12 and 13). 138 of these (86%), are indigenous artifacts, and the remaining 23 (14%) are historic.

Eighty one percent of these artifacts, totalling 130, were recovered during the subsurface testing of six of the project area sites. The remaining 19%, or 31 artifacts, were collected from the ground surface throughout the course of the inventory survey fieldwork.

An in-depth analysis of the artifact assemblage is not undertaken here because of the limited sample size. It is believed that these artifacts do not accurately reflect the full range of artifact types and/or quantity present within the project area. The following is only a preliminary discussion of artifact types and their relation to traditional and historic land use within the project area based upon the present artifact inventory.

Indigenous Artifacts

Stone artifacts (basalt and volcanic glass) comprise the majority (68%) of the indigenous artifact inventory and include: 68 volcanic glass flakes, seven basalt adzes, four cores, four files, four manuports (4), one pestle, one saw, a sinker, and an abrader.

Coral artifacts represent 14% of the indigenous artifact inventory and include: 12 files, three sinkers, and three abraders.

Bone artifacts represent 8% of the artifact inventory and include; three picks, two ornaments, two fishhooks, and four segments of cut bone.

Sea urchin files represent 3.5% of the indigenous artifact inventory.

Wooden artifacts, also representing 3.5% of the indigenous artifact inventory, include: two spear fragments, a possible *pahe'e* (fire plow), and a *tapa* beater.

Shell artifacts represent 3% of the indigenous artifact inventory and include; an ornament, a fishhook, a scraper and a cut shell.

Other artifacts include one coconut shell cup and a length of twined fiber.

The majority of the indigenous artifacts were collected from Site 17199 Feature B Lava Tube (64%), a component feature of a recurrent habitation site complex located on the coast and from Site 17225 Feature A Lava Tube (17%), a component feature of a permanent habitation site complex located in at approximately 525 feet a.m.s.l. The remaining indigenous artifacts (19% of the total) were recovered from four habitation sites located on the coast (Sites 1948, 1955, 17194, and 17197), and from one permanent habitation complex (Site 17224) located at 500 ft. a.m.s.l.

Site 17199 Feature B was initially interpreted as a temporary habitation feature but, based on the quantity of artifacts and midden observed during subsurface testing, it was re-

Table 12 - Indigenous Artifact Catalog

Acc #	State Site 50-10-47-	Test Unit	Stratum	Depth (cm.)	# Pieces	Length cm.)	Width (cm.)	Thickness (cm.)	Weight (gms.)	Material	Function	Comments
1	1948A	8	--	surface	1	0.9	0.7	0.3	0.3	V-glass	flake	
2	1948A	8	II	20-30	1	1.3	1.3	0.7	2.2	V-glass	flake	
3	1948A	8	IIIA	30-40	1	1.8	1.4	1.0	4.1	V-glass	flake	
4	1948A	8	IIIB	40-50	1	0.9	0.5	0.3	0.3	V-glass	flake	
5	1955B	--	--	surface	1	37.0	2.0	1.9	87.8	Wood	spear	
6	1955B	--	--	surface	1	28.1	2.0	1.7	38.3	Wood	spear	
7	1955B	--	--	surface	1	15.4	7.5	0.5	53.3	Coconut	cup	half shell
8	1955B	--	--	surface	1	15.8	12.9	7.8	1199.4	Basalt	sinker	
9	17194F	--	--	surface	1	3.3	2.4	2.0	13.0	Coral	sinker	
10	17197	5	IB	100-110	1	4.5	2.4	0.3	4.2	Shell	cut	possible fish hook preform
11	17197	--	--	surface	1	17.0	6.5	4.0	310.0	Basalt	pestle	
12	17197	5	IB	110-120	12	1.2/2.2	0.6/0.7	0.2/0.5	4.6	V-glass	flakes	
13	17197	5	IB	110-120	1	6.6	1	0.1	6.6	Bone	ornament	pig
14	17199B	--	--	surface	2	1.3/3.3	1.1/1.1	0.5/0.5	1.7	Urchin	file	tip
15	17199B	--	--	surface	1	7.0	3.9	0.7	20.7	Basalt	file	
16	17199B	6	--	surface	1	3.6	2.5	2	13.3	Coral	sinker	
17	17199B	6	--	surface	1	9.3	5.5	3.7	107.9	Coral	abrader	
18	17199B	6	--	surface	1	3.3	2.0	0.6	9.1	Basalt	adz	fragment
19	17199B	6	--	surface	1	3.7	0.7	0.3	0.7	Urchin	file	
20	17199B	6	--	surface	1	4.6	3.9	1.5	43.2	Basalt	file	
21	17199B	6	--	surface	1	5.3	4.7	1.2	66.1	Basalt	adz	fragment
22	17199B	6	--	surface	1	3.5	2.7	1.7	13.3	Coral	abrader	
23	17199B	6	--	surface	1	6.2	3.0	1.1	11	Coral	file	tip
24	17199B	6	--	surface	1	4.5	3.0	3.0	31.9	Basalt	manuport	
25	17199B	6	--	surface	1	3.2	1.5	0.9	3.2	Coral	file	
26	17199B	6	--	surface	1	6.2	3.0	1.6	73.7	Basalt	adz	
27	17199B	6	--	surface	1	3.3	1.0	0.5	1.8	Urchin	file	
28	17199B	6	--	surface	1	8.5	5.8	3.0	360.0	Basalt	core	
29	17199B	6	--	surface	1	4.5	0.5	0.3	0.9	Bone	pick	
30	17199B	6	I	0-10	1	2.6	0.4	0.1	0.3	Bone	pick	

Table 12 - Indigenous Artifact Catalog (cont.)

Acc #	State Site 50-10-47-	Test Unit	Stratum	Depth (cm)	# Pieces	Length cm)	Width (cm)	Thickness (cm.)	Weight (gms.)	Material	Function	Comments
61	17225A	--	--	surface	1	2.7	2.2	0.3	1.5	Bone	ornament	tooth
62	17225A	--	--	surface	1	5.5	3.3	1.0	8.3	Coral	abrader	
63	17225A	--	--	surface	1	3.7	2.0	2.0	15.9	Coral	sinker	
64	17225A	--	--	surface	1	8.9	6.9	0.2	51.8	Shell	scraper	large opihi with hole
65	17225A	--	--	surface	1	29.5	2.3	1.7	90.5	Wood	possible pahe'e	
66	17225A	--	--	surface	1	14.7	0.6	0.3	5.3	Wood	undetermined	worked
67	17225A	--	--	surface	1	4.7	2.7	0.5	6.3	Coral	file	
68	17225A	--	--	surface	1	*	*	*	*	Fiber	twine	*mostly disintegrated
69	17225A	--	--	surface	1	4.7	4.0	1.5	65.8	Basalt	adz	
70	17225A	--	--	surface	1	4.0	1.7	1.7	2.8	Coral	file	tip
71	17225A	--	--	surface	1	4	3.5	0.6	7.4	Basalt	saw	
72	17225A	--	--	surface	1	5.3	1.8	1.0	18.6	Basalt	manuport	worked
73	17225A	--	--	surface	1	5.1	2.0	1.1	5.7	Coral	file	
74	17225A	--	--	surface	1	6.2	3.0	0.5	13.6	Bone	cut	possible net gauge
75	17225A	--	--	surface	1	21.5	5.5	5.5	434.6	Wood	tapa beater	later used as torch
76	17225A	7	I	0-20	1	8.7	2.2	1.3	17.8	Bone	cut	possible fish hook preform
77	17225A	7	I	0-20	1	7.0	6.1	1.2	56.1	Basalt	abrader	
78	17225A	7	--	surface	1	6.5	2.6	0.4	10.1	Bone	cut	possible fish hook preform

Table 12 - Indigenous Artifact Catalog (cont.)

Acc #	State Site 50-10-47-	Test Unit	Stratum	Depth (cm)	# Pieces	Length cm)	Width (cm)	Thickness (cm)	Weight (gms)	Material	Function	Comments
31	17199B	6	I	0-10	1	2.5	1.1	0.9	1.6	Coral	file	tip fragment
32	17199B	6	I	0-10	1	2.1	1.6	0.9	2.3	Coral	file	smooth fragment
33	17199B	6	I	0-10	11	1.2/1.7	0.8/1.0	0.4/0.2	3.4	V-glass	flakes	
34	17199B	6	II	10-20	1	3.2	2.1	0.9	6.8	Coral	file	fragment
35	17199B	6	II	10-20	1	3.9	0.7	0.2	0.5	Bone	cut	with hole
36	17199B	6	II	10-20	1	5.0	0.5	0.3	0.3	Bone	pick	bird
37	17199B	6	II	10-20	1	7.5	8.2	5	425.0	Basalt	core	
38	17199B	6	II	10-20	1	3.3	2	2	7.3	Coral	sinker	
39	17199B	6	II	10-20	6	1.4/4.4	1.1/3.6	0.2/0.5	26.4	Basalt	flakes	
40	17199B	6	II	10-20	1	5.5	3.2	2.2	61.6	Basalt	core	
41	17199B	6	II	10-20	1	4.2	2.5	1.7	10.8	Coral	file	fragment
42	17199B	6	II	10-20	1	4.7	2.0	1.3	8.4	Coral	file	fragment
43	17199B	6	II	10-20	1	4.2	2.2	2.2	20.5	Basalt	core	
44	17199B	6	II	10-20	1	1.6	1.4	0.7	1.4	Coral	file	fragment
45	17199B	6	II	10-20	23	1.1/2.0	0.4/1.1	0.4/0.6	11.2	V-glass	flakes	
46	17199B	6	II	20-30	1	1.3	1.3	0.5	1.9	Basalt	manuport	smooth
47	17199B	6	II	20-30	1	2.2	1.5	0.6	2.6	Basalt	file	
48	17199B	6	II	20-30	1	4.5	0.8	0.7	1.2	Urchin	file	
49	17199B	6	II	20-30	5	1.0/2.2	1.0/1.6	0.3/0.5	6.7	Basalt	flakes	
50	17199B	6	II	20-30	7	1.2/1.7	0.8/1.4	0.3/0.4	5.1	V-glass	flakes	
51	17199B	6	II	20-30	1	3.5	2.5	0.6	4.9	Coral	file	
52	17199B	6	II	20-30	1	3.0	2.7	1.7	9.6	Basalt	manuport	worked
53	17199B	6	II	20-30	2	2.5/3.0	2.0/2.1	1.4/1.0	11.5	Basalt	file	
54	17224	--	--	surface	1	4.5	0.9	0.6	2.7	Shell	ornament	
55	17225A	--	--	surface	1	6.5	2.9	1.4	51.5	Basalt	adz	
56	17225A	--	--	surface	1	7.7	3.6	1.6	143.9	Basalt	adz	
57	17225A	--	--	surface	1	4.2	2.7	0.6	16.9	Basalt	adz	
58	17225A	--	--	surface	1	5.0	1.2	0.4	3.0	Bone	fish hook	shaft
59	17225A	--	--	surface	1	4.3	2.3	0.3	5.1	Bone	fish hook	preform
60	17225A	--	--	surface	1	3.8	2.7	0.3	4.5	Shell	fish hook	preform

interpreted as a recurrent habitation feature. The artifacts collected during the excavation of site 17199 B include primarily fish hook manufacturing tools and materials and other artifacts interpreted as directly or indirectly related to fishing such as net sinkers and woodworking tools. The presence of these artifacts together with the abundance of marine midden suggest that the primary activities engaged in at this site were related to marine resource exploitation and the processing of materials for marine resource exploitation.

Site 17199 had evidence of recent vandalism and had quite likely been looted by pot-hunters. It is almost certain that artifacts were taken from this site prior to the archaeological survey fieldwork.

Site 17225 Feature A is a well-preserved lava tube which is interpreted as having functioned as an auxiliary feature within a permanent habitation site complex. Artifacts that were collected from the surface were whole, indicating that the lava tube had been relatively undisturbed (in comparison to Site 17199 Feature B). Four basalt adzes, two bone fish hooks, one shell fish hook, coral files and abrnders, worked pieces of wood, a shark tooth ornament, a tapa beater, and several pieces of cut bone, some of which were possibly net gauges or fish hook blanks, were collected from the surface. The excavation unit produced bone, cut bone, and a basalt abrader. The variety and amount of artifacts collected from this site suggest it had been used for a wide range of traditional activities including tool manufacturing and possibly *tapa* making.

The complement of artifacts collected throughout the project area indicate that the exploitation of marine resources was an important, if not the primary activity of the indigenous inhabitants of this area. The majority of the artifacts collected from the project area are interpreted as associated with fishing, including fish hooks, fish hook manufacturing materials and tools, and other fishing equipment such as sinkers and possible net making tools.

The distribution of fishing related artifacts within those portions of the project area subjected to limited subsurface testing suggest that the primacy of activities associated with marine resource exploitation was not limited to the coastal zone but included intermediate zone sites as well. The distribution of fishing related artifacts also indicated that these activities were engaged in at recurrent, temporary and permanent habitation sites within the project area.

Figures 83 through 90 are photographs of some of the indigenous artifacts recovered during the present study.

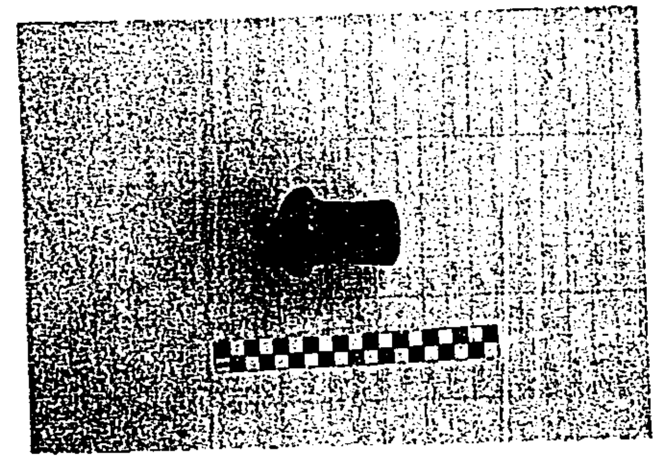

Figure 83 Site 50-10-47-17197: Basalt Pestle (Acc. 11)

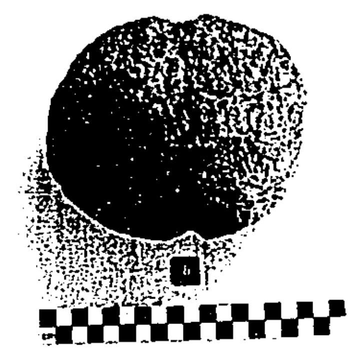

Figure 84 Site 50-10-47-1955 Feature B: Basalt Sinker (Acc. 8)

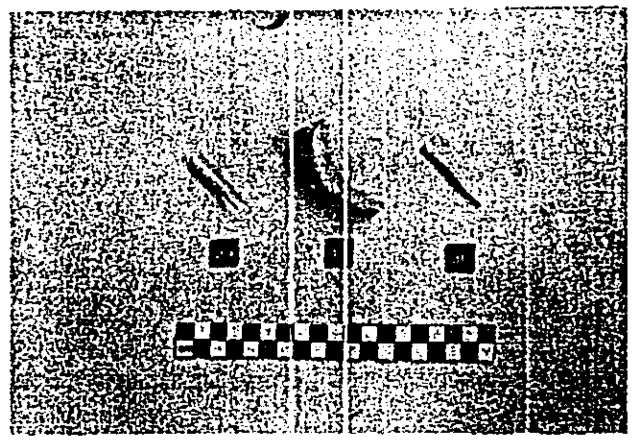

Figure 85 Site 50-10-47-17197: Bone Ornament (Pig) (Acc. 13); and Site 50-10-47-17199 Feature B: Bone Picks (Accs. 29 and 36)

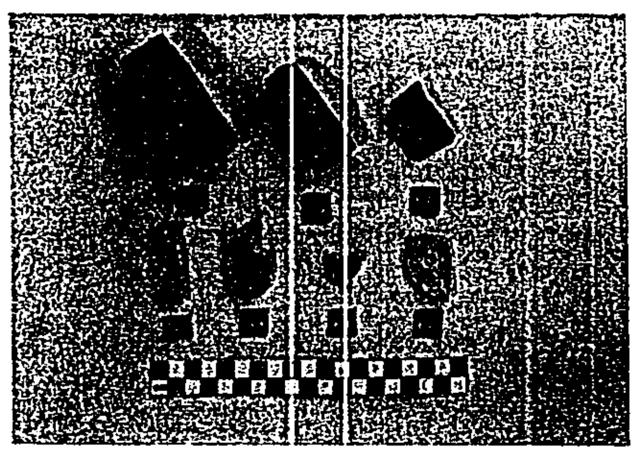

Figure 86 Site 50-10-47-17225 Lava Tube: Basalt Adzes (Accs. 55- 57); Bone Fishhook Shank (Acc. 58); Bone Fishhook Preform (Acc. 59); Shell Fishhook Preform (Acc. 60); and Drilled Shark Tooth (Acc. 61)

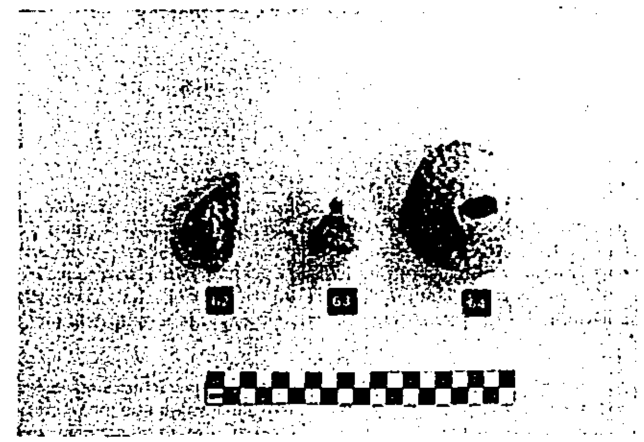

Figure 87 Site 50-10-47-17225 Lava Tube: Coral Abrader (Acc. 62); Coral Sinker (Acc. 63); and Possible Shell (*opihi*) Scraper (Acc. 64)

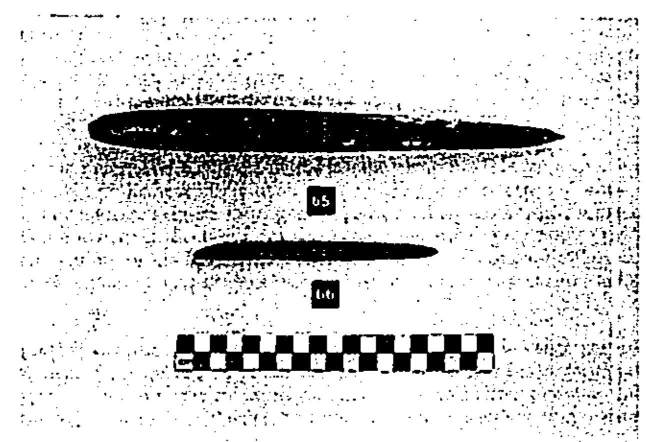

Figure 88 Site 50-10-47-17225 Lava Tube: Wooden *Pahe'e* Stick (Acc. 65) and Worked Wood (Acc. 66)

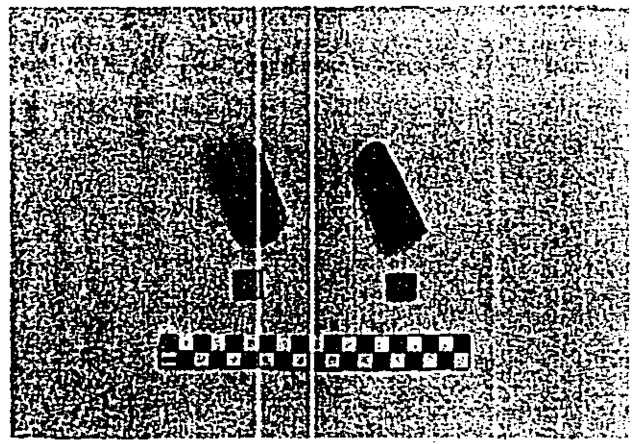

Figure 89 Site 50-10-47-17225: Bone Preform (Acc. 74) and Worked Bone (Acc. 78)

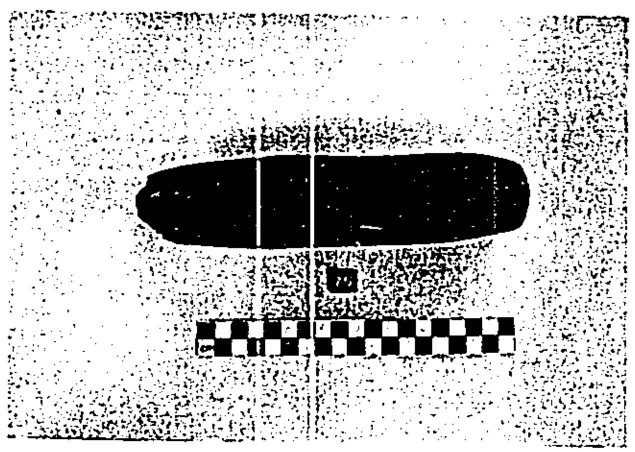

Figure 90 Site 50-10-47-17225: Wooden Tapa Beater (Acc. 75)

Historic Artifacts

Out of the 23 historic artifacts recovered, glass artifacts comprise the majority, accounting for 87% of the historic artifact inventory. These artifacts include 20 glass bottle fragments. Other historic artifacts include two metal fragments, accounting for 9% of the historic artifact inventory; and one ceramic fragment, representing 4%.

Twenty one of the historic artifacts (91%) were recovered from one of the sites tested, site 1948, Test Unit 8. This site also contained indigenous artifacts and, based on the presence of indigenous artifacts and other criteria, such as structural characteristics of the component features, is interpreted as having functioned primarily as a traditional permanent habitation site.

The presence of historic and modern artifacts within traditional features suggests historic and/or modern use of the pre-existing traditional sites. The remaining historic artifacts of the historic artifact inventory were collected from sites 17197 and 17199, both having contained one historic artifact each. Both of these sites also contained indigenous artifacts and, based on the presence of indigenous artifacts and other criteria, were interpreted as having functioned primarily as traditional or prehistoric habitation sites with subsequent use in historic and/or modern times.

In addition to the three sites in which historic artifacts were collected, historic and/or modern artifacts were observed at approximately 20 other sites within the project area. All of these sites were also interpreted as having been prehistoric in origin and use but, being located along the coast, have been subjected to historic and/or modern use or simply disturbance. The historic and modern artifacts observed included glass bottles, plastic tarps, and fishing gear, all of which is considered to represent the refuse left by intermittent visitors, most likely fishermen who used the coast of Keopuka for fishing and perhaps temporary or recurrent use of sites as camp sites."

Only four sites within the project area have been interpreted as exclusively historic in origin. These sites include two historic roads, site 10290 (also known as the King's trail) and site 17189, the Cart Road; one historic petroglyph (site 17179) and one wall segment (site 17210), considered to be a ranch-related wall. None of these historic sites is represented by portable artifacts.

The type and distribution of historic artifacts collected and simply observed within the project area suggest very limited use of the project area in historic times. Historic artifacts are limited to several coastal zone sites and appear to reflect the use of pre-existing sites as camp sites probably used by visiting fisherman. No evidence of other historic land use activities within either the coastal zone or the intermediate zone was represented in the historic artifact inventory.

Table 13 - Historic Artifact Catalog

Acc #	State site 50-10-47-	Test Unit	Stratum	Depth (cm.)	# Pieces	Length (cm)	Width (cm)	Thickness (cm)	Weight (gms)	Material	Function	Comments
H-1	1948A	8	–	surface	7	1 0/7.0	0 5/2 8	0 1/0 5	41 3	Glass	bottle	fragments
H-2	1948A	8	–	surface	1	9 5	8 0	0 5	572 3	Glass	bottle	broken neck
H-3	1948A	8	I	0-10	1	1 2	1.1	0 2	0 4	Glass	bottle	fragment
H-4	1948A	8	I	0-10	1	2 5	1 3	0 3	0 7	Glass	bottle	fragment
H-5	1948A	8	I	0-10	1	5 3	4 7	0 3	12 5	Glass	bottle	fragment
H-6	1948A	8	II	20-30	3	3 4/4.1	1.1/1 4	0 3/0 4	5 9	Glass	bottle	fragments
H-7	1948A	8	II	20-30	1	6 0	1 5	0 4	2 1	Glass	bottle	fragment
H-8	1948A	8	II	20-30	1	4 8	4 0	0 2	12 6	Glass	bottle	neck fragment
H-9	1948A	8	II	20-30	1	5 6	2 2	0 6	10 7	Glass	bottle	fragment
H-10	1948A	8	IIIa	30-40	1	1 5	0 7	0 2	0 7	Glass	bottle	fragment
H-11	1948A	8	IIIa	30-40	2	1.0/1.5	0.7/1 4	0 1/0 1	0 4	Metal	fragments	rusted
H-12	1948A	8	IIIb	40-50	1	2 3	1 2	0 3	3 3	Glass	bottle	fragment
H-13	17197A	5	Ib	100-110	1	1 3	1 0	0 3	0 6	Ceramic	vessel	fragment
H-14	171093	6	–	surface	1	2 8	1 5	0 2	1 0	Glass	bottle	fragment

Midden

Midden was recovered from four of the eight test units excavated during the testing phase of the project (Table 14). Marine midden (vertebrate and invertebrate) accounted for 95.6% (1894.2 gms.) of all midden collected from the project area. Of the total midden inventory, 94.8% represents shellfish (invertebrates) and the remaining 5.2% includes fish, bird, reptile, mammal and floral remains (*i.e.*, ***kukui*** endocarp).

The most common types of shellfish recovered in the project area include the following types (in descending order of quantity): snakehead cowry (*lehokupu*) *Cypraea caputserpentis*; dry shells (*papua*) *Thaididae* sp.; limpets (*'opihi*) *Cellana* sp.; pitchy sea snail (*pipihi*) *Nerita picea*; reticulate cowry (*leho*) *Cypraea maculifera*; periwinkles (*pipipi'akolea*) *Littorina* sp.; cone shells (*pupu'ala*) *Conus* sp.; toothed pearl shells *Isognomon* sp., turbo *sandwicensis*; oyster (*pipi*) *Pinctada* sp.; top shell (*ha'upu*) *Trochus intextus*; and auger shells (*pupulolo*) *Terebra* sp. The majority of these shellfish species are typically found in the tidal zone along rocky shores or sandy areas. Unidentified shell fish midden represented the category with the third highest quantity by weight.

Ten fish species are represented in the midden inventory including (in order of descending quantity): file fish (*oilili*) Monacanthid; trigger fish (*humuhumunukunukuapua'a*) Balistid; parrot fish (*uhu*) Scarid; shark (*mano*) Shark; squirrel fish (*ala'ihi*) Holocentrid; porcupine fish (*makimaki*) Deodontid; barracuda (*kaku*) Sphraenid; wrasse (*laenihi*) Labrid; and tuna mackerels (*ahi*) Scombrid. Fish bone unidentified to the family level represents the highest quantity of fish midden, by weight.

Of the total midden inventory, the terrestrial midden consists of 1.9% mammal bone, 0.2% bird bone, 2.1% kukui endocarps, and 0.1% medium vertebrate. The mammal and avian midden includes the following (in order of descending quantity): common dog (*'ilio*) *Canis familiaris*; small to medium mammal; hooved animals (Medium Artiodactyl); pig (*pua'a*) *Sus scrofa*, Medium Procellariid; medium bird; jungle fowl *Gallus*, and mongoose *Herpestes auropunctatus*.

The predominance of marine midden recovered from the project area clearly attests that coastal resources were a primary source of protein-related food for the residents of Keopuka. The shellfish types represented in the midden inventory are typically found in the tidal zones (shallow water) of both rocky and sandy areas. Most of the shellfish species were likely obtained locally along the Keopuka coastline and are attributable to near-shore shellfish collection. The fish midden recovered also reflects near-shore marine resource exploitation, and the presence of shark and *ahi* (Scombrid) suggests offshore exploitation as well.

The relatively low percentage of terrestrial midden (4.4%) recovered (and the predominance of marine midden) further indicates that the residents of Keopuka primarily exploited marine resources for food.

Table 14 - Continued

State site 50-10-47-	1948A	1948A	1948A	1948A	1948A	17197	17197	17197	17199B	17199B	17199B	17199B	17225A	Totals
Trench	8	8	8	8	8	5	5	5	6	6	6	6	7	
Depth(cm)/Stratum	0-10/I	10-20/II	20-30/II	30-40/IIIA	40-50/IIIB	0-10/VIA	100-110/VII	110-120/VII	surface	0-10/I	10-20/II	20-30/II	0-20/I	
Class Aves														
Medium Procellariid									0.8				2.4	3.2
Gallus gallus										0.6				0.6
Medium bird				0.4					0.2			0.3		0.9
Total Aves	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	1.0	0.6	0.0	0.3	2.4	4.7
Class Mammalia														
Canis familiaris								0.2					8.7	8.9
Herpestes auropunctatus							0.2							0.2
Sus scrofa								0.2	3.0					3.2
Medium Artiodactyl										3.5				3.5
Small-to-medium mammal							0.5		0.2	1.5		3.3		5.5
Medium mammal				3.5				2.6	4.2	0.7			6.7	17.7
Total Mammalia	0.0	0.0	0.0	3.5	0.0	0.0	0.7	3.0	7.4	5.7	0.0	3.3	15.4	39.0
Medium vertebrate												1.3		1.3
Kukui endocarps							4.1	3.9		6.3			28.2	42.5
Total Terrestrial Midden	0.0	0.0	0.0	3.9	0.0	0.0	4.8	6.9	8.4	12.6	0.0	4.9	46.0	87.5
Total Midden	44.1	87.8	146.1	192.9	45.4	52.2	151.2	144.6	9.5	285.2	344.1	431.1	47.5	1981.7

Table 14 - Midden Catalog

State site 50-10-47-	1948A	1948A	1948A	1948A	1948A	17197	17197	17197	17199B	17199B	17199B	17199B	17225A	Totals
Trench	8	8	8	8	8	5	5	5	6	6	6	6	7	
Depth(cm)/Stratum	0-10/I	10-20/II	20-30/II	30-40/IIIA	40-50/IIIB	0-100/IA	100-110/II	110-120/II	surface	0-10/I	10-20/II	20-30/II	0-20/I	
Class: Gastropoda														
Cellana sp.	13.5	32.7	31.9	7.6			3.0	14.1		6.6	14.5	7.9		131.8
Conus sp.			7.4					2.2			1.6	9.2		20.4
Cypraea caputserpentis			10.5	40.4	15.1	37.6	86.7	50.7		139.5	50.2	136.9		567.6
Cypraea maculifera	5.1	8.8	3.9	4.4	1.7			6.1		4.6		19.0		53.6
Littorina sp.	0.4	0.6	6.7	7.3	1.7		1.9	2.9		2.0	1.6	7.5		32.6
Nerita picea	0.6	4.1	12.7	8.9	2.1	0.4	7.2	9.1		23.1	21.4	18.9	-	108.5
Terebra sp.										0.3			1.2	1.5
Thaididae sp.	11.6	28.5	57.5	77.8	16.2	10.4	24.2	33.9		38.5	123.2	109.2		531.0
Trochus intextus								1.7						1.7
Turbo sandwicensis											2.7	0.3		3.0
Class: Pelecypoda														
Isognomon sp.							1.9	0.9			3.7	1.7		8.2
Pinctada												2.3		2.3
Unident./Other species	11.0	6.4	7.7	32.9	1.1	3.8	13.7	5.7	1.1	43.1	78.4	80.5		285.4
Total Mollusca	42.2	81.1	138.3	179.3	37.9	52.2	138.6	127.3	1.1	257.7	[illegible]	[illegible]	[illegible]	1747.6
Crustacean	1.5												0.1	1.6
Echinoderm	0.4	3.7	6.5	9.3	7.2		7.4	8.2		14.3	46.8	26.4	0.2	130.4
Total Invertebrate Midden	44.1	81.8	144.8	188.6	45.1	52.2	146.0	135.5	1.1	272.0	344.1	419.8	1.5	1879.6
Class: Chondrichthyes														
Shark								0.1		0.1				0.2
Class: Osteichthyes														
Holocentrid												0.2		0.2
Sphyraenid										0.1				0.1
Mullid												0.1		0.1
Labrid												0.1		0.1
Scarid		0.5	0.1									0.2		0.8
Scombrid												0.1		0.1
Balistid			0.1					0.8						0.9
Monacanthid								0.3		0.1		0.5		0.9
Diodontid										0.2				0.2
Misc. or Indeterminate		2.5	1.1	0.4	0.3		0.4	1.0		0.1		5.2		11.0
Total Chordata	0.0	3.0	1.3	0.4	0.3	0.0	0.4	2.2	0.0	0.6	0.0	6.4	0.0	14.6
Total Marine Midden	44.1	87.8	146.1	189.0	45.4	52.2	146.4	137.7	1.1	272.6	344.1	426.2	1.5	1894.2

Charcoal Analysis and Chronology

Radiocarbon Dating

A total of six charcoal samples were collected from four sites within the project area during the course of the present inventory survey (Table 15). Two of these samples (Accs. C-4 and C-6) were submitted to Beta Analytic Inc. of Miami, Florida for radiocarbon dating analysis. A charcoal sample from one other site within the project area was submitted for radiocarbon analysis during the course of the inventory survey conducted by PHRI in 1991 (Walker et al. 1991:22-23).

The source for one of the charcoal samples submitted for radiocarbon dating analysis during the present study (Acc. C-4) was site 17217, a lava tube interpreted as a recurrent habitation and burial site. A charcoal concentration was observed on the interior floor of the lava tube and a 15.0 gram sample was collected. Radiocarbon analysis of this charcoal sample produced a date range from a.d. 1662 to 1955 (calibrated dates from Stuiver and Reimer 1993).

The source for the other charcoal sample submitted for radiocarbon analysis during the course of the present study (Acc. C-6) was site 17225, Feature A lava tube, Test Unit 7. A 19.1 gram sample of charcoal and burnt wood was collected from Stratum I, 0-20 cm. level during the excavation of this test unit. Based on the quantity and quality of cultural material observed within site 17225 and the absence of evidence indicating modern use or disturbance of the site, site 17225 was considered to be a well-preserved site and the context of the charcoal sample within Test Unit 7 was considered to have been good. Radiocarbon analysis of this charcoal sample, however, yielded a modern date, suggesting that the sample had been contaminated.

According to a representative at Beta Analytic Inc., contamination of this sample during the handling process was unlikely, as was contamination from a typical Hawaiian lava flow since there was little "juvenile" carbon present (pers. comm., 1993). Contamination of this sample was more likely a result of modern charcoal from range fires in the area that had filtered down into the top soil stratum.

The source for the charcoal sample submitted during the PHRI inventory survey (Walker et al. 1991) was the surface of site 14192, a lava cave containing the remains of some seventeen individuals. Radiocarbon analysis of this sample produced multiple age ranges, the most likely of which was 1470-1680 AD, based on the following.

> While multiple age ranges are more difficult to interpret archaeologically, detailed examination of statistical sample curves, combined with evidence from artifactual material and feature stratigraphy, generally provides a means of selecting one age range as more probable than the others. (ibid:22)

Table 15 - Charcoal Catalog

Acc#	State site 50-10-47-	Feature	Test Unit	Stratum	Depth (cm)	Weight (gms)	Comments
C-1	17199	B	6	I	0-10	5.8	Charcoal flecks
C-2	17199	B	6	II	10-20	3.8	Charcoal flecks
C-3	17199	B	6	II	20-30	1.2	Charcoal flecks
*C-4	17217	--	--	--	surface	15	Charcoal flecks
C-5	17219	C	--	--	surface	4.9	Charcoal flecks
*C-6	17225	A	7	I	0-20	19.1	Charcoal flecks & wood chunks

*= samples sent to Beta Analytic for dating

Relative Dating

Prehistoric sites or complexes are typically distinguished by architectural characteristics (*i.e.*, traditional Hawaiian site and site complex characteristics), association with other prehistoric sites or complexes, presence of indigenous cultural materials, similar states of preservation and similar characteristics as other known prehistoric sites in the region and, in some cases, presumed function. Based on these general criteria, all but four of the 69 sites within the study area (94.2%) are considered to be prehistoric in origin.

Historic sites or complexes are typically distinguished by architectural characteristics (e.g., high walls, core-filled wall construction, spatial layout), the presence of historic-era artifacts and, in some cases, presumed or known function. Historic age determinations are also assisted by historic research and documentary evidence of historic land use in the vicinity of the project area. Based on these general criteria, only four of the 69 sites within the project area (5.8%) are interpreted as historic sites. The four sites interpreted as historic in origin include site 10290 road (the King's Trail), site 17189 road (Cart Road), site 17210 wall segment, and site 17179 petroglyph.

Although over 94% of the sites and site complexes within the project area are considered to be prehistoric in construction and use, historic and/or modern artifacts were observed at as many as 30% of these, suggesting these sites have been also used, or simply disturbed in historic and/or modern times. The presence of historic fishing gear, historic and modern water containers, and camping-related refuse at these sites indicate that much of the historic and modern use of these sites was by people fishing and camping along the coast of Keopuka and intentionally or unintentionally utilizing the pre-existing sites and features.

VI. SUMMARY AND CONCLUSIONS

The inventory survey identified 70 archaeological sites in the lower elevations of Keopuka *Ahupua'a* between the coast and approximately 660 ft. a.m.s.l. With exception to two historic roads (Site 10290 and 17189), the identified sites are believed to be associated primarily with prehistoric and maybe early historic use. These sites include a range of functional types: habitation (short-term and permanent), recreation (*heiau*), agricultural, *heiau*, burial, and trails.

A. Site Distribution

The majority of the 70 recorded sites in the project area (68%) are located along or immediately inland of the Keopuka coast, with the most compact clustering of sites occurring in the southern portion of the coast. Inland to a maximum elevation of 670 ft. a.m.s.l., sites are distributed sporadically - but at deliberate locations among pahoehoe lava *kipuka*.

Site distribution in the project area is predicted mostly by the topography and lava type of the landscape and the functional site types generally reflect their proximity to acquirable subsistence resources. The sites are distributed among three particular areas characterized by differing natural landscapes: (1) the shoreline terrace (beach) on the south coast; (2) the steep-sided sea cliff on the north coast and; (3) inland among lava tubes and *kipuka* in pahoehoe lava surrounded by the dominant a'a flow. A low site density occurs at the center of the coastline and almost no sites are located on the a'a flow encompassing much of the inland portion of the project area. The south coast clustering constitutes the northern fringe of the Ka'awaloa settlement.

On the coast, permanent habitation sites are clustered along the south bay area, where the coastline provides suitable access to the ocean and perhaps most importantly canoe landings. Other functional sites types occur in association with the south coast cluster of permanent habitation sites, such as complexes of burial monuments, a holua slide, the *makai* end of the main *mauka-makai* trail in Keopuka, and intermittent occurrences of lava excavations (probable agriculture pits). Temporary and recurrent habitation sites also occur behind the coastal sites.

The north portion of the coast, being dominated by a sea cliff, has limited areas where ocean access can be gained. Seemingly as a response to this restricted landscape, only two permanent habitation sites are located there among prominent niches in the sea cliff that provide access to the sea. A scattering of short-term habitation shelters predominate along the sea cliff and immediately inland among a large concentration of lava excavations (interpreted as agricultural pits). The agricultural features cover most of the pahoehoe lava terrain that essentially constitutes the point of Keopuka land (Keawekaheka Point) that forms the sea cliff of the north coast.

The distribution of sites inland form a distinct linear, *mauka-makai* pattern that follows the natural course of lava tube formations and pahoehoe lava *kipuka*. Lava tubes utilized for both short-term (temporary and recurrent) and permanent occupation, and burial placement, comprise roughly 60 percent of the inland site types, with the remaining types associated with *mauka-makai* travel (trails, *ahu* and temporary shelters), and only one site is attributable to agricultural activities - an endeavor that appeared to be restricted to a single gully formation made up of older a'a lava material.

B. Settlement Pattern and Land Use

Using information acquired from the previous archaeology and historic background of Keopuka *ahupua'a* and Kealakekua region, and survey results of the present study, a settlement pattern typifying *ahupua'a* landuse on the leeward (Kona) side of Hawai'i Island is indicated in Keopuka *Ahupua'a*. Three general terrestrial zones reflect the pattern of landuse: (1) Coastal Zone; (2) Intermediate Zone; and (3) Upland Zone.

These three terrestrial zones probably provided the majority of subsistence resources (except upland forest goods) available to the traditional Hawaiian residents of Keopuka. Using this model, the present study area appears to only encompass the Coastal and Intermediate Zone of Keopuka. Archaeological data regarding the Upland Zone has been taken from a previous study (Rosendahl and Jensen 1989).

Coastal Zone

The Coastal Zone appears to have been the primary locus of permanent settlement during prehistoric times in Keopuka, with the main core of permanent residences generally centered around the south end of the Keopuka coast. This relatively small settlement consists of at least nine permanent residences, a *holua* slide (that crosses the south boundary of Keopuka), complexes of burial monuments, agricultural pits (lava excavations), and a network of trails. Temporary and recurrent-use shelters occur behind the settlement and may have represented "guest houses" of visiting family and friends, or shelters simply utilized by upland residents of Keopuka while procuring coastal resources. Such coastal resources of the south coast could have included salt, marine resources (obtained by near-shore fishing and shellfish collection) and canoe access for travel and off-shore fishing. The settlement is concentrated in the south bay area probably because it offers the best ocean access on the Keopuka coast. This settlement was probably the northern fringe of the major prehistoric-historic population center at Ka'awaloa to the south.

The village settings at Ka'awaloa and Kealakekua (both on Kealakekua Bay) were probably the most important political and religious centers in South Kona known to have been homes to the agricultural god Lono (whom with his wife lived "beneath the steep rock" at Kealakekua [Beckwith 1971:31]), and several *ali'i nui* during both prehistoric and early historic times. The name Ka'awaloa, as translated by Pukui (1974:61) "as the distant kawa" also suggests that chiefs who resided there, as Pukui explains, made use of "runners [from Ka'awaloa who] went to Puna or Waipi'o to get kawa for chiefs" (*ibid.*).

In contrast to the south coast, the north coast of Keopuka is characterized by a scattering of short-term shelters near the sea cliff and in proximity to an extensive complex of agricultural lava excavations. A coastal trail likely existed somewhere along the perimeter of the coast, as is suggested by the presence of three short, parallel sections of trails on the central portion of the coast. Three main activities appear to be associated with use of the shelter sites on the north coast: (1) near-shore resource procurement of mainly "hook and line fishing" and hazardous shellfish collection (2) tending the agricultural gardens in the lava excavations, and (3) travel along a coastal trail. The presence of a fishing shrine or *koa* along the north coast attests that marine resources, although seemingly more difficult to acquire, were indeed an important procurement in this region. The *koa* - being in close proximity -

may also be affiliated with one of the only two permanent habitation sites located on the north coast near the north boundary of Keopuka.

The large number of lava excavations located among the permanent habitation sites on the south coast and behind the short-term shelters on the north coast represents an interesting component of the coastal settlement in Keopuka. These features may have functioned as supplemental gardens that provided special plant types (*e.g.*, *ti* and medicinal herbs) that were needed in the permanent residences on a daily basis. It may be further speculated that the expansive lava excavations on the coast were due to the lack of potential agricultural plots immediately inland in the Intermediate Zone because of the dominating a'a flow.

This same pattern of coastal zone agriculture in the form of lava excavations has been identified in association with other coastal settlements nearby in Hokukano (Hammatt *et. al.* 1994) and at more distant locations such as at Palima Point, in Ka'u (McDermott *et. al.* 1993). The similarities between these three settlements is that the coastal terrain is predominantly pahoehoe lava. Successful cultivation in the lava pits in the dry environment of the Keopuka coast would have required careful attendance and most importantly constant watering.

Given the potential association between the permanent settlement along the south coast of Keopuka and the political and religious settlement at Ka'awaloa, and the presence of a *holua* slide close to the Keopuka residences, individuals of high-status may have been connected to the south coastal cluster in Keopuka. This speculation is based on the knowledge that *holua* slides were commonly associated with *ali'i* and their primary residences (*e.g.*, *holua* slides identified in coastal settlements in Keauhou, Honaunau and Honokohau) and that a few of the residential sites appear to be larger and more substantially constructed than others (*i.e.*, suggesting a dichotomy of social classes in the settlement).

Although no absolute dates are available for any of the permanent habitation sites in Keopuka or nearby Ka'awaloa, we posit that permanent occupation of Ka'awaloa would have been one of the earliest in South Kona, particularly because Kealakekua Bay would have provide the best protected bay on the Kona coast. The agriculturally productive uplands evidenced in Ka'awaloa and the degree in which the landscape was modified for agriculture (*e.g.*, Kona Field System) indicates that Ka'awaloa attracted and subsequently supported a large and thriving populace during prehistoric times. This population probably grew following the development of intensive, upland agriculture, sometime during the middle of the Expansion Period, *ca.* A.D. 1400 (Kirch 1985:305). The permanent settlement at the coast of Keopuka, being at the outer fringe of the Ka'awaloa settlement, may have developed during late prehistory as the result of a lateral expansion of the population at Ka'awaloa. The dominant a'a flow that encompasses much of the uplands of Keopuka was probably a major factor for the development of only a small settlement at a later time in prehistory.

Intermediate Zone

The Intermediate Zone is a relatively arid landscape that stretches between the Coastal Zone and the Upland Zone of Keopuka, the latter of which is presumably the agriculturally productive lands of the *ahupua'a* where intensive dryland sites have been identified, above approximately 800 ft. a.m.s.l.

The inland portion of the project area is considered to be in the Intermediate Zone because of its arid character and low potential for agricultural productivity. Almost all of the sites in the Intermediate Zone occur in lava tubes, and include utilization of the tubes for habitation and burial placement. Although short-term use is the prominent mode of habitation represented at the sites, a few permanent habitation sites (characterized by surface structures) also occur in proximity to large lava tubes around the 600 foot contour.

With the exception of the three permanent habitation sites, the Intermediate Zone of Keopuka was apparently valued for its lava tubes for burial placement and used mainly as a passage while traveling between the coastal settlement and the productive agricultural uplands. This type of travel is evidenced by the presence of a *mauka-makai* trail (primarily one along the south boundary), *ahu* (trail markers), and associated short-term (temporary and recurrent) shelter sites. Perhaps an indication of which portion of the Intermediate Zone was commonly traveled through, the main *mauka-makai* trail completely avoids the interior and northern portion of the *ahupua'a*, choosing a course near and along the south boundary of Keopuka, beginning at the main permanent settlement on the coast. The *mauka* section of the main trail was probably deliberately routed next to a series of lava tubes on the south boundary of Keopuka. These lava tubes were apparently used for permanent and temporary habitation and burial placement.

Only one agricultural site (covering an area approximately 500 m.²) was identified in the Intermediate Zone. This site exemplifies traditional agriculture methods of cultivating in a gully formation and *kipuka* of older a'a flow deposits. The natural gully formation was probably one of only a few areas (if any others exist) in the Intermediate Zone that had the potential for providing accumulation and retention of moisture, as well as partially tillable soils for cultivation. Therefore, it is likely that if such micro-environments existed at similar elevations, more agricultural sites would have developed in the Intermediate Zone.

Two radiocarbon dates were obtained from two of the large Intermediate Zone lava tubes, situated between 525 and 670 ft. a.m.s.l., respectively. A lava tube (Site 14192), used exclusively for burial placement (19 individuals), yielded a date range of A.D. 1470-1680. This date taken from a charcoal sample on the floor of the lava tube, is probably attributable to placement of one or some of the burials. The time range plausibly reflects when *mauka-makai* travel was common along the adjacent trail because of the development of upland, dryland agriculture during the middle Expansion Period, *ca.* 1400 (Kirch 1985:305) and its intensification into all upland subzones up into the 17th century (*i.e*, Refuge, Habitation, and Intensive/Extensive Gardening Phase, *ca.* A.D. 1600/1650-1779 [Schilt 1984:284]). The other radiocarbon date - A.D. 1662-1955 -was obtained from Site 17225 lava tube, a feature that was apparently used for permanent habitation (auxiliary to) and burial placement in the more isolated, interior portion of the Intermediate Zone in Keopuka.

Upland Zone

A predominance of agricultural sites, associated with a few habitation sites, were identified in a portion of the Upland Zone of Keopuka between the present study area (approximately 750 ft. a.m.s.l.) and roughly 1150 ft. a.m.s.l. (Rosendahl and Jensen 1989). As in the Intermediate Zone, this upland portion of Keopuka is dominated by the a'a flow, and as a result the agricultural landscape differs greatly from the classic field system "type" (*e.g.*, Kona Field System) identified more expansive soil areas in Ka'awaloa *Ahupua'a* to the south and Onouli to the north. The agricultural sites are characterized by "agricultural pits", terraces, and mounds (and minor agricultural features that were not recorded) - most of which seem to be clustered near the south boundary of Keopuka. Rosendahl and Jensen describe the upland landscape of Keopuka (the southern portion of the actual project area) as "an uneven a'a substrate". A trail section oriented east-west was also identified near the south boundary of Keopuka and likely represents the upland extension of the *mauka-makai* trail recorded between the coast and Intermediate Zone.

This portion of the Upland Zone in Keopuka seems to contain evidence of intensive, dryland agriculture that is distinctive when cultivating in predominantly lava landscapes. But the number of agricultural features and proportion of the landscape modified is clearly meager in comparison to other agricultural landscapes at this elevation, such as the extensive field complexes and apparently sizable upland settlements identified in the neighboring Ka'awaloa and Onouli *Ahupua'a*. Thus, it may be posited that Keopuka, as an independent land division, did not have the natural resources, mainly productive agricultural lands) to sustain a large populace at the coast. This may explain why a relatively small permanent settlement developed at the coast and why only a few permanent residences in the Upland Zone were necessitated to maintain the limited crop lands.

VII. SIGNIFICANCE EVALUATIONS

A total of 70 sites of varied archaeological significance are present in the project area (see Table 1). Sites were evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

- A Site reflects major trends or events in the history of the state or nation
- B Site is associated with the lives of persons significant in our past
- C Site is an excellent example of a site type
- D Site may be likely to yield information important in prehistory or history
- E Site has cultural significance; probable religious structures (shrines, *heiau*) and/or burials present (the designation E* is given to possible burial sites)

Of the total 70 sites recorded, 42 sites are classified solely with significance criterion D and four sites with criterion E (or E*); the remaining 24 sites meet multiple significance criteria (Table 16).

Criterion A - "site reflects major trends or events in the history of the state or nation" is assigned to three sites in the project area, the "Old Government Road (Site 10290); the "Old Cart Road" (Site 17189); and a historic petroglyph of a person's name and date (Site 17179). The historic roads represent a major trend in the 19th Century in which transportation routes - following straighter courses than traditional trails - were constructed specifically for horse and cart travel. During the mid-20th century, one of these historic roads (Site 17189) was mechanically widened and levelled for use as a jeep road; thus, marking another trend of historic road building and the development of motorized, off-road vehicles following WWII. Site 17199 petroglyph, which denotes a Hawaiian name "Kainoa" written in "1890", symbolizes a post contact stage in the evolution of petroglyph styles, in which Hawaiian names and words became transcribed into Roman letters.

Criterion B - "site is associated with the lives of persons significant in our past" is assigned to one site, the *holua* slide (Site 17207). The recreation of *Holua* sledding is known to have been affiliated with the Hawaiian *ali'i*, being both participant and spectator (Malo 1951:224). Holua sledding was also an annual event associated with the *makahiki* (*ibid.* 1951:148).

Eleven sites are considered to be "excellent site types" (Criterion C) because they appear to represent the best examples of structural (*i.e.*, best condition) and functional archaeological components in the project area. Included among these sites are: two possible and confirmed burial complexes (Site 1960 and 17205); two sections of the *mauka-makai* trail (Site 7728 and 14186); the *holua* slide (Site 17207); five largely intact permanent habitation sites (Site 1948, 17192, 17193, 17197, and 17203) - four of which have substantial architecture; and the "Old Government Road" (Site 10290).

Criterion D - "site may be likely to yield information important in prehistory and history" - is assigned to most of the sites (65), except for solitary burial sites. It is believed that these sites yield varying types of scientific data and contribute to some or all of the following analyses: (1) material culture; (2) site architecture and function; (3) chronology; and (4) settlement patterns. We believe that 13 of these 65 sites lack any additional scientific data beyond what was acquired during the inventory survey (*i.e.*, site configuration, description, and plotted location).

Upland Zone

A predominance of agricultural sites, associated with a few habitation sites, were identified in a portion of the Upland Zone of Keopuka between the present study area (approximately 750 ft. a.m.s.l.) and roughly 1150 ft. a.m.s.l. (Rosendahl and Jensen 1989). As in the Intermediate Zone, this upland portion of Keopuka is dominated by the a'a flow, and as a result the agricultural landscape differs greatly from the classic field system "type" (*e.g.*, Kona Field System) identified more expansive soil areas in Ka'awaloa *Ahupua'a* to the south and Onouli to the north. The agricultural sites are characterized by "agricultural pits", terraces, and mounds (and minor agricultural features that were not recorded) - most of which seem to be clustered near the south boundary of Keopuka. Rosendahl and Jensen describe the upland landscape of Keopuka (the southern portion of the actual project area) as "an uneven a'a substrate". A trail section oriented east-west was also identified near the south boundary of Keopuka and likely represents the upland extension of the *mauka-makai* trail recorded between the coast and Intermediate Zone.

This portion of the Upland Zone in Keopuka seems to contain evidence of intensive, dryland agriculture that is distinctive when cultivating in predominantly lava landscapes. But the number of agricultural features and proportion of the landscape modified is clearly meager in comparison to other agricultural landscapes at this elevation, such as the extensive field complexes and apparently sizable upland settlements identified in the neighboring Ka'awaloa and Onouli *Ahupua'a*. Thus, it may be posited that Keopuka, as an independent land division, did not have the natural resources, mainly productive agricultural lands) to sustain a large populace at the coast. This may explain why a relatively small permanent settlement developed at the coast and why only a few permanent residences in the Upland Zone were necessitated to maintain the limited crop lands.

VII. SIGNIFICANCE EVALUATIONS

A total of 70 sites of varied archaeological significance are present in the project area (see Table 1). Sites were evaluated for significance according to the broad criteria established for the National and State Registers. The five criteria are:

- A Site reflects major trends or events in the history of the state or nation
- B Site is associated with the lives of persons significant in our past
- C Site is an excellent example of a site type
- D Site may be likely to yield information important in prehistory or history
- E Site has cultural significance; probable religious structures (shrines, *heiau*) and/or burials present (the designation E* is given to possible burial sites)

Of the total 70 sites recorded, 42 sites are classified solely with significance criterion D and four sites with criterion E (or E*); the remaining 24 sites meet multiple significance criteria (Table 16).

Criterion A - "site reflects major trends or events in the history of the state or nation" is assigned to three sites in the project area, the "Old Government Road (Site 10290); the "Old Cart Road" (Site 17189); and a historic petroglyph of a person's name and date (Site 17179). The historic roads represent a major trend in the 19th Century in which transportation routes - following straighter courses than traditional trails - were constructed specifically for horse and cart travel. During the mid-20th century, one of these historic roads (Site 17189) was mechanically widened and levelled for use as a jeep road; thus, marking another trend of historic road building and the development of motorized, off-road vehicles following WWII. Site 17199 petroglyph, which denotes a Hawaiian name "Kainoa" written in "1890", symbolizes a post contact stage in the evolution of petroglyph styles, in which Hawaiian names and words became transcribed into Roman letters.

Criterion B - "site is associated with the lives of persons significant in our past" is assigned to one site, the *holua* slide (Site 17207). The recreation of *Holua* sledding is known to have been affiliated with the Hawaiian *ali'i*, being both participant and spectator (Malo 1951:224). Holua sledding was also an annual event associated with the *makahiki* (*ibid.* 1951:148).

Eleven sites are considered to be "excellent site types" (Criterion C) because they appear to represent the best examples of structural (*i.e.*, best condition) and functional archaeological components in the project area. Included among these sites are: two possible and confirmed burial complexes (Site 1960 and 17205); two sections of the *mauka-makai* trail (Site 7728 and 14186); the *holua* slide (Site 17207); five largely intact permanent habitation sites (Site 1948, 17192, 17193, 17197, and 17203) - four of which have substantial architecture; and the "Old Government Road" (Site 10290).

Criterion D - "site may be likely to yield information important in prehistory and history" - is assigned to most of the sites (65), except for solitary burial sites. It is believed that these sites yield varying types of scientific data and contribute to some or all of the following analyses: (1) material culture; (2) site architecture and function; (3) chronology; and (4) settlement patterns. We believe that 13 of these 65 sites lack any additional scientific data beyond what was acquired during the inventory survey (*i.e.*, site configuration, description, and plotted location).

Table 16 - Sites with Multiple Significance Criteria

Site No.	Site Type	Interpreted Function	Multiple Significance
10290	Trail	Transportation-"Old Govt. Rd."	A,C,D
17189	Trail	Transportation-"Old Cart Rd."	A,D
17179	Petroglyph	Special	A,D
7727	Trail	Transportation	A,D
17207	Hōlua slide	Recreation	B,C,D,E
17197	Complex	Permanent habitation	C,D
17203	Complex	Permanent habitation	C,D
17193	Complex	Permanent habitation	C,D
1948	Complex	Permanent habitation	C,D
17192	Complex	Permanent habitation	C,D
14186	Trail	Transportation	C,D,E
7728	Trail	Transportation	C,D,E
17205	Complex	Burial (possible); Special	C,D,E*
1960	Complex	Burial; burials (possible)	C,E
17217	Lava tube	Recurrent habitation; burial	D,E
17224	Complex	Recurrent habitation; burial	D,E
17235	Complex	Recurrent habitation; burial	D,E
17216	Complex	Recurrent habitation; Transportation	D,E
1949	Complex	Heiau	D,E
14190	Complex	Permanent habitation; burial	D,E
17194	Complex	Recurrent habitation; burial (possible)	D,E*
17202	Complex	Permanent habitation; burial (possible)	D,E*
17198	Complex	Recurrent hab.; burial (possible); marker	D,E*
1952	Complex	Permanent habitation; burial (possible)	D,E*

Criterion E - "site has cultural significance; probable religious structures (shrines, *heiau*) and/or burials present" - is assigned to 18 sites in the project area. These sites include: nine sites with confirmed burials (Site 1960, 14185, 14190, 14192, 17217, 17224, 17229, and 17235); six sites with possible burials (1952, 17194, 17198, 17202, 17204, and 17205); one *heiau* (Site 1949); the *Hōua* slide (Site 17207): and the three, presumed to be, *mauka-makai* trail sections (Site 7728, 14186, and 17216). The burial and *heiau* sites reveal traditional belief systems. The *Hōua* slide symbolizes an important recreational activity of the Hawai'ian *ali'i* and *maka'ainana* as well. The recreation was also a consequential component of the *makahiki*. Lastly, the three trail sections probably denote the location of a primary travel route through Keopuka and the traditional method of land transportation used by the Hawai'ians (*i.e.*, foot travel).

VIII. RECOMMENDATIONS

Of the 70 sites recorded in the project area, it is recommended that 31 sites be subjected to a program of data recovery and 26 sites be preserved. The remaining 13 sites (see Table 1) in the project area are not recommended for further work, as it is believed that no additional scientific data is obtainable from the sites, beyond what was acquired during the inventory survey (*e.g.*, site configuration, description, and plotted location. Sixty-five percent of these sites consist of temporary habitation shelters that occur in small lava tubes and blisters with no soil or cultural deposits, or in enclosures with no structural integrity and that lack subsurface deposits. *Ahu* that are solely interpreted as markers comprise the remaining 25 percent of the sites not requiring further work.

A. Data Recovery

The 31 sites recommended for data recovery (Table 17) should be subjected to intensive documentation, and if feasible, excavation to address scientific and informational concerns. Five of these sites (Site 1952, 1958, 17194, 17198, and 17202) may contain burial components (possible burials) and if identified through limited testing, require preservation treatment. These possible burial sites contain significant habitation component features that we believe warrant a data recovery level of work. Data recovery will only proceed in accordance with a data recovery plan which is submitted to the DLNR-State Historic Preservation Division and Hawai'i County for approval.

The sites selected for data recovery include a variety of site/feature types and function types attributable to traditional Hawai'ian use. These sites are represented by all modes of habitation (temporary, recurrent and permanent), the only two agricultural sites in the project area, and six trails. Data recovery at these sites may range from additional historic research of the "Old Cart Road" (Site 17189) and extensive mapping and intensive documentation of the lava excavations (Site 17172), to intensive excavations at select sites.

In consideration of Keopuka's close proximity to a major population settlement surrounding Kealakekua Bay, we would advocate that future data recovery work focus largely on defining the nature and chronological development of the permanent settlement identified along the south coast of Keopuka. Three research topics could be considered.

Table 17 - Sites Recommended for Data Recovery and Possible Preservation

Site No.	Site Type	Interpreted Function	Significance
7727	Trail	Transportation	A,D
17189	Trail	Transportation-"Old Cart Rd."	A,D
1950	Complex	Recurrent habitation	D
1953	Lava blister	Temporary habitation	D
1955	Complex	Recurrent habitation	D
1956	Platform	Recurrent habitation	D
1957	U-shaped enclosure	Recurrent habitation	D
1959	C-shaped enc/pavement	Recurrent habitation	D
1961	Complex	Recurrent habitation; modern hearth	D
14188	Complex	Permanent habitation	D
17172	Lava excavations	Agriculture	D
17174	Trail	Transportation	D
17183	Trail	Transportation	D
17185	Trail	Transportation	D
17188	Lava blister	Temporary habitation	D
17191	Lava tube	Temporary habitation	D
17199	Complex	Recurrent habitation	D
17206	Pavement	Permanent habitation	D
17209	Complex	Transportation; Marker	D
17213	Lava tube	Temporary habitation	D
17218	Lava tube	Temporary habitation	D
17219	Complex	Recurrent habitation	D
17220	Lava blister	Recurrent habitation	D
17221	Complex	Permanent habitation	D
17222	Rectangular enclosure	Permanent habitation	D
17228	Complex	Agriculture	D
1958	Complex	Recurrent habitation; ✗ possible burial	D
17198	Complex	Recurrent hab.; ✗ possible burial; marker	D,E*
1952	Complex	Permanent habitation; ✗ possible burial	D,E*
17194	Complex	Recurrent habitation; ✗ possible burial	D,E*
17202	Complex	Permanent habitation; ✗ possible burial	D,E*

✗ Possible Preservation, pending data recovery testing results

The prevalence of multiple-structure permanent habitation sites may provoke a more detailed functional analysis of the individual house structures:

(1) *Functional Analysis* of individual component features in permanent habitation sites and their relationship to other component features (*i.e kau-hale* type residences). External correlations may be made with ethnohistoric sources regarding *kau-hale* designs (*e.g.*, Handy and Pukui 1991) and previous archaeological analyses of household models (*e.g.*, Cordy 1991; Mitchell and Kolb 1992, among others)

Based on an apparent dichotomy of permanent habitation site types on the coast (large *vs.* small and simple *vs.* complex), the subject of socio-political rank may be investigated:

(2) *Socio-political rank* of inhabitants of the permanent habitation sites. External correlations may be made with ethnohistoric sources (*e.g.*, Ellis 1963, Malo 1951, among others) and previous archaeological analyses (*e.g.*, Cordy 1981, 1991, among others)

The site excavations may also provide data that indicates:

(3) The *chronology* of permanent habitation on the Keopuka coast. Temporal affiliation could be explored through radiocarbon dating of stratified cultural deposits - if possible. This information may provide some clues as to when the Keopuka coast was first occupied, if there was a certain period in prehistory when Keopuka was most populated, and when the Keopuka coast became abandoned.

B. Preservation

Twenty-five sites in the project area are recommended for preservation (Table 18). Recommendations for site preservation - with the exception of burials - were made based on comparisons between the sites in the project area, and with the intent to preserve a cluster of seemingly interrelated sites located primarily along the south coast of Keopuka.

The twenty-five preservation sites include a *heiau* (Site 1949); *Hōlua* slide (Site 17207); all confirmed burial sites (Site 1960, 14185, 14192, 17229); all sites with confirmed burial features (Site 14190, 17217, 17224, 17225, and 17235); two sites with petroglyphs (17179 and 17205-includes a possible burial feature); the three sections of a *mauka-makai* trail (Site 7728, 14186, and 17216); eight permanent habitation complexes (1948, 17192, 17193, 17195, 17197, 17201, 17203, and 17208); and the "Old Government Road" (Site 10290).

The *heiau* (Site 1949) is recommended for preservation because it embodies cultural and religious beliefs that are integral to the traditional Hawai'ian culture. To maintain the symbolism and religious nature of the *heiau*, stringent buffer zones must be considered in the preservation of the *heiau*.

The confirmed burials in the project area are recommended for protective preservation; that is the individual burial feature of the site should be preserved in place and

Table 18 - Sites Recommended for Preservation

Site No.	Site Type	Interpreted Function	Significance
7728	Trail	Transportation	A,C,D
10290	Trail	Transportation-"Old Govt. Rd."	A,C,D
17179	Petroglyph	Special	A,D
17207	Hōlua slide	Recreation	B,C,D,E
1948	Complex	Permanent habitation	C,D
14186	Trail	Transportation	C,D
17192	Complex	Permanent habitation	C,D
17193	Complex	Permanent habitation	C,D
17197	Complex	Permanent habitation	C,D
17203	Complex	Permanent habitation	C,D
17205	Complex	Possible burial; Special	C,D,E*
1960	Complex	Burial; possible burials	C,E
17195	Complex	Permanent habitation	D
17201	Complex	Permanent habitation	D
17208	Complex	Permanent habitation	D
17216	Complex	Recurrent habitation; Transportation	D
17225	Complex	Permanent habitation; burial	D
1949	Complex	Heiau	D,E
14190	Complex	Permanent habitation; burial	D,E
17217	Lava tube	Recurrent habitation; burial	D,E
17224	Complex	Recurrent habitation; burial	D,E
17235	Complex	Recurrent habitation; burial	D,E
17204	Platform	Possible burial	*E
14185	Lava tube	Burial	E
14192	Lava tube	Burial	E
17229	Lava tube	Burial	E

protected from any potential adverse impact. Future treatment of these burials and any other burials encountered on the property will be done in accordance with a burial treatment plan, which will be reviewed and subject to approval by the DLNR and the Hawai'i Burial Council.

The trails, permanent habitation sites, petroglyphs and *Hōlua* slide are recommended for interpretive preservation. We define interpretive preservation as a mode for protecting select archaeological sites from destruction (due to development and any other potential adverse impact) so that a microcosm of the prehistoric cultural landscape distinctive to Keopuka may be maintained for future study and reverence. Some level of additional research of the sites may be warranted as a supplement to the site preservation (*e.g.*, oral historical research, excavations, and more detailed documentation) to insure that accurate functions and associations of the preserved sites are known.

Data recovery and preservation must be implemented through plans submitted to the DLNR-SHPD for review and approval. Data recovery and preservation plans are not included in the scope of the present study.

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Appendix: Project Photographs

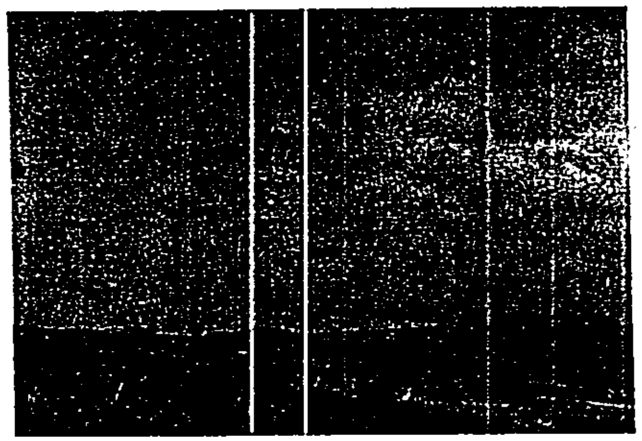


Figure 91 Keopuka Project Area, General View to North

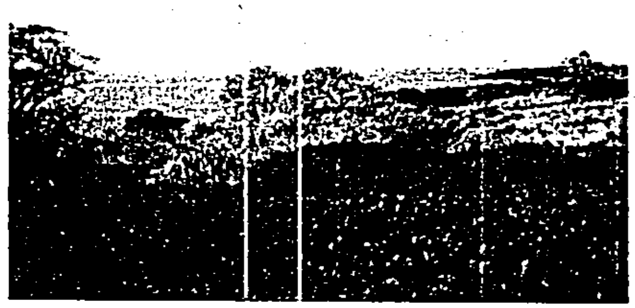


Figure 92 Keopuka Project Area, General View to West (*makai*)

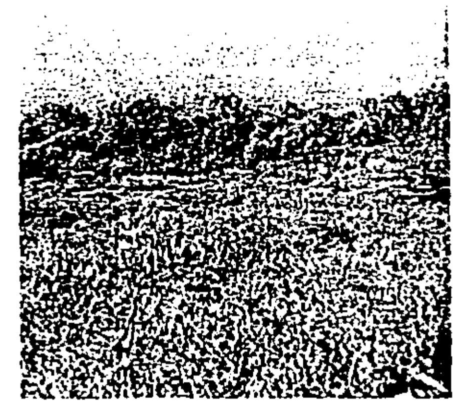


Figure 93 Keopuka Project Area, General View to South (*makai*)

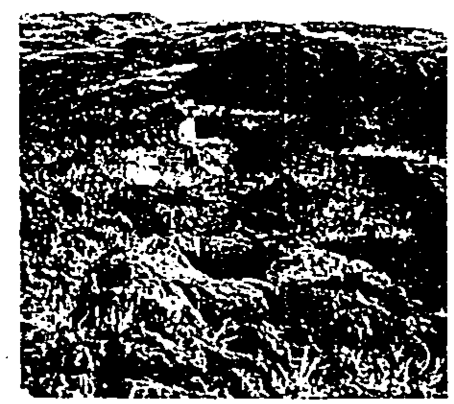


Figure 94 Keopuka Project Area, General View to East (*mauka*)

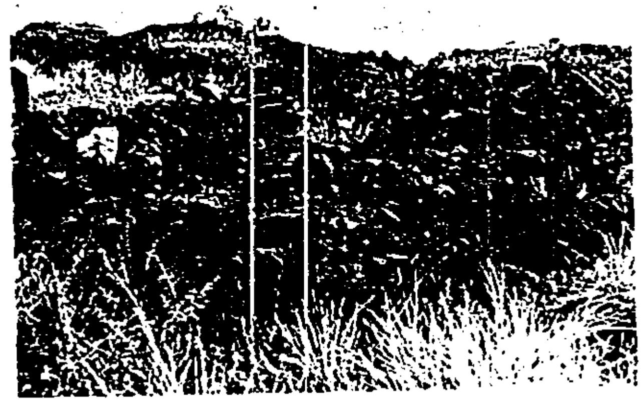


Figure 95 Site 50-10-47-1955 Feature A Platform

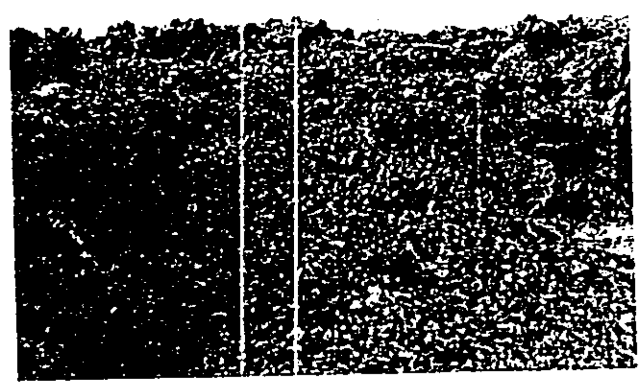


Figure 96 Site 50-10-47-1960 Complex

Figure 97 Site 50-10-47-7728 Stepping-Stone Trail

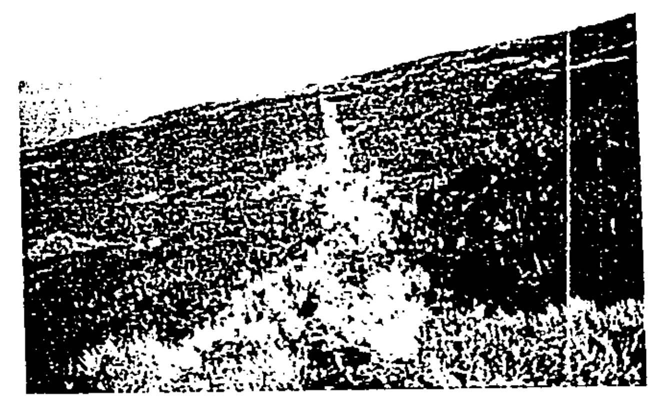


Figure 98 Site 50-10-47-10290 Historic Trail ("Old Government Road": View North

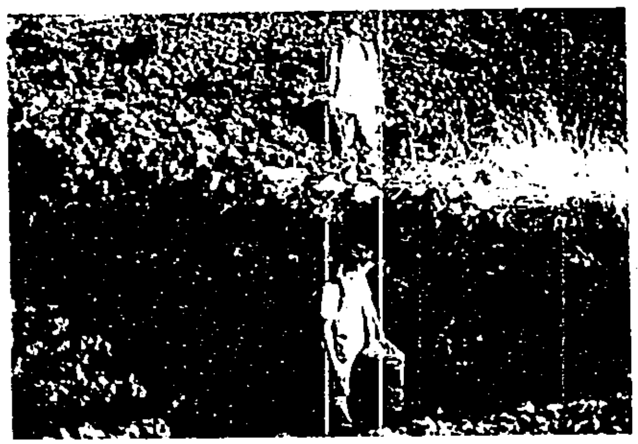
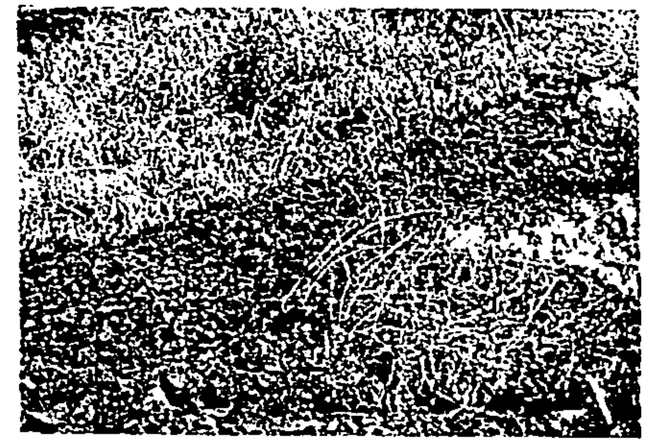


Figure 99 Site 50-10-47-10290 Historic Trail ("Old Government Road"): Showing Berm Construction

Figure 100 Site 50-10-47-17181, Showing Lava Tube Entrance



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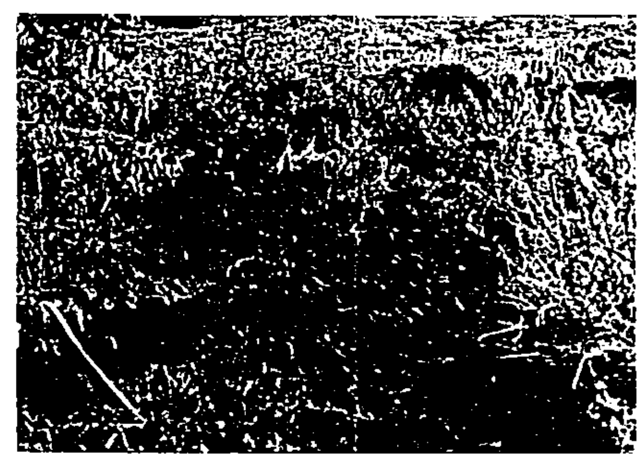

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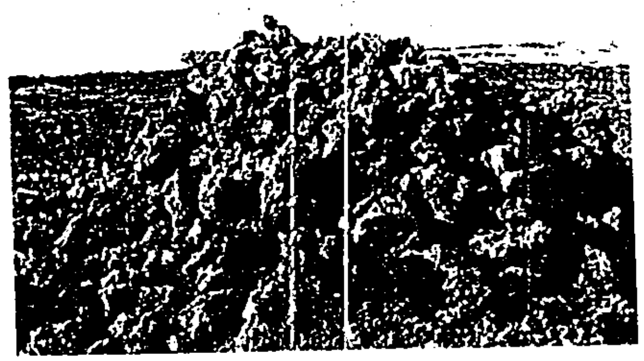
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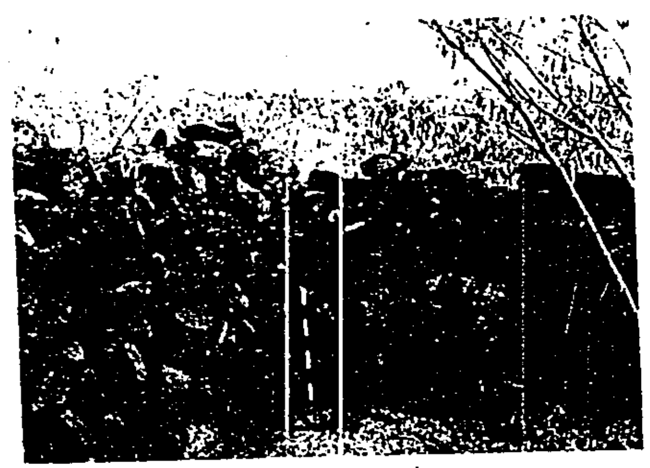
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APPENDIX I-3

Cultural Impacts Survey

SCS Project Number 211-2

ORAL HISTORY INTERVIEWS, AND AN ASSESSMENT OF CULTURAL IMPACTS FOR KEŌPUKA, SOUTH KONA, HAWAI'I ISLAND [TMK: 8-1-7:01, 54 AND 55]

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March 2000

Prepared for:
Pacific Star, LLC

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711 Kapiolani Blvd. Suite 1475 Honolulu, Hawai'i 96813

ABSTRACT

At the request of Pacific Star, LLC, Scientific Consultant Services (SCS) was contracted to conduct a Cultural Impact Assessment to be included within an Environmental Impact Statement concerning 660 acres encompassing the *ahupua'a* of Keōpuka, South Kona, Hawai'i Island (TMK: (3)8-1-7:01, 54 and 55).

This project contains several components which primarily include appropriate archival/background research, identification and consultation with a number of informants, and a synthesis and assessment of the findings from applicable archaeological work, archival/background, and ethnographic research.

Seven individuals were recommended to SCS through consultation with OHA O'ahu and Hawai'i Island representatives, as well as suggestions from long term South Kona residents. Limited oral interviews were conducted in Kona between the dates of March 16 to April 20, 2000.

The ethnographic interviews with these individuals did not identify any specific traditional cultural properties as defined in the National Register Criteria for Evaluation. Presently, the only known culturally significant sites are the archaeological features that have been identified throughout the project area. Mitigation of these resources are discussed within the various archaeological site reports.

ACKNOWLEDGMENTS

The author would like to thank those individuals who gave of their time and knowledge and whose contributions helped make this report possible. These include OHA representatives Lynn Lee on O'ahu and Ruby MacDonald in Kona, Gorden Leslie, Jean Greenwell, Frank Silva, Billy Paris, Toshio Shirai, Kazue Yoshiki, and Nobu Shibuya.

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INTRODUCTION

At the request of Pacific Star, LLC, Scientific Consultant Services (SCS) was contracted to conduct a Cultural Impact Assessment to be included within an Environmental Impact Statement concerning 660 acres encompassing the *ahupua'a* of Keōpuka, South Kona, Hawai'i Island (TMK: (3)8-1-7:01, 54 and 55; Figure 1).

Several publications pertaining to the process of evaluating and documenting traditional cultural properties and for assessing cultural impacts provided guidance in ascertaining information for this report. The National Park Service was directed to prepare guidelines to assist in the documentation of intangible cultural resources and to encourage the identification and documentation of such resources by State and Federal agencies (Parker and King 1990). National Register Bulletin No. 38 was developed and intended to be an aid in determining whether properties thought to have traditional cultural significance are eligible for inclusion in the National Register.

Guidelines suggested by the Environmental Council and adopted by the State of Hawai'i provide information concerning cultural practices and cultural features that may be impacted by certain activities, such as land development, and requires environmental assessment of cultural resources in determining the significance of a proposed project (OEQC 1997).

Consultation with The State Historic Preservation Division resulted in guidance provided in the Draft Procedures For Ethnographic Inventory Surveys.

SCOPE OF WORK

The scope of work for this project contains several components. These primarily include appropriate archival/background research, identification and consultation with a number of informants, and a synthesis and assessment of the findings from applicable archaeological work, archival/background, and ethnographic research.

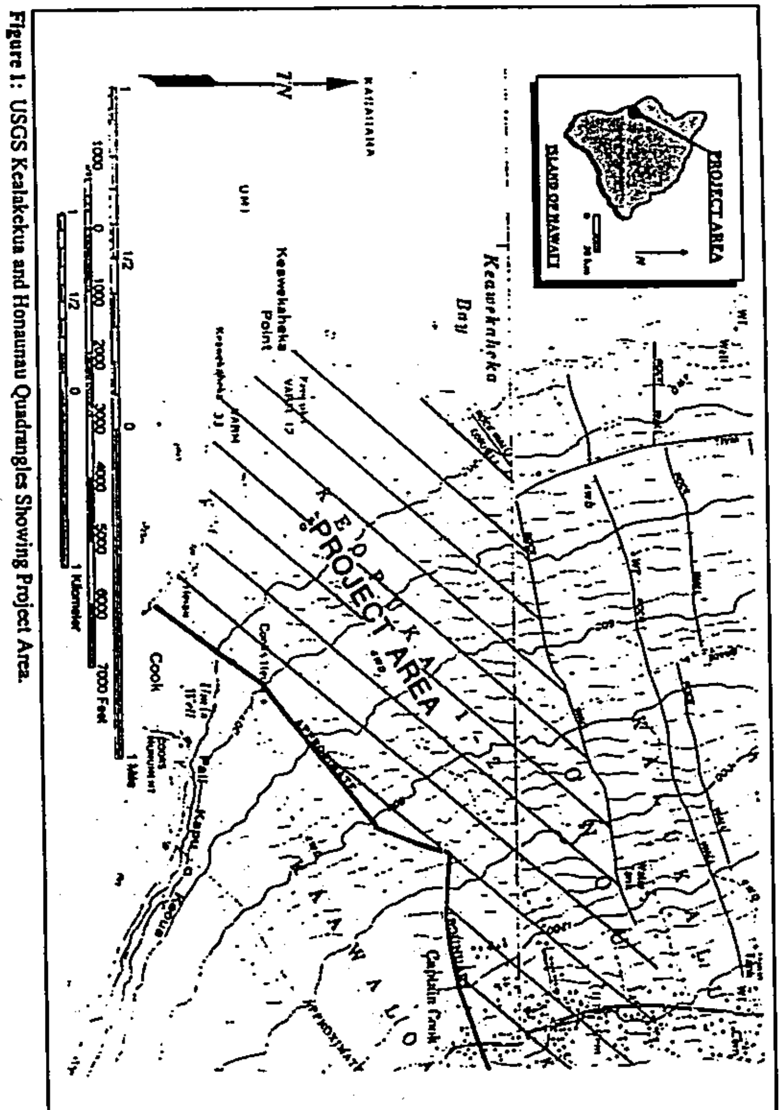

Figure 1: USGS Kealakekua and Honaunau Quadrangles Showing Project Area.

Archival/background research required accessing both published and unpublished sources including surviving recorded legendary and traditional accounts; early historical journals, narratives and other written accounts describing life-styles, noted events; missionary accounts; land records such as Land Commission Awards and their associated claims and testimonies; Royal Patent Grants; Boundary Commission records containing survey notes and maps; and information supplied by previous archaeological studies.

Informant interviews form a critical part of the assessment process. Individuals having knowledge of traditional practices and beliefs that have been associated with a project area or historical properties within a project area for more than fifty years, and whose knowledge is founded in a continuity of traditions passed down from preceding generations and the individual's personal familiarity with the project area, are sought for interviews. Ethnographic inventory survey, which identifies and acceptably documents historic properties within the project area, can then take place.

Several knowledgeable individuals were recommended to SCS through consultation with OHA O'ahu and Hawai'i Island representatives, as well as suggestions from long term South Kona residents. Limited oral interviews were conducted in Kona between the dates of March 16 to April 20, 2000 by Leann McGerty and Leina'ala Benson. Kona residents who contributed to the information in this report are Jean Greenwell, Frank Silva, Billy Paris, Toshio Shirai, Kazue Yoshiki, and Nobu Shibuya.

This report contains a cultural historical overview of the project area, a review of the appropriate archaeological and ethnographic studies, land tenure history, the results of consultations with knowledgeable individuals in the South Kona community, and a synthesis and assessment of the findings.

GENERAL DESCRIPTION OF KEŌPUKA AHUPUA'A

Keōpuka is one of the *ahupua'a* located in South Kona (Figure 2). Comprising 660 acres and rising to 1,350 ft. above mean sea level (amsl), its moderate sloping lands consist predominately of exposed lava flows. The entire shore of Keōpuka is sea cliffs extending approximately 20 feet amsl, and contains numerous blowholes, fissures and lava tubes. The flat

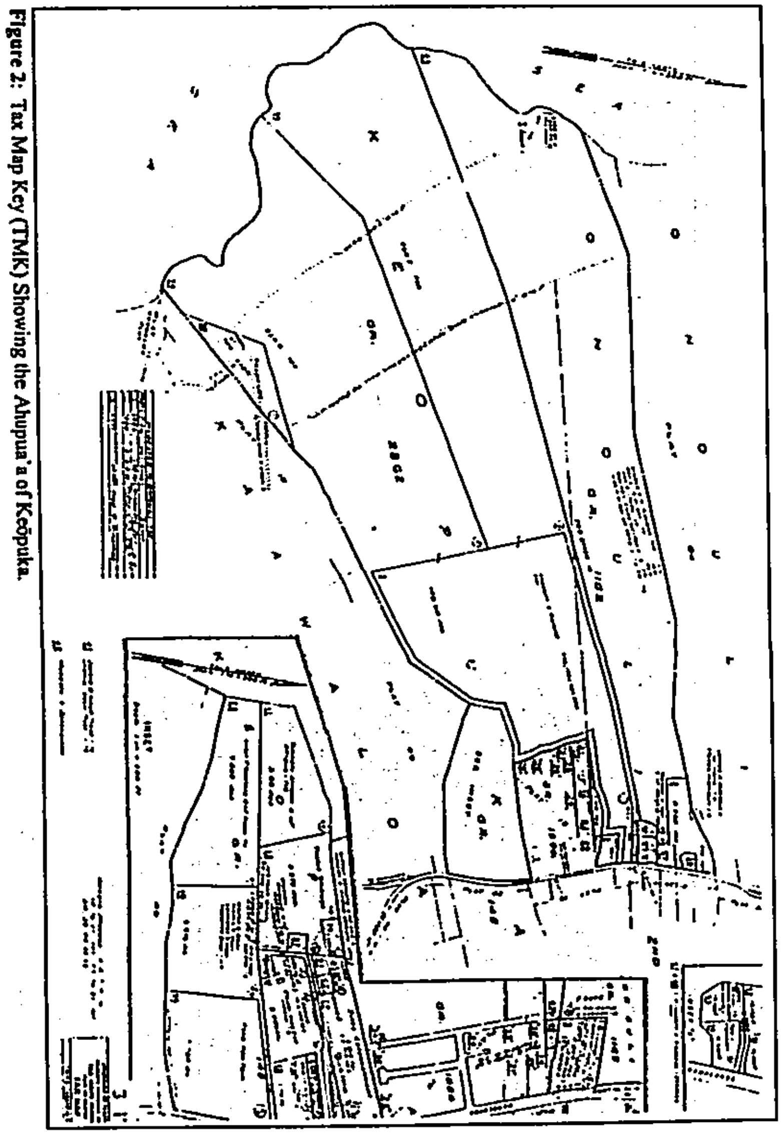

Figure 2: Tax Map Key (TMK) Showing the Ahupua'a of Keōpuka.

coastal region extending from the shore cliffs is identified as Keawekaheka Point which becomes known as Ka'awaloa Flat towards its southern end. A small section of the *ahupua'a* hooks north above Mamalahoa Highway.

The majority of the terrain from the shore to approximately 850 feet (approximately 500 acres) consists of rough lava (Figure 3). The jagged a'a presently supports very sparse vegetation except in the higher elevation. The a'a flow reached the shore at the southern boundary of Keōpuka. The broad, flat promontory of Keawekaheka consists of an older pāhoehoe flow on which a few scattered *uhaloa* (*Waltheria indica*), *'ilima* (*Sida* sp.), and *noni* (*Morinda citrifolia*) have been seen along with small patches of various grasses. At the southwestern corner, near the Ka'awaloa boundary, *kiawe* (*Prosopis pallida*) and *koa haole* (*Leucaena leucocephala*) are well established along the shore. On the coast, a few clusters of coconut trees can be seen.

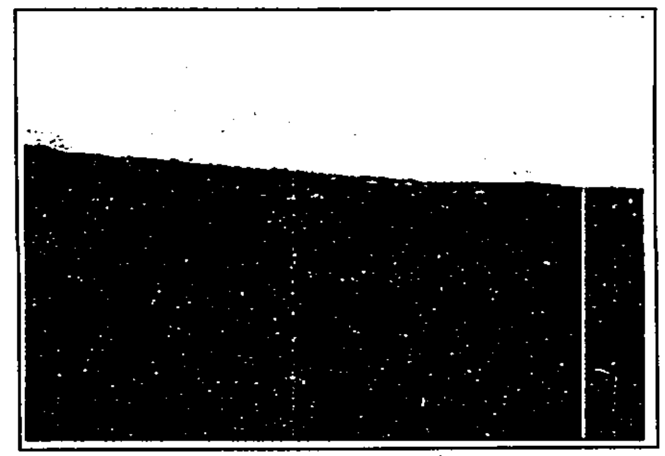

Figure 3: General View of Keōpuka Ahupua'a. View to East.

In higher elevations, thin layers of soils identified as Kaimu Extremely Stony Peat cover portions of the a'a flow (Sato *et al.* 1973: sheets 111 and 121). Occasional pockets of soil can be found in lava depressions. Vegetation is dense in some areas above 650 ft amsl and consists mainly of exotic species with a few native and Polynesian introduced species (Figure 4).

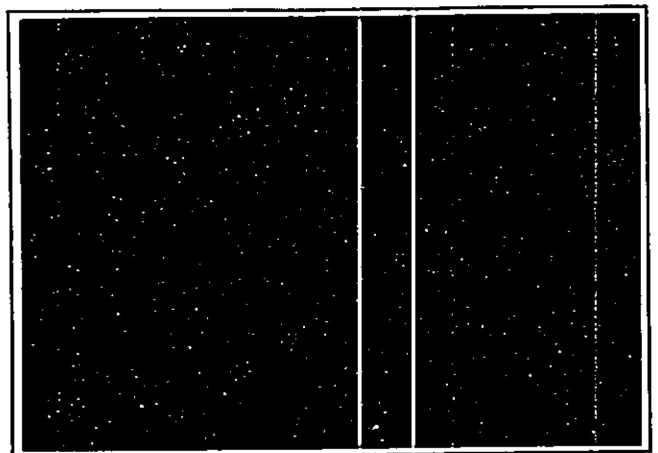

Figure 4: General View of Vegetation Zone and Keawekaheka Point in the Distance. View to West.

Rainfall is the only water source and averages between 40 to 50 inches, generally lighter near the coast and increasing with elevation to 65 to 85 inches in the upland region (Armstrong 1978: 63,64).

PREVIOUS ARCHAEOLOGY WITHIN THE AHUPUA'A OF KEŌPUKA

A reconnaissance survey was conducted in 1929 by John E. Reinecke in West Hawai'i (1930). His findings were limited to the coastal region where he identified thirty sites including permanent and temporary habitation complexes with house platforms, enclosures, low-walls (interpreted as windbreaks), cave shelters, possible burials, modified outcrops and a possible *heiau*. One site in particular was referred to as "Keawe's sea pool" and was located on the point Keawekaheka. Many of these sites were re-identified during a subsequent survey in 1971 conducted by the State Historic Preservation Division as part of the State Inventory of Historic Places. State site numbers were assigned to sites in 1971. Subsequent surveys had difficulty in locating many of Reineke's original sites.

As part of the 1971 State Inventory of Historic Places, previously unidentified sites were added to the list established by Reineke and were reorganized into fifteen sites or site complexes. State Sites 1948 through 1962 include campsites, rock shelters, low stone walls, platforms, midden scatters, burial platforms and terraces, pavements, enclosures, platforms, stone walls, and a small possible *heiau* (Figure 5).

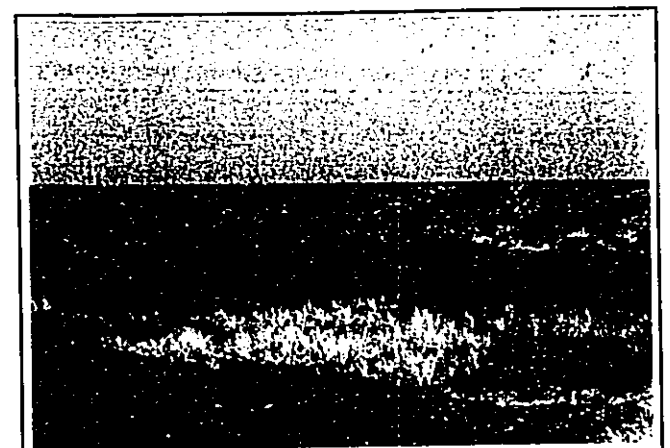

Figure 5: Archaeological Features in the Coastal Region of Keōpuka.

In 1980, Lloyd J. Soehren conducted a reconnaissance survey in the upper portion (850 to 1400 feet amsl) of Keōpuka (Figure 6). He recorded:

> ...the entire area is within the Kona Field System (Hawaii Register of Historic Places number 10-37-6601) A small portion of the southwest corner is included within the Kealakekua Bay Archaeological and Historic District (10-47-7000). That distinction however, is due more to the requirement that such districts be defined as quadrilaterals than to any intrinsic archaeological or historic value.

Soehren said that although the upper portion of the property is within the Kona Field System, he doubted that it was utilized to any great extent, if at all. It was his opinion that the land would have been of little use to the aboriginal Hawaiian as it had little capacity for production of food or for other culturally significant plants and better agricultural land was

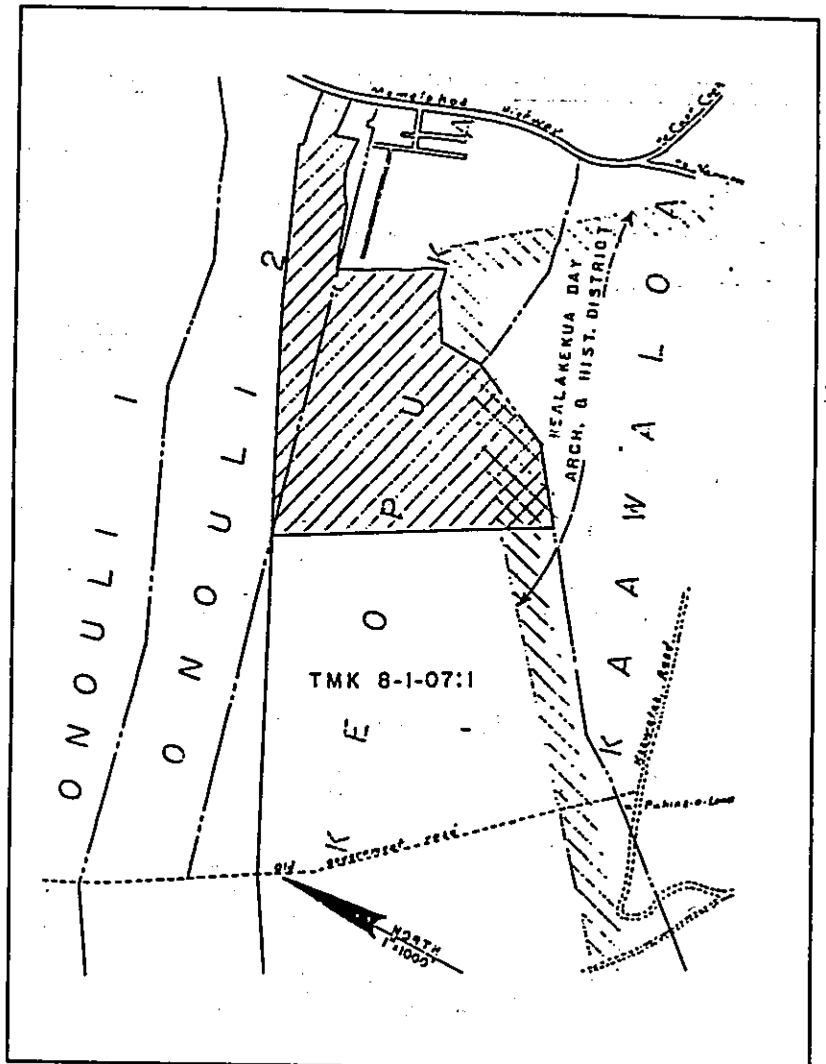

Figure 6: Planview of a Portion of Current Project Area. Hatched Area is Soehren's 1980 Survey (Soehren 1980).

available in *ahupua'a* to the north and south. Verification of this were the aerial photographs identifying Kona Field System features in bordering *ahupua'a* including areas that had been reused in modern times for agriculture.

He continues by saying that the terrain provided crevices for disposal of the dead and abundant stone with which to erect monuments over them and small areas that could have been cleared for camp sites perhaps using low stone walls for windbreaks. No archaeological sites were identified during the 1980 survey.

In 1981, Soehren conducted a reconnaissance survey of the lower portion of Keōpuka Ahupua'a (Figure 7). Soehren re-identified several trails in the lower portion of the project area. At about the 400 foot elevation is the old government road/trail from Kealakekua pali to Kainaliu beach (State Site 10290) which, according to him possibly dates to 1840 (Figure 8) and was probably built as a type B or C horse trail (as described by Apple, 1965). Soehren also re-identified Site 17189, a trail further *makai* connecting the landing at Ka'awaloa with the coastal villages to the north, including Kainaliu, Keauhou and Kailua. The trail is now referred to as the "old cart road" or "old wagon road" and is presently being used as a jeep road, but probably evolved from an earlier stepping stone foot path as attested by the smooth flat waterworn boulders which have been moved and now rest along either side of the track (Figure 9).

A portion of an old cart road (Site 14176) extending from Ka'awaloa landing, up the *pali* to Kuapehu, intrudes briefly into the *ahupua'a* of Keōpuka. The road ended at the residences' of the missionaries Samuel Ruggles and Rev. John D. Paris, to whom the building of the road is attributed. This road has been, and is presently, referred to as the "Ethel Paris Road" and the "Ka'awaloa Road".

Soehren identified two stepping stone trails leading from the shore inland across the lava near the south side of Keōpuka. A third trail crossed the "old cart road" (also called the old wagon road), but appears to have been abandoned at the base of the *pali* and did not receive a state site number. The more northerly trail (Site 7727), leads from a habitation site (Site 1962) consisting of two platforms surrounded by a stone fence. Site 1962 is located on pāhoehoe with other platforms, pavements and enclosures adjoining it to the south. The trail continues inland across an old pāhoehoe "*kīpuka*" cut off by a later a'a flow. The trail appears intermittently until

Figure 8: Old Government Road Entering Keōpuka. View to South.

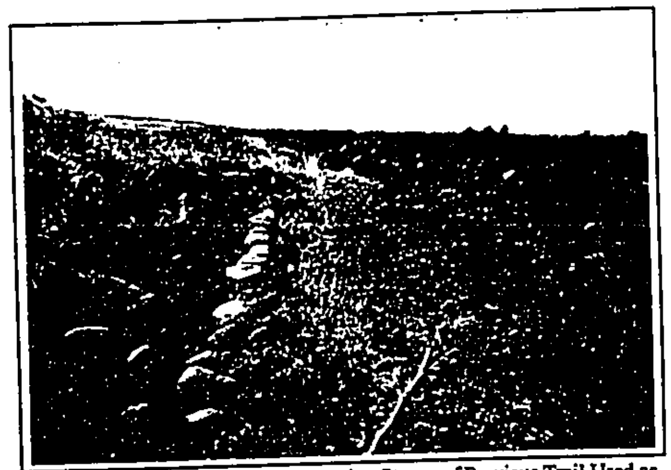

Figure 9: Old Wagon Road with Stepping Stones of Previous Trail Used as Curbing on the Side. View to South.

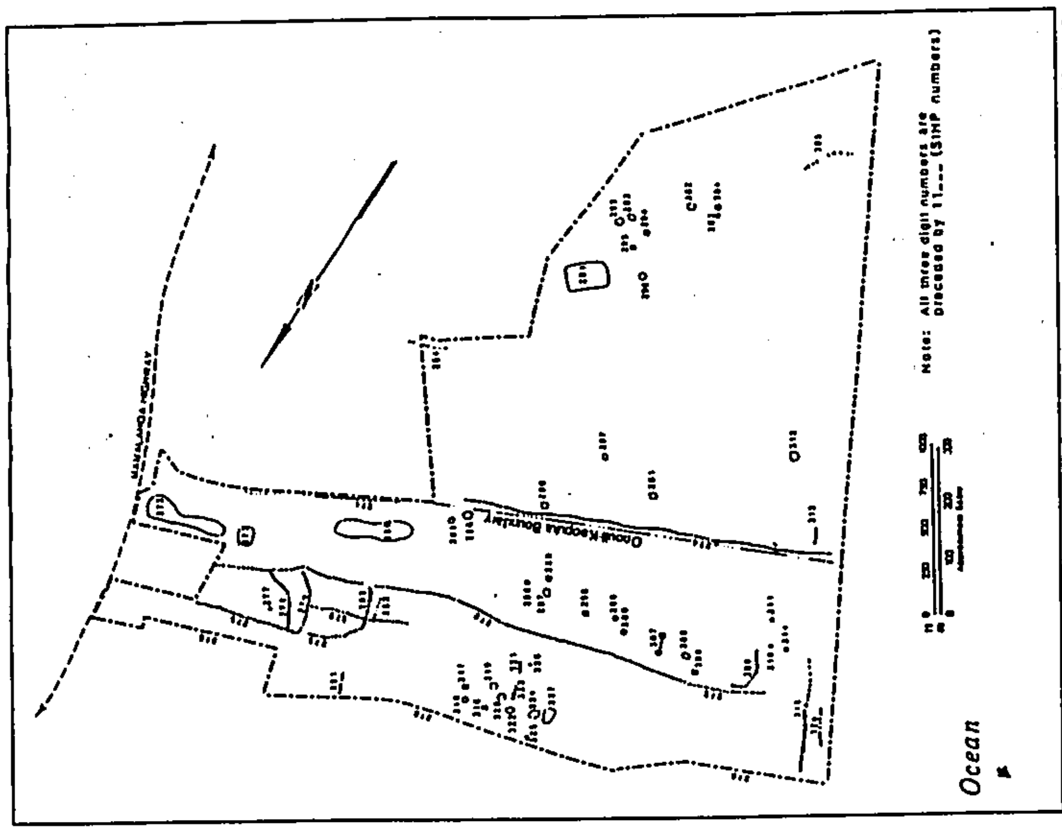

Figure 10: Planview of Upper Portion of Current Project Area Showing Rosendahl and Jensen's 1989 Survey Areas (Rosendahl *et al.* 1989).

it crosses the old wagon road where the trail is clearly marked by waterworn stepping stones placed nearly to the top of the pali. Site 7728 consists of the another trail which lies entirely on the a'a and follows the shore up the pali then south towards the gardens of Ka'awaloa.

An inventory survey conducted in 1989 re-investigated a 248 acre land parcel between the elevations of 800 feet and 1,350 feet in Ono'uli and Keōpuka (Rosendahl and Jensen 1989). A total of 57 new sites were identified, sixteen of which were located in Keōpuka (Figure 10). Ranching and features associated with the Kona Field System, enclosures, terraces, habitation complexes, a modified sinkhole, a walled depression, a habitation cave, a burial cave, and trails and a railroad bed, located in the *ahupua'a* of Ono'uli, were recorded during this study.

Subsequently, a field inspection survey was conducted which included all previously surveyed lands in the *ahupua'a* of Keōpuka (Walker and Rosendahl 1990)(Figure 11). Eleven new sites were identified during the field inspection survey. These sites retain the temporary site numbers assigned to them as they were identified during a reconnaissance survey. Recorded features included habitation complexes consisting of enclosures, enclosure remnants and walls, possible burial complexes consisting of platforms and modified outcrop. Again, a trail, the old wagon road and the old Government Road were noted.

An inventory survey predominately within Ka'awaloa but partially extending into the southern boundary of Keōpuka was conducted in 1991 (Walker *et al.* 1991). Six sites were identified within the boundaries of Keōpuka. These included a stepping stone trail remnant, a previously identified historic road (Site 10290), two habitation complexes consisting of terraces, pavements, modified outcrops and caves, and two burial sites located within caves. A charcoal sample collected from the interior surface of one burial cave (Site 14192) resulted in a date range of A.D.1470-1680 (*Ibid.*:22).

An archaeological inventory survey with limited subsurface testing was conducted on a 500 acre portion of Keōpuka (Hammatt *et al.* 1995)(Figure 12). A total of 165 features were identified and organized into 70 distinct sites. Site functions were interpreted as agriculture, habitation, burial, ritual, transportation, recreation, petroglyphs, and markers. Seven sites representing permanent and temporary habitation, burial and ritual activities were tested. Results reflected a traditional settlement pattern with permanent settlement concentrated on the coast and intensive agriculture occurring in Upland portions of Keōpuka free of a'a lava flow. Two charcoal samples were collected from two caves, one yielding a radiocarbon date range of A.D.1662 to 1955 and the other a modern date.

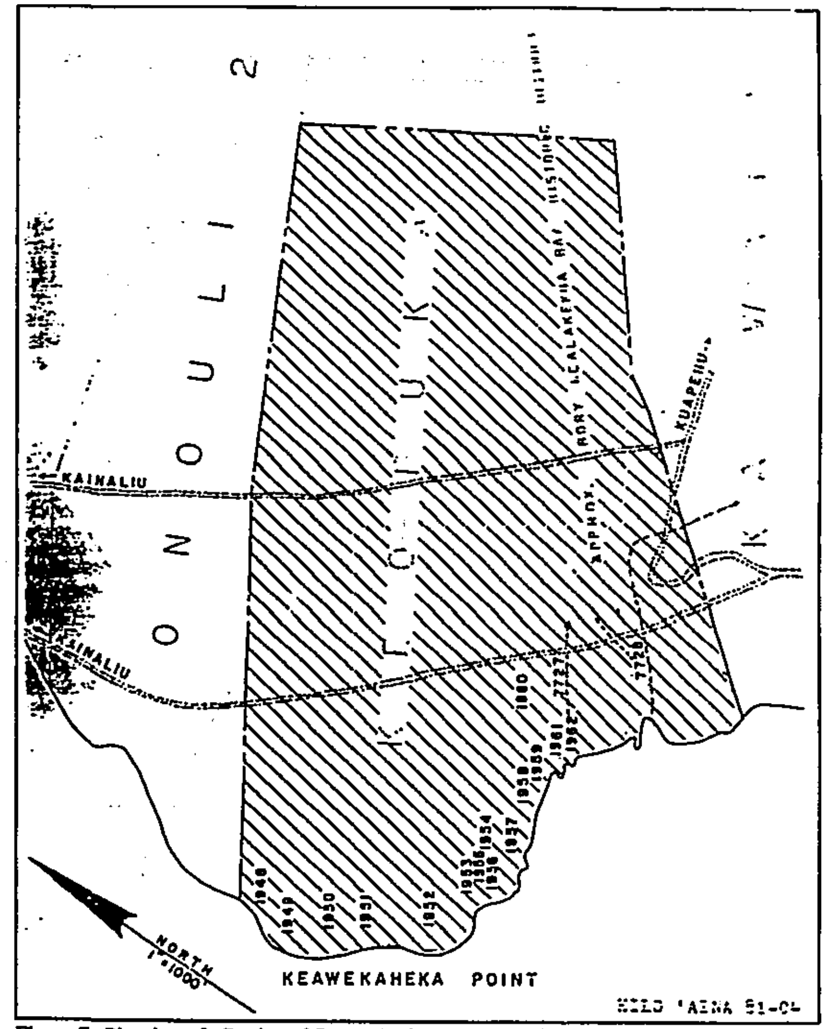

Figure 7: Planview of a Portion of Current Project Area Showing Soehren's 1981 Survey Area (Soehren 1981).

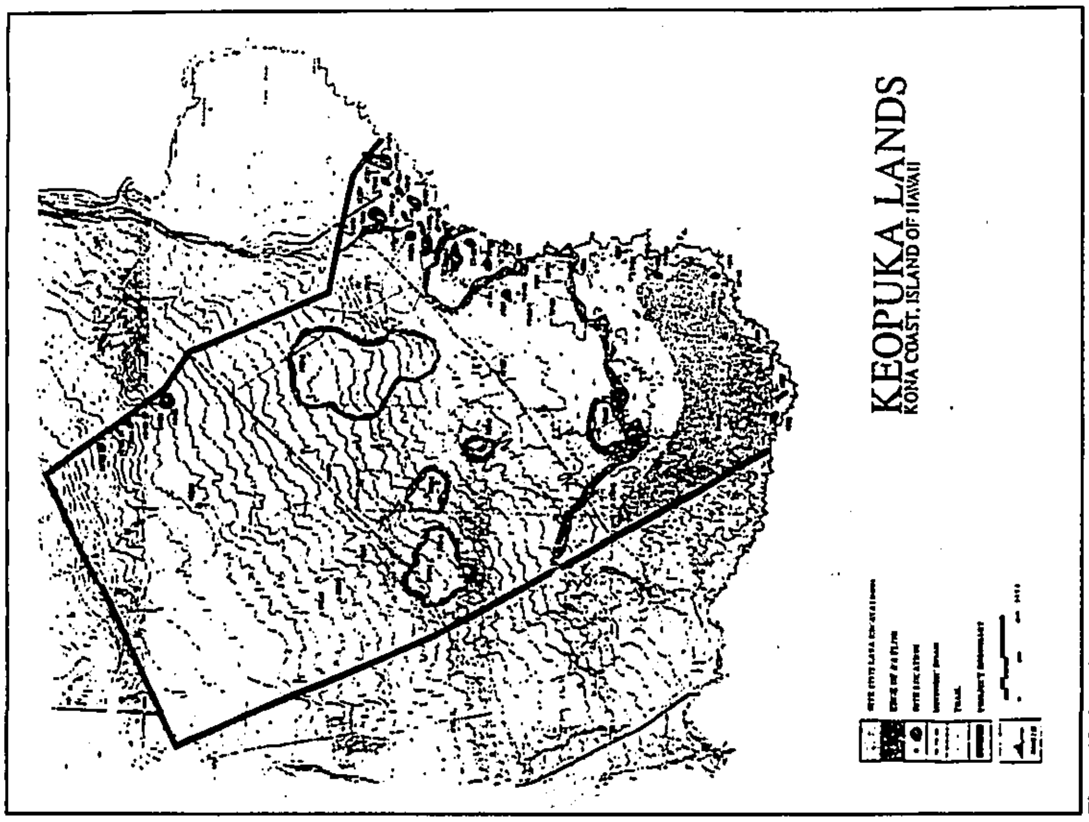

Figure 12: Planview of Keōpuka Lands from Hammatt *et al.* 1995

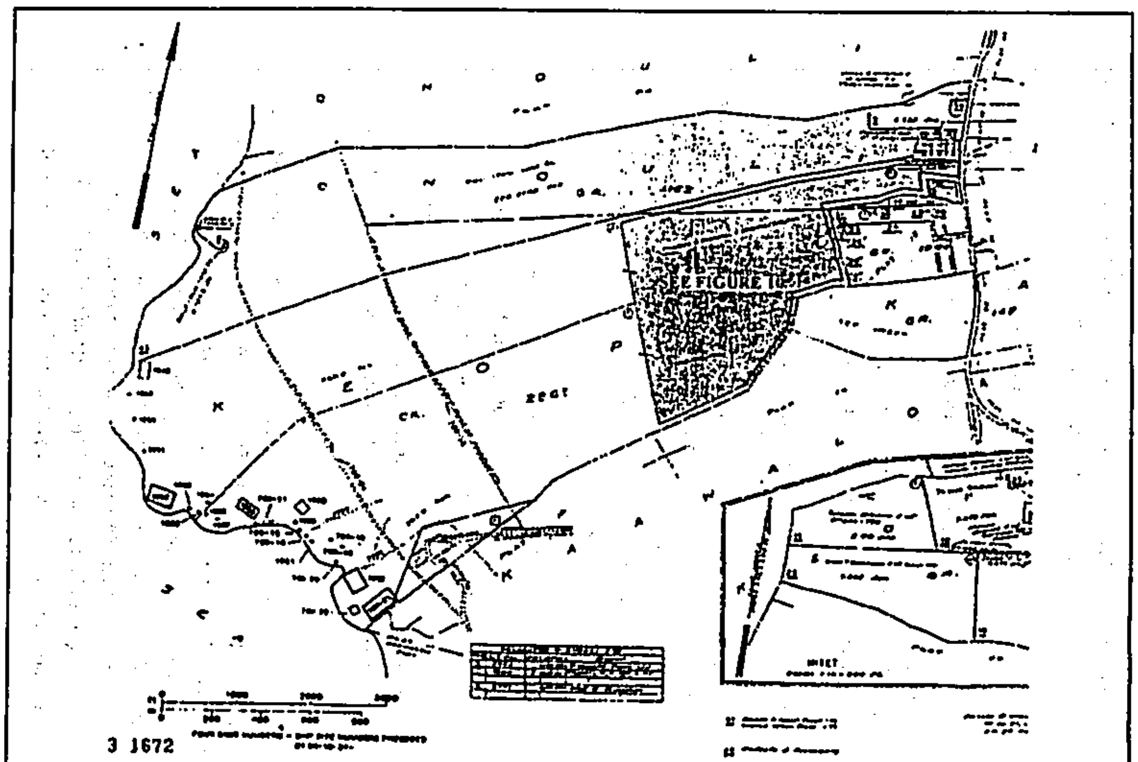

Figure 11: Planview of Current Project Area Showing Walker and Rosendahl's 1990 Survey Areas (Walker *et al.* 1990).

An inventory survey was conducted through 17 *ahupua'a* in conjunction with the proposed Māmalahoa Bypass Road Corridor in 1997-1999 (Robins *et al.* 1999)(Figure 13). One site, Site 11301 a complex of a'a pits, was re-identified from an earlier survey within the proposed Bypass corridor in Keōpuka and had been interpreted as a component of the Kona Field System (Rosendahl and Jensen 1989:A20,21). This site is located at an elevation of approximately 800 ft. amsl.

TRADITIONAL AND HISTORICAL OVERVIEW

The traditional Hawaiian subsistence economy was based on agricultural production, marine exploitation, as well as, animal husbandry, wild plant and bird collecting. Extended household groups settled in various *ahupua'a*, smaller land divisions within a district, that customarily continued inland from the ocean. Within the *ahupua'a*, residents were able to harvest from both the land and the sea. Ideally, this situation allowed each *ahupua'a* to be self-sufficient by supplying needed resources from different environmental zones (Lyons 1875:111).

TRADITIONAL LAND USE

Direct references to the *ahupua'a* of Keopka are difficult to find. It is mentioned briefly in a legendary account by I'i describing the feats of an exceptional canoe paddler, Akalele, while racing down the Kona coast with the double canoe's of King Kamehameha. I'i says: "...After they passed Keōpuka and reached Kalaemano at Kaawaloa, they again turned shoreward." (1959:131-2).

It can be assumed that settlement patterns and land use of Keōpuka was the same as those of other South Kona *ahupua'a*. Much is known concerning the history and land use of Ka'awaloa directly to the south and, in addition, extensive historical and ethnographic research has been conducted of *ahupua'a* to the north between Keauhou and Ka'awaloa, providing a foundation for interpretation of cultural activities in Keōpuka (Smith and Maly 1999).

Previously conducted archaeological, ethnographical and historical studies have confirmed the importance of Kona both religiously and politically (Kirch 1985:161). Attractive to the *ali'i*, Kona, and more specifically Ka'awaloa, had become a place of residence of

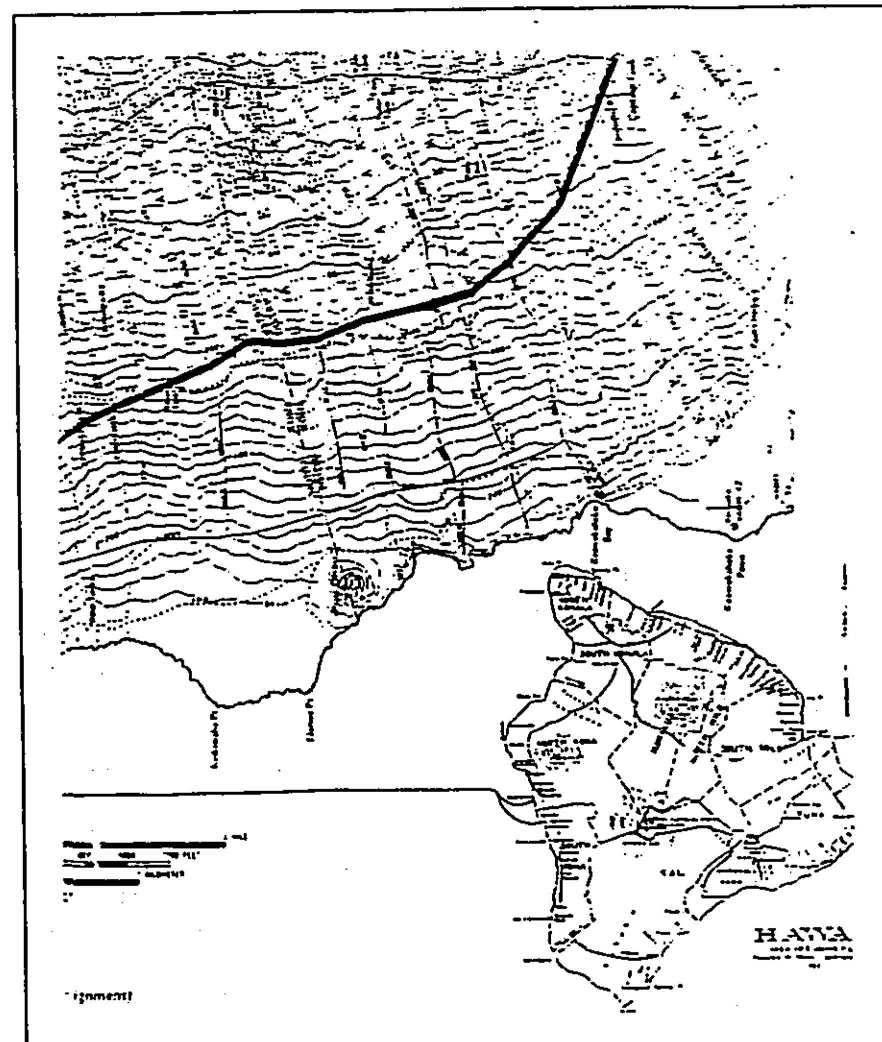

Figure 13: Planview of Keōpuka Lands with Proposed By-Pass Road Corridor (from Maly and Smith 1999).

paramount chiefs of Hawai'i long before the time of Umi (1400s). Its close association with the rituals and celebrations of Lono (who was associated with agriculture and fertility in Hawai'i) and the Makahiki season brought, at least annually, a vast number of *ali'i* with their entourage to Kona (Handy, Handy and Pukui 1972:522). An immense field system, excellent fishing grounds, and fishponds, supported the large population centers along the Kona coast such as Honaunau, Ka'awaloa, Kailua, and Keauhou, and produced one of the most complex societies and powerful cheifdoms in Polynesia (Newman 1970; Kelly 1983, Schilt 1984; Kirch 1985:167; 1994:321).

Several miles down the coast from Keōpuka was the religious center of Hōnaunau. This sacred site was of the greatest significance containing three *heiau* within its walls, one of which contained the *'iwi* of the paramount chiefs descended from 'Umi and Liloa (Kirch 1985:166). A *pu'uhonua* (place of refuge) in ancient times, it was associated with the residences of chiefs and priests. Areas outside the sacred wall of the *pu'uhonua* were densely settled.

The presence of four *luakini heiau*, constructed by paramount chiefs only, the sacred complex at Hōnaunau, and residences for a ruling chief and his followers at Ka'awaloa, indicates strong economic power. This is evidenced in the Kona and Kealakekua Field Systems, which had to be supported by a large resident population (Kolb 1991:15, 18; Kirch 1985:167).

LAND TENURE

Handy and Handy have described several traditional planting methods practiced in the Kona area (1972). They report:

> Kona, like eastern Maui, with its decomposing lava mixed with humus and with intermittent rainfall which soaks away quickly in the porous soil and rock, is ideal for sweet-potato cultivation. Sweet potatoes were the staple in lowland localities where there was sandy soil, as in Kailua, Honaunau, Kealia and Ho'okena (*ibid.*:526).

Higher elevations (1,000 to 3,000 ft. amsl) supported dryland taro which were still being cultivated in the 1930s. A resident of South Kona related a taro planting method that utilized the warmth of lower elevations for quick initial growth and then transplanting them in the higher forest zone for their second period of growth. The taro corms reportedly averaged 25 pounds each (*ibid.*:525).

Handy reported that South Kona's agriculture was determined by rainfall and moisture (1940:116). Sweet potato and coconuts were successfully grown in sand or soil among the lava near the shore where rainfall and moisture were the least. Small bananas and poor cane subsisted to approximately 1,000 feet becoming more prolific up to 3,000 feet, and breadfruit were planted between 1,000 and 2,000 feet.

Indeed, early historical records indicate that during the Māhele, four environmental zones were claimed necessary to support the traditional lifestyle (Kelly 1983:47-50, 52). While discussing central Kona settlement patterns, Cordy suggests the shoreline as an additional environmental zone (1995). This land section, extending from the ocean to approximately 600 feet, was previously not considered as part of the cultivated land. The immediate shoreline typically contained the majority of permanent house sites within the *ahupua'a*.

THE KONA FIELD SYSTEM

An important component of land use in Kona was the previously mentioned Kona Field System (50-10-37-6601). This "...extensive and monumental work of ancient Hawai'i" (Soehren and Newman 1968, Newman 1970) originated north of Kailua and continued far south of Kealakekua, determined by environmental factors. It was this immense agricultural system that made large settlements tenable. Agricultural fields extending from the coastal region, up to three miles inland, supported villages and the frequent large parties of visiting *ali'i* (Kelly 1983; Schilt 1984).

The exact age of the field system is unknown, however, oral traditions and legends refer to the time when Pili-a-ka'aiea was sovereign chief of all of Kona (1300s) describing large, regional upland plantations among which are the agricultural features of Kuapehu, Nā'uluoweli, and Keomo, which extended from Mā'ihi to Kealakekua including Keōpuka, as well as features, trails, religious structures, coastal and upland occupation, and fishing zones of the region (The Heart Stirring Story of Ka-Miki, translated by Maly 1992-1993; 1993:16). These ancient gardens are undoubtedly the precursor to, and included in, what is now referred to as the Kona Field System.

While correlating aerial photography with various descriptions in historic accounts and journals, T. Stell Newman was able to identify and classify the planting areas of the Kona Field System into subzones based on elevation, rainfall and crop types (1970):

Kula/Coastal Area
Elevation: Sea level to 500 ft. (0-150 m.)
Annual Rainfall: c. 30-35 in.
Sweet Potato, gourds, and *wauke*, grown in very rocky areas

Kaluulu/Seaward Slope
Elevation: 500-1000 ft. (c. 150-300 m.)
Breadfruit, with sweet potato and *wauke* interspersed; mountain apple, and some taro

'Apa'a /Upland Slope
Elevation: 1000-2500 ft. (300-750 m.)
Annual Rainfall: c. 55-80 in.
Taro in upper portion, sweet potato in lower portion, field boundaries planted with *ki*, and sugarcane

'Ama'u /Upland Jungle
Elevation: 2500-4000 ft. (750-1200 m.)
Annual Rainfall: c. 80 in
Banana and plantains planted just below and within the forest

The *ahupua'a* of Keōpuka contained three of these subzones, the *kula*, *kauulu*, and *'apa'a* and identified archaeological remnants of the Kona Field System in the upper portion of the *ahupua'a* (Rosendahl and Jensen 1989; Walker and Rosendahl 1990).

HISTORIC LAND USE

First Encounters

The earliest descriptions of the South Kona coastline are from journals of Captain Cook and his men who provided the first recorded western contact with Hawai'i Island in 1779. David Samwell, surgeon on the Discovery, described Kona from a vantage point aboard ship several miles off shore:

> This part of the Country is called Atona, is a ragged barren place almost entirely covered with lava, there are but few house here" (Samwell 1967:1157).

William Ellis, Surgeon's second mate on board the Discovery, added:

> We were now off a part of the island, which had rather a remarkable appearance, there being large tracts of a dark and almost black matter, which we at first supposed was the soil which the natives had dug up and manured; but we afterwards found it was the produce of a volcano, being in fact nothing but lava (Ellis 1782:83).

Once on shore, however, they were amazed to find the well tended gardens and plantations of the producing a wide variety of crops. Impressed by the industriousness of the Hawaiian people, Lt. King observed in 1779 that sweet potato and *wauke* were successfully cultivated in dry land fields close to the shore:

> Barren & desolate as the appearances of many parts of the southwest side of Owhyhe are, yet if we are to judge from the Number of Villages, & crowds of People, it is nearly as populous as any other part of the Islands; this lava surface prevails mostly within 2 or 3 miles of the Sea, & amongst it the sweet potato thrives prodigiously, indeed it is such Plenty that the poorest natives would throw them into our Ships for Nothing. . . . the first 2 ½ miles it is composed of burnt loose stones, & yet almost the whole surface beginning a little at the back of the town, is made to yield Sweet potatoes and the Cloth plant (Beaglehole Vol. 3, 1967:521, 618).

George Gilbert, also a member of Cook's party, records the first impression of the Kona Field System. He writes:

> The country here is one entire plantation as far as the eye could see from the ship, which is divided into squares by stones thrown together, or hedges of sugar cane ... (Restarick 1928:7)

In 1779, Lt. King recounted the observations of crew members exploring inland of the present town of Nāpo'opo'o:

> The plantain trees are mixed amongst the breadfruit trees & did not compose any part of the plantation except some in the Walls: these walls separate their property & are made of the Stones got on clearing the ground; but they are hid by the sugar cane being planted on each side ... (Beaglehole, Vol. 3, 1967:521).

In 1792, 1793, and 1796, Vancouver returned to Ka'awaloa. His descriptions of their welcome and of the large population filling the bay suggests there had been few changes in the intervening 13 years. Approximately three to five thousand people swam around the ships and the beaches were lined with citizens (Menzies 1920:67). Kamehameha I was again in residence at Ka'awaloa and, with his assistance, Menzies, the botanist with Vancouver's voyage, explored the area around Kealakekua Bay. He reiterates previous descriptions of the field system, enumerating the produce of the various environmental zones:

> On leaving this station, we soon lost sight of the vessels, and entered their bread-fruit plantations, the trees of which were a good distance apart so as to give room to their boughs to spread out vigorously on all sides, which was not the case the crowded groves of Tahiti, where we found them always planted on the plains along the sea side. But here the size of the trees, the luxuriancy of their crop and foliage, sufficiently show that they thrive equally well on an elevated situation. The space between these trees did not lay idle. It was chiefly planted with sweet potatoes and rows of cloth plant [*Broussonetia papyrifera*]. As we advanced beyond the bread-fruit plantations, the country became more and more fertile, being in a high state of cultivation. For several miles round us there was not a spot that would admit of it but what was with great labor and industry cleared of the loosed stones and planted with esculent roots or some useful vegetables or other. In clearing the ground, the stones are heaped up in ridges between the little fields and planted on each side, either with a row of sugar cane or sweet root of these islands where they afterwards continue to grow in a wild state, do that even these stony uncultivated bands are by this means made useful to the proprietors, as well as ornamental to the fields they intersect.(1920:74).

Menzies continued his narrative by describing activities besides farming occurring in the uplands indicating a functioning *ahupua'a* system. Huts at the edge of the forest were inhabited as people gathered resources and worked in the gardens. Orange trees were found growing from seeds left earlier. Little villages of temporary shelters were observed in the woods. Menzies saw men cutting planks of wood for canoes and other structures. A group of natives were catching birds for their feathers while women were busy making *kapa* from *mamaki* (*Pipturus* spp.) after steaming the raw material in an *'imu*, and forest shrines were well attended (*Ibid*.:76-85). On a later trip, he records villages situated in "rich" plantations growing, among other things, bananas and plantains located at the edge of the forest (*ibid*.:167-168).

Population Shifts

In the late 1700s and early 1800s, increased contact between the two cultures occurred in the large centers of population, such as Kealakekua and Kawaihae which provided sheltered harbors, food, and supplies for traders traveling to China and the west coast of America. In 1794, Kamehameha I moved his residence to Kailua causing a shift in the population from Kealakekua Bay to further north. Instead of calling at Ka'awaloa, most of the visiting ships now went to Kailua or Kawaihae, which quickly became the centers of activity. John Young greeted people on behalf of the king at Kealakekua but before long he too, moved to Kawaihae. By 1804, Honolulu had become the favorite port of call.

The missionary, William Ellis (Ellis 1979:186) journeyed down the coast by canoe in 1823 praising the agricultural fields of Kealakekua and describing the district:

> The northern part, including Kairua, Kearake'kua, and Honaunau, contains a dense population; and the sides of the mountains are cultivated to a considerable extent; but the south part presents a most inhospitable aspect.

Population density along the Kona coast, including Kailua, was estimated to be not less than 20,000 in 1824 (Kelly 1983). As illustrated on Holland's Population Distribution map, there were two sections in which habitation clustered: on the seacoast and another section approximately two miles inland (Figure 14). With each dot representing 50 people, Keōpuka had 250 people living inland and 650 inhabitants on the coast, for a total of approximately 700 people.

A missionary census taken barely eight years later recorded a drop in population to 12,432 individuals (Schmitt 1973:21). Introduced diseases had taken their toll, along with a general shift in population to the more lucrative townships on Maui and O'ahu. In addition, a severe fire coupled with drought, occurred in 1824-25 forcing many families to seek residence elsewhere on the island (Schilt 1984:24).

The Māhele

In the 1840s a drastic change in the traditional land tenure resulted in a division of island lands and a system of private ownership based on western law.

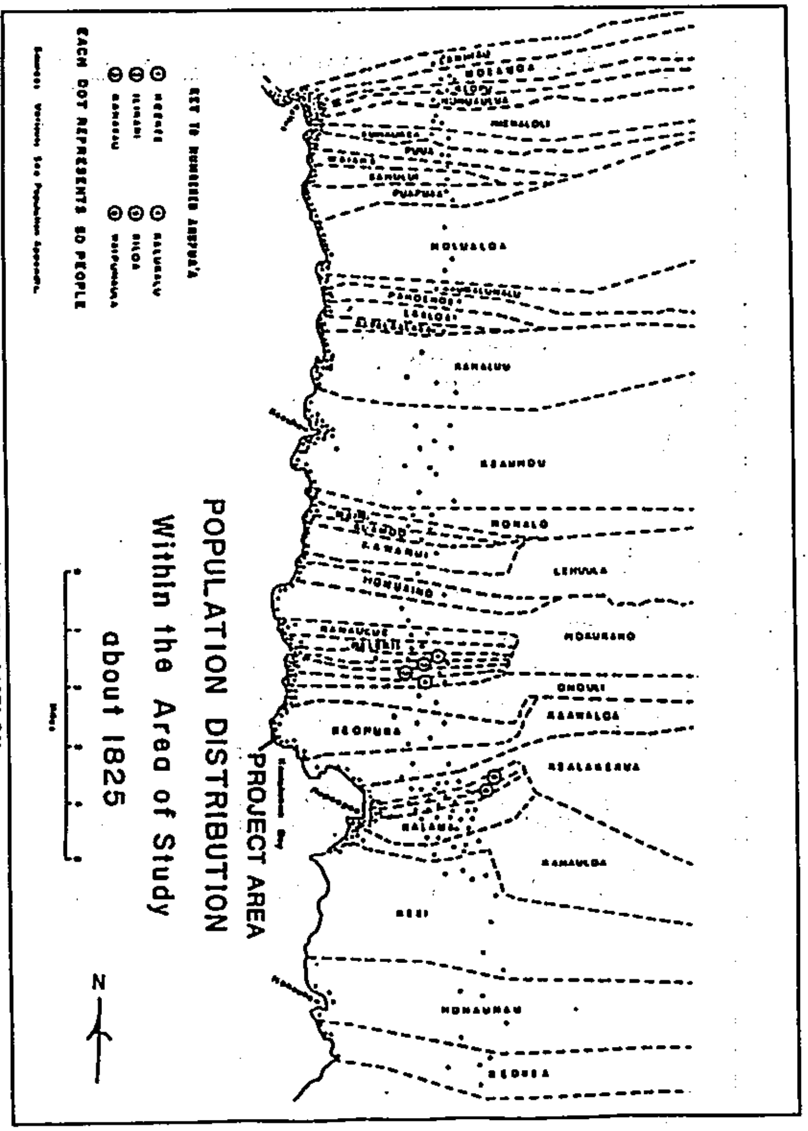

Figure 14: Nineteenth Century Population Distribution of Kona (from Holland 1971:31).

This land division, or Māhele, occurred in 1848. The awarded parcels were called Land Commission Awards (LCA). If occupation could be established through the testimony of two witnesses, the petitioners were awarded the claimed LCA, issued a Royal Patent number and could then take possession of the property (Chinen 1961:16).

While it is a complex issue, many scholars believe that in order to protect Hawaiian sovereignty from foreign powers, Kauikeaouli (Kamehameha III) was forced to establish laws changing the traditional Hawaiian society to that of a market economy (Daws 1982:111; Kuykendall Vol. I, 1938:145 footnote 47, 152, 165-6, 170; Kame'eleihiwa 1992:169-70, 176; Kelly 1983:45).

Among other things, foreigners demanded private ownership of land to insure their investments (Kuykendall Vol. I, 1938:138, 145, 178, 184, 202, 206, 271; Kame'eleihiwa 1992:178; Kelly 1998:4). Once lands were made available and private ownership was instituted, the *maka'āinana* (commoners) were able to claim the plots on which they had been cultivating and living, if they had been made aware of the foreign procedures (*kuleana* lands, LCAs). These claims could not include any previously cultivated or presently fallow land, *'okipu'u*, stream fisheries, or many other resources necessary for traditional survival (Kelly 1983; Kame'eleihiwa 1992:295; Kirch and Sahlins 1992).

Keōpuka was set aside for the Government by Kamehameha III, allowing the fee simple sale of its land. No LCAs were claimed in the lands of Keōpuka. A search of Ahupua'a Boundary Records resulted in no boundary description or documentation for Keōpuka Ahupua'a (Waihona 'aina Corporation, 1998, Mahele Database, Honolulu, Hi.). As government land, sections of Keōpuka could be purchased outright. Four individuals bought and received five land grants in Keōpuka: Awahua purchased Grant 2862 (145.50 acres), D. Barrett purchased Grants 1584 (38.5 acres) and 148 (83+ acres), J.D. Paris purchased Grant 1161, and P. Cummings purchased Grant 1171 (96 acres; Figure 15). The balance of the *ahupua'a* remained with the government

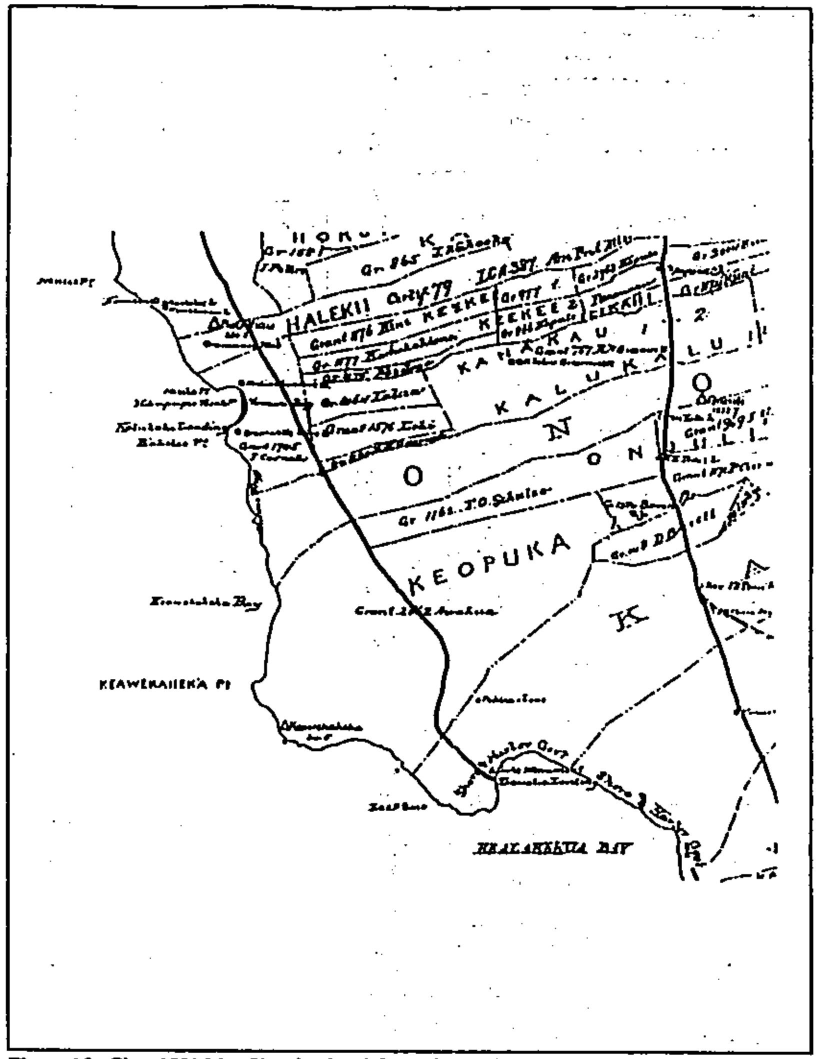

Figure 15: Circa 1891 Map Showing Land Grants in Keōpuka (from J.S. Emerson 1891).

In Kona throughout the first half of the 19th century, introduced food plants were cultivated mainly for provisioning the whaling and sandalwood ships, and to satisfy the newly acquired taste of the *ali'i* for such fare. Slowly, gardens previously planted with taro and sweet potato began to nurture foreign cultivars including cabbage, melons, onions, oranges, beans, coffee, corn, pineapple, Irish potatoes and pumpkin (Schilt 1984:24).

In addition, Kona lands were used for macadamia nuts, cotton, tobacco, and sisal. In fact, cotton was grown successfully in a'a with little or no soil. Areas that had formerly been in *wauke* and sweet potato were turned into thriving, albeit short-lived, cotton plantations. Sisal was cultivated before 1898 for its fiber. Coffee was a major cash crop starting as early as 1841 at Kealakekua. The plants were best in the same zone where upland *kalo* had previously grown, approximately 800 to 1,700 feet above sea level, the healthiest and most fruitful being those grown in the shade of *kukui* trees (Kelly 1983).

Land use in Keōpuka reflected the same patterns. Henry Nicholas Greenwell settled in Kona in1850. Purchasing newly available land from the government, he farmed crops, was a coffee broker, sold hides of wild goats and cattle in Honolulu, and started dairies in the upland forests to produce butter. Eventually he was appointed School Agent for Kona and Collector for Customs at Kealakekua Bay. Extensive land purchases established him as the owner of the largest cattle and sheep ranch in Kona. Greenwell's journal entries and newspaper notices from the 1800s supply occasional references to activities and occupants in Keōpuka (Kona Historical Society records). Much of this information is included below (pers. Comm. Jean Greenwell).

John Young, trusted advisor of Kamehameha I, referred to Awahua (Grant 2862) as an "overseer" or *konohiki* for Keohokalole, the mother of Kalākaua and Lili'uokalani. In a notice published on May 3, 1862 in *Ka Nupepa Ku'oko'a*, Awahua warns others in Ono'uli and Keōpuka to keep their animals off his land and not to take the crops he had been growing. Unfortunately, the type of cultivars and the location on his property are not known. Another notice in the same newspaper five months later from Charles Kana'ina (father of the future king, Lunalilo), informed people of Awahua's death and, that as of July 1, 1862, he had leased Awahua's lands intending to use them. Awahua willed his land in Keōpuka to Likelike (mother of Princess Kai'ulani) and to his wife, who in turn sold the lands to Charles Kana'ina in 1863. Kana'ina then sold the land back to Likelike in 1871.

Awahua's land grant was sold by Likelike and her husband Archibald Cleghorn in 1875 to Mr. A. Todd, who, in 1896, sold portions of it to Renee Rodant. Mr. Rodant, in turn, sold to Kona Vineyard, suggesting a wine making enterprise for which no records have been located. Land sections from the original grant remained in the Todd family into the 20th century. After 1940, Grant 2862 and protions of Graint 1162 in Ka'awaloa were acquired by the Greenwell Estate (Hammatt *et al.* 1995).

Born in Wiltshire England, Daniel Barrett arrived in Hawai'i in1835. He was described by Rev. Paris as "...a gypsy from old England that had been left in the Island sick, but was now well" (1926:13,16). He married twice and had his residence in Keōpuka. Although his occupation had been a ships carpenter, he became a coffee farmer with his lands being located in the wetter *'apa'a* subzone, perfect for such crops. He died in 1893 at 90 years of age. Barretts's Keōpuka land was later bought by a Joseph Conradt.

In 1840, Reverend John Davis Paris and his wife arrived in the Ninth Company of American Missionaries. They were the first missionaries to be assigned to the Ka'ū District which was considered the most unaccessible station in the islands (Cahill 1996:41). By the 1852, he and his second wife Mary (the first wife having died earlier) had moved to Kona where he had purchased some land in Keōpuka (Grant 1161). Reverend Paris remained in Kealakekua until his death in 1892.

P. Cummings (Grant 1171), born in 1811 (died in 1866), was from Massachusetts and had been a captain of a whaling ship before settling in Hawai'i. He married and settled in Kona around 1845. Cummings had quite a varied career including having been Deputy Sheriff of the province and a member of the House of Representatives from 1855 to 1856. He seems to be best known for engaging in "merchantile pursuits," having established a stone store at Kealakekua Bay. He was the "collector of the port," and the only foreigner living in Ka'awaloa in 1861. He grew coffee on his lands as well as harvesting his upland trees. Several letters refer to the yearly fees for a person cutting timber and an 1854 letter to a Mr. Sheldon concerning stripping *koa* bark. It is known that J. Atkins who owned Grant 969 in Ono'uli adjoining Cummings woodland grant was engaged in harvesting timber from the *koa* and *'ōhi'a* trees and it would seem that Cummings also engaged in utilizing this important economic resource.

An interesting advertisement directed to the "masters of whale ships" concerning the advantages of anchoring at Kealakekua, reflects the variety of produce cultivated on nearby lands. It said:

> You will find here in the greatest abundance of the best kind the following articles which will be furnished at the shortest notice and moderate prices. And they have the best of squashes, oranges, melons, coconuts, beef, muffins, fowls, turkeys, wood (in any quantity delivered at the landing). Lastly and most importantly, run no risk of smallpox as that has not appeared here nor several miles of this bay. Every attention will be paid to those who may favor us or call Kealakekua (Sept. 1, 1853).

Another resident of Keōpuka was Richard B. Neville, who purchased Grant 1171 from Cummings. He became sheriff but H..N. Greenwell, a resident of Kona since 1850, called him a "cane grower" (H.N.Greenwell Journal, 1869). Greenwell still referred to Neville's land on the *mauka* side of the government road as "woodland" and mentioned the use of a road from the woodlands to Ka'awaloa from where materials were brought by mules for the building of a house for a shoemaker. Greenwell eventually purchased the *mauka* land, as well as Neville's house in 1884, two years before Neville was tragically killed in an uprising in Kona while performing his duties as sheriff (Greenwell 1987).

Thomas Jagger, a well-known Hawaiian volcanologist, owned a land parcel next to the Ono'uli boundary of Keōpuka. Apparently, he purchased the land from the Henriques who did some ranching. The most recent activities within this *ahupua'a*, including portions of Keōpuka has been cattle ranching in the upper sections by the Henriques Family.

The upper most section of Keōpuka presently contains macadamia and some coffee cultivation. A narrow strip along Mamalahoa Highway, contains houses and shops. The lower section contains barren fields of a'a and pāhoehoe with some vegetation in the higher elevations.

INTERVIEW GUIDELINES

SCS conducted limited ethnographic interviews of six residents of the Kona area. Oral interviews were preformed to determine if there were any identifiable traditional cultural properties that might be impacted by future activities within the *ahupua'a* of Keōpuka.

As stated by the Procedures For Ethnographic Inventory Surveys (Draft) a Traditional Cultural property is defined as:

> Any historic property associated with the traditional practices and beliefs of an ethnic community or members of that community for more than fifty years. These traditions shall be founded in a community's history and contribute to maintaining the community's cultural identity. Traditional associations are those demonstrating a continuity of practice or belief until present or those documented in historical source materials, or both. These properties include but are not limited to, some types of archaeological sites.

According to the Guidelines for Assessing Cultural Impacts adopted by the State of Hawai'i;

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural, including submerged cultural resources, which support such cultural practices and beliefs.

The National Register states:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting materials, workmanship, feeling, and association.

Criteria established by the National Register for evaluating a property's eligibility for listing in the National Register includes properties that:

(a) are associated with events that have made significant contribution to the broad patterns of out history; or
(b) are associated with the lives of persons significant in our past; or
(c) embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
(d) have yielded, or may be likely to yield, information important in prehistory or history. [36 CFR, part 60.4]

Guidelines suggested by the Environmental Council and adopted by the State of Hawai'i provide information concerning cultural practices and cultural features that may be impacted by certain activities, such as land development, and requires environmental assessment of cultural resources in determining the significance of a proposed project (OEAC 1997).

RESULTS OF LIMITED ETHNOGRAPHICAL INTERVIEW

Six individuals contributed oral history interview documentation concerning the South Kona area with some references pertaining to Keōpuka. Specific knowledge about historical individuals living in, or associated with the *ahupua'a* of Keōpuka, as well as land use, was recorded within the Historical Land Use section of this report.

METHODOLOGY

All of the oral history interviews were conducted in Kona between March 16 and April 20, 2000. This portion of the research was guided by the Draft Procedures For Ethnographic Inventory Surveys and included a limited number of interviews with individuals known to be closely associated with the project area or the environs. After initial contact was made, an appointment was arranged for a meeting. Permission was asked to tape the conversation which would later be transcribed and sent back to the individuals for their corrections and approval.

A total of eleven individuals were originally suggested as likely to be familiar with Keōpuka. Two individuals could not be contacted for these interviews, three others said they knew nothing of the history of Keōpuka, and six agreed to meet with SCS. Two individuals did not wish to be taped but contributed enthusiastically to the historical content of this report. The remaining taped interviews are included in Appendix A. Those interviewed were informed that a signed release form was necessary before transcripts could be made public (Appendix B).

Although efforts were made to identify and contact previous residents of Keōpuka, this has not been possible up to this time. Frank Silva, who was a cowboy on the Greenwell ranch for 50 years beginning in 1950 escorted SCS through the Keōpuka on the Old Wagon Trail and contributed his vast knowledge of ranching activities which would have included some of the Keōpuka land (Figure 16).

Figure 16: Mr. Frank Silva.

Both Jean Greenwell and Bill Paris are residents of Kona whose family roots go back to the mid-1800s in this region and whose family associations included lands in Keōpuka (Figure 17). Nobu Shibuya was born and raised in Kona and as a boy, would often go fishing with his friends off the coast of Keōpuka.

Toshio Shirai and his sister Kazue Yoshiki grew up in Ka'awaloa, south of the *ahupua'a* of Keōpuka. Their family's livelihood came from the sea around Ka'awaloa and Keōpuka and from the food they grew on a piece of *mauka* land in Keōpuka that they rented from the Paris family (Figure 18).

During the interviews, other people were mentioned as potential sources of information. It is possible that individuals previously living in Ka'awaloa may have knowledge of Keōpuka. Mr. Silva remembers a Hawaiian family growing pineapple next to the Ka'awaloa road in the 1950s. Their name was Keli'i, which is a well known Kona family from at least the 1800s.

Figure 17: Mr. William Paris.

Figure 18: Mr. Toshio Shirai and His Sister Ms. Kazue Yoshiki.

Two Hawaiian families were apparently living in Ka'awaloa in the 1920s-1940s. In the 1920s-30s, the children of the Kani'au family played with the Shirai children. Another family named La'anui also may have been living there during this same time period. Due to time restrains and scope of this report the descendants of these families could not be contacted for interviews but these additions could be pursued in the future.

Additional research was conducted at the Kona Historical Society and included records of boundary descriptions, newspaper articles, letters and private journals that mentioned Keōpuka only in passing.

DISCUSSION

Six individuals agreed to participate in interviews contributing their knowledge of Keōpuka Ahupua'a and its environs in an effort to identify any traditional cultural properties.

In general, although all the interviewees had been within the boundaries of Keōpuka at one time or other, none had lived permanently within its borders with the exception of one family who rented a parcel of land for agriculture and to which they eventually moved.

The topography coupled with the dry, hot lava fields in the lowlands with little soil and no readily available water source is not conducive to cultivation or permanent year round habitation. Indeed, several participants stated that to their knowledge no one had lived in the coastal region. It was suggested that fishermen might camp for several days at a time, as they still do now, resulting in temporary structures. The fishing was good along the coast and several of the participants as children living upland, along the Māmalahoa Highway, would walk down to the cliffs to fish for the day and then hike home.

In the 1920s there were two families and one, lone Japanese fisherman living in nearby Ka'awaloa where there was a brackish well to provide some water. The men and boys would venture along the coast of Keōpuka to fish for their families and the women would sell the excess to the plantations in the uplands along the highway. This, along with seasonal coffee picking (which included all able family members), provided the needed income to support a household.

From the 1920s into the 1950s, the old wagon road crossing Keōpuka from north to south provided passage for people traveling to Kainaliu and beyond but was used most frequently for driving cattle from Ono'uli to Ka'awaloa for shipment to Honolulu. The steep Ka'awaloa road, improved upon in the 1850s, and that briefly intrudes into Keōpuka, was and is the main pedestrian access to the coast. In the early 1900s, the daughters of J.D. Paris turned the family home near the highway into a little hotel- the first in Kona.

The uplands received more rain and was cooler, making it more conducive to a greater variety of activities. Coffee plantations along with other agricultural endeavors were located on the upper slopes and along the highway. Water was always difficult to obtain in Kona and the catchment system provided the only water supply until the 1950s. When droughts occurred it was necessary to ration water or bring it all the way from Waimea. Ranching on a small scale, or pasturing a few cows, was also conducted in some upland sections, although most of the best ranch land was situated above the highway on the slopes of Hualalai. Several dairies were established in the higher elevations where butter was made and then brought to the stores for sale. As the herds grew in size and the natural water holes in the mountains were not enough, a system of pumps were installed that brought water from coastal areas to a large catchment shed on the mountain. Gravity would then disperse the water through pipes, to the different paddocks located lower on the slopes of the mountain.

On the relatively fertile belt adjacent to either side of the Māmalahoa Highway, small plots of land were rented to individuals for cultivation of vegetables and other cultivars for family and commercial use. Crops not demanding a lot of water, such as orange trees, were planted in the early 1800s. Vineyards were established by a few of the Portugese families mainly for their personal use. Homes were Interspersed throughout the plantations and some shops were located adjacent to the road.

CULTURAL ASSESSMENT

The definition of a traditional cultural property is:

> Any historic property associated with the traditional practices and beliefs of an ethnic community or members of that community for more than fifty years. These traditions shall be founded in a community's history and contribute to maintaining the community's cultural identity. Traditional associations are those demonstrating a continuity of practice or belief until present or those documented in historical source materials, or both. These properties include but are not limited to, some types of archaeological sites.

Limited ethnographic interviews were obtained by SCS from six appropriate individuals. These six people were recognized as knowledgeable, long-time residents of the Kona area. Interviews with these individuals did not identify any specific traditional cultural properties as defined in the Criteria for evaluation. Presently, the only known culturally significant sites are the archaeological features that have been identified throughout the project area. Mitigation of these resources are discussed within the various archaeological site reports.

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APPENDIX A
Interview Text

Proj. 211
Keōpuka Interview
William Paris
Project 211, Tape 4
Interview conducted by Leann McGerty (LM) and Lei Benson (LB) at Lanikila Church in Kainaliu, Kona.

William Hawawakaleoonamanuonakanahele Paris is descended from both Hawaiian and Caucasian *kama'āina* Kona families. He was born in 1922 on O'ahu but was brought home to Kona when barely three weeks old. "Uncle Billy", as he is known by most people, has been involved in ranch managing and ranching activities most of his life, as have many members of his extended family. Uncle Billy's knowledge of traditional Hawaiian practices and history is extensive and is, indeed, a valuable addition to this oral history.

March 28, 2000

BP: ...There was six Shipman, had left his share of the farm property to Lanikila so when the remaining Shipman family decided to sell this property, we took our share of the property...

LM: I'll tell you some of the things we need to know. We're doing a cultural assessment of properties, we're trying to find out if there are important or traditionally used properties [places associated with traditional activities] ... this is kind of specific to the *ahupua'a* of Keōpuka and, as you know, it's rather difficult to know [find] someone who lived there or who knows a lot about it.

BP: The Noheau and Kanī'au family used to fish at Ka'awaloa but their homesteads were up in Keōpuka.

LM: Really.

BP: That's with Gordon Leslie with Oceanside 1250 [Referring to development project adjacent to Keōpuka]. His mother was a Kanī'au.

LB: Right, Aunty Mary.

LM: Ah, so, this is Gordon's family.

BP: They lived in the upper portion but they used to go down to Ka'awaloa and catch *'ōpelu*. I can remember their son Oliver used to carry the *'ōpelu* and come up on a donkey from Ka'awaloa which the Hawaiians used a great deal, the rectangular kerosene? Kits. After they'd use the five gallon cans, they'd clean them out then use *limu 'aki'aki* [a type of seaweed] from the beach and *milo*, *hau* leaves and that's how they kept the fish moist and brought it up. My grandmother Paris' home is right at the top of Ka'awaloa trail. That's where my sister lives now. My cousin Jack and I–my grandmother would always tell us to go down in the morning because she was a "cracker jack" at the making of *lomi* and raw *'ōpelu* and taught us how to pick out the *'ōpelu*, look at the eyes, etc. We'd go and meet him at the head of the trail. My cousin Jack started. We had to do something when he came. We'd sing. My grandmother was a wonderful person, each summer she'd have all the cousins who lived in Honolulu, Maui and all over for about two weeks at Ka'awaloa. Her house had a lot of bedrooms and was two story. Most of us preferred sleeping out on the veranda. It was nice and cool. We'd yell and talk, play ghost in the house. She had a wonderful friend Kanimasu and he just loved kids and he made us a lot of toys.

LM: What years are you talking about?

BP: I was born in 1922 so this is all the late 1920s, early 1930s.

LM: We'd heard that at one time a Machado who was growing grapes, or had a small vineyard on some of the land in Keōpuka. Had you heard about this?

BP: The agriculture was done in that portion of the land that is up near the highway. You have people now down there now. Even the Isbell's live down in the agriculture and macadamia nut orchard across from the Chevron Service Station. Agriculture land is just in the upper portion. The land below-- Keōpuka lava flow covered the bulk of that land) and never was much agriculture. Ka'awaloa was same, the *kīpuka* goes down a little farther. Our Paris estate had an agricultural subdivision we put in and they were able to farm a little further down because we had more soil in the Ka'awaloa portion. The Keōpuka portion, once you get below the *kīpukas* there's not much agriculture. Vineyards were common in Kona, especially amongst the Portuguese families. Holoaloa Kaumalumalu–I can still see those great farmers and they made wine and everything else. They'd sell some excess but mostly for family. They made good wine.

LM: Holualua, Kaumalumalu?

BP: The Portuguese families that lived in that area all raised grapes.

LM: We also heard that the Henriques family or a Mr. Henriques did some ranching in portions of Keōpuka and I hear his name but I don't know anything about him or his family. Is this familiar to you at all?

BP: That's probably up *mauka* near the Gasper Dairy that was in that Kealakekua Ka'awaloa area. I would imagine they would have done some grazing up there because there's not much grazing land down below. You have the great lava flat and the *pali*.

LM: So you have to go *mauka*.

BP: The Gaspers' have a dairy up above and as far as that goes, the agricultural land, a lot of people are still farming on it today. The lower lands not so much.

LM: What about trails?

BP: The main trail was the trail going across from above Cook's cross to the Kainaliu area.

LM: What is Cook's cross?

BP: That is Puiolono. That's where the[y] steamed [the] fleshed off of Capt. Cook's bones. ["Cook's cross" refers to Puhina-o-Lona Heiau where Capt. Cook's body was burned and de-fleshed].

LM: That is now called the Wagon Trail?

BP: That is down below. This is further up, before you descend the *pali*.

LM: There's another one that goes...

BP: It goes right behind the new pavilion they have on Hōkūlea. I can remember a couple of weeks before he died, they had a blessing down there. I said the prayer and Don Gatewood, the person who committed suicide, he walked on that trail and they asked him to have supper with us down there.

LM: Its Oceanside [1250] properties.

BP: He had walked across from Keōpuka

LB: On the Old Government Road.

LM: Is that what's its called?

BP: Yes

LM: What is the one further lower down called?

BP: That is the King's Trail or the beach trail and it was improved in parts so that they could haul coffee and we used to ship wool and coffee out of Ka'awaloa, and they'd bring it across the lower road. In 1917 Kona had money appropriated from the legislature at that time to build a seaport in Kona. North and South Kona could never get together. The Kona group, always factions all my life and still goes on today. The people in North

Kona wanted it in Kailua and the South Kona wanted the harbor at Ka'awaloa. Ka'awaloa is the best anchorage in Hawaii. The Governor and the legislature said the heck with it and gave the money to Kahului on Maui and Port Alan on Kauai and we still didn't get any. Alan Wong and I were talking the other day and he said, "Just think if that ever happened, we'd have the Keawe Industrial Park and everything".

LM: When you were growing up from your grandmother or others of that generation, do you recall any stories or any references to places that might have been either in Keōpuka or nearby-any traditional names in reference to certain areas.

BP: More on the Ka'awaloa side. I don't know too much about Keopuka.

LM: That's what we're finding out-mostly Ka'awaloa.

BP: Of course you have 'Onouli then Keōpuka, then Ka'awaloa but my grandmother had hali'ilua lot down. That's why that song "Hali'ilua" is dedicated to Anna Paris. We had several lots in Ka'awaloa but then the government condemned them and they still haven't done anything.

LM: When they turned it over to a park or reserve?

BP: Prior to this they condemned some lots also. Then in the 1980s, the Kealakekua Bay Historical area, they condemned the lands on the top of the *pali* and the lands on Ka'awaloa flats. That's what that lower area is called-Ka'awaloa flats.

LM: That road that goes up to Ka'awaloa went up to your great grandfather's house.

BP: It met in the area Ka'awaloa they called Keōpuka and this vicinity because of the hump back ridge up above-I mean Kuapehu, swollen ridge.

LM: And that was the only road for a long time. Was it not?

BP: Ka'awaloa and then you had the trail that travelers from the *pali* and you can see it zigzaging-especially in the dry weather in the Nāpō'opo'o side.

LM: I saw that. So it went right across the *pali* from the Ka'awaloa side?

BP: Near where the trail goes across to Kainaliu from above Cook's cross. You have that trail, then when they had pineapple, they started making a road a little further up. You can see portions of it. In Ka'awaloa they were going to have improved roads cause where the coffee mill is down the road to Nāpō'opo'o, that was originally a pineapple factory. They were raising pineapple in lower Ka'awaloa and every place at that time.

LM: That's right, a Hawaiian gentleman down there and the family Keli'i and someone was growing pineapples.

BP: Keli'i planted pineapple for his family to eat. The place at Ka'awaloa has several descendants that are members of this church.

LM: I saw their graves down there. [Referring to Lanikila Church graveyard].

BP: I also am related to the Keli'is because my great, great grandmother was married originally to John Davis who was the nephew of Isaac Davis who helped Capt. Cook. She was full blooded Hawaiian. Then they had some problems-her false accusations, so they didn't hit it off. They were living in Waimea at that time. So the father and the mother had the king annul the marriage, brought her home. They lived in South Kona, went by mule and donkey, brought their daughter back. She had two children.

Elisa, who is here and a son named Charles. She remarried to Nauino and that's where all the Keli'is and Ho'omanawanuis and everything come from. They're my cousins, distant cousins. So our side of the family, her daughter Elisa, marries William Johnson. She's half white. Like my grandmother Shipman grandmother Paris are all 1/4. They all married back to Caucasians so the Hawaiian blood got confused along the way.

LB: Where does the Johnson come into the Paris family?

BP: He was a trader, ship person, everything else. He came to Hawaii from California during the gold rush era, settled here, married Elisa. I think a lot of those marriages by those early was done with a little thinking so when the Māhele came about since she had a good background both from Davis and the *alii* from South Kona they were given these great grants. That's how the Johnson's acquired this land-during the Great Māhele. He was quite a person-planted all kinds of things, citrus, melons, cattle, used dual purpose cattle up above, they made butter, cheese, etc. He was an enterprising individual.

LM: We learned that the land of Keōpuka, during the Māhele, was given back to the government and [was] basically for sale and one of your ancestors, J. Paris bought a small section in Keōpuka up by the highway. Do you have any idea what he used that land for? It was way up high by that road, he could have grown things.

BP: They also used that land to pasture the few cows. Aunt Ella kept those cows almost till she couldn't handle them any more. She used that land to pasture her dairy cows.

LM: I see

BP: She had aunt Ella right above Nāpō'opo'o junction, her home was up there. After father died in 1892, she turned it into a little hotel. Prior to the building of the Kona Inn, your inter-island steamship navigation company was the main means of transportation between the islands and they'd have these tourists come in. Most of them would come on the *Waialeale* or *Hualalai* to Hilo and there would be met by limousines with chauffeurs with leggings, breachings, white shirt, bow tie. Those people would tend to them and in the Manukā area the road was terrible. It took about thirteen hours when I was a kid to go from Hilo to Kona. So they'd spend the night at the Volcano, [House] come in and had a rest station at Manukā where the state park is today, so the driver could go in and have propane gas and he could heat up the food for them. He was a regular chef, chauffeur, and everything. Below her home she had cottages especially for these tour drivers. She'd tend to these people and the rest of the group would stay there and the others would stay at Manoenoe wall at her hotel which was called Mahealani here in Kawanui. We had no form of hotels then. All the sales people back in that era, McInerny, Liberty House, those big companies in Honolulu, because transportation was so hard, you didn't travel much between the islands other than to go to school or special business. You spent all night to get to Honolulu. The fastest time would be eleven hours, depending on freight and everything that was on board. Sometimes it took twenty-eight hours. We unloaded heavy sugar equipment in Kohala and Māhukona in a terrible storm. We had the best seamen in the world on those ships–they were outstanding. That was how we went back and forth and when the ship didn't come up to the pier, you got in the little ships and they would bring you to the docks.

LM: When you were a kid were they still using Ka'awaloa as a place to bring things in and unload them?

BP: Not too much because American Factors had their main store was right at the junction of where the road comes down from up above, where one branches off to the beach and the other goes to City of Refuge. On that left hand side of that junction on the *makai* side was a store and the wharf was where the little boats would bring the freight into. The lumber yard, the Standard Oil yard up above, they had fuel, lumber, everything in there in Nāpō'opo'o. We had a lot of people there. So as time went on, Alan went out of business, that was the end of it. Young Brothers used to bring their barge into Kailua but in high seas they'd have a hard time. They abandoned coming to Kailua any more. We used to take all of our freight to Waimea and then go down to Keauhou. We pushed a lot for that coastal highway. Hauling cattle down–cattle is a tricky load to haul down a twisty road because it shifts. It's amazing they didn't have more accidents. Our drivers were good. Kona in those days was altogether different.

LM: You would think that Keōpuka itself, because of the way the lava has gone through it and the *pali* that's there, that there really would have been very few areas where you could have done some successful agriculture.

BP: I would imagine places like that–when you notice some certain lands, you would see a stone platform or something, and if you look you would have very good plains. We call this the "*kilohana*". Its where you would place sentinels or things like that. I imagine that land would be used for things like that too, where they would have both for the ocean and ...you have commanding views from that *pali*. Strategically, you have a good view–you can imagine the land in the old days were open. We didn't have *kiawe* or anything like that. We didn't have large trees in the *kula*. The low lands in Kona are called the *kula*. We didn't have that type of vegetation that is there now. You have *pili* grass and native shrubs and things of that nature but large trees were not common. The largest trees that came in were breadfruit, subsequently mangoes, etc. In the beginning, it was a open. I remember when the county was trying to think about making beach trail as some sort of attraction where people could go through and look. I took them through and we made sure we stayed, Norman Greenwell and I, right on the old trail. Many places the ranches are diverted away. What can you see from this trail? Unless you clear the vegetation from here to the ocean, you can't see a thing.

LM: We were driving on the old wagon road in Keōpuka, there are archaeological sites and some of them are platforms, suggesting that there was some living down there. Do you think it might have been mainly for the fishing?

BP: I think so

LM: Sort of a seasonal thing going down there.

BP: Just like this time of the year, they all have places like Kainaliu Beach. They'd go down there to catch the fish. We had families living down there. The father worked for Tommy White, one of the rancher's in the area and he lived up in the mountain most of the week but those families did all their planting, etc. up here. The beach was where they could go and then in dry weather, they'd move. Because most of the water supply up here was so critical in those days. Even my father's family in dry weather, all moved to Ka'awaloa Beach, because they kept their water up above for the animals and things of that nature. People moved *makai*. You could get water for washing your clothes, at the beach. We had a special soap that was very good and it was maroon with white streaks in it. That's what we used.

LM: So then the water up *mauka* was for the animals.

BP: Yes, and plants. As time went on, we had a battery of tanks here in Kainaliu and later on when Aloha Theater was built, we took all their overflow water and everything else. Water was so critical. Prior to 1959 we had no municipal water in Kona. It just came about since that time.

LM: So before that it was catchment.

BP: It was all that. As times went on, we got modern facilities and we had no electricity till the mid 1930s. As they got washing machines, and everything else, and time of dry weather, one year we had to bring naval barge into Kailua and pump water into the lower system down there and then pump water into tank so they could come and fill your drinking water up on the main highways. Then they would bring water from Waimea in times of drought. People got so they couldn't live the way they used to.

LM: They had to have their washing machines, etc.

BP: Even our family had flush toilets in the house but when dry weather came, we went to the out house. That was how we conserved water. Every family had an out house.

LM: So wells down by the coast we very important.

BP: Yes. Hawaiians were smart. In the Hamakua area, (North Hilo area), Hawaiians knew where they could get where the springs come out under the ocean they take a gourd with the weight down and in it they would have a cork that would go through the salt water. They knew where these springs were, then they'd pull the cork out when it got down there, so when it got filled with fresh water, then they'd bring it up because it was full, salt water couldn't intrude as they brought it up. The fishermen would go out and that's how they'd get their drinking water, just throwing the gourd.

LM: Have you heard anything like that off the Kona coast?

BP: Some of the divers used to do that. They knew where fresh water bubbled up. They used to walk with just a canteen. It was known here you had underwater springs.

LM: Do you know what these were called?

BP: Some would have names but not all. Outside of Keōpuka you'd have some too. Just like Ka'awaloa, Puku'i [Mary Kawena Puku'i] did a wonderful job until she came to Kona then she messed up. Her reason for calling Ka'awaloa-when the original dictionary came out, we went crazy. We wrote letters and everything else. Ka'awaloa was the center of the *alii* where our last reigning monarchs used prior to Kamehameha came in, they all were there and so the *ali'i* would send runners to Puna to get *'awa*. That's why they acted a lot on *'awa*. We had the best *'awa* in the state of Hawaii. It grew in the Kalahiki area of Kona. We had an export business. We used to send them to Germany, Sweden, so they could used it for anesthesia.

LM: Really?

BP: Oh yes. We had an export business of *'awa* and why would we send to Puna to get *'awa*. The *'awa* is your landing, it was the best. When our coast line was rough down here

our Kainaliu people couldn't come in. They would take their canoes to Ka'awaloa and come back, that's why its called the "long landing of the landing far away". Just like North Kona, Kaulehu, she said it was because the girls were roasting breadfruit and one of them sassed Pele. That's south of Kaupelea. That was formerly called Manuwai. No, that is where the Kona Airport flow comes from Kaiweopele. That is where Manuwai village was. I can still see the two coconut trees that were growing on the south side of the hill. They were there for years until just a few years ago, and then they fell over. The village was there and the stone platform of the house, half of it is covered with lava and half is still good. She said to tell your parents to put a leper (this is a legend on Elisa's Kona legends my aunt taught school in Makalawena.) That is where the two sisters were. The portion of the house that had the leper was not covered by lava but the sassy sister side was covered.

LM: That's wonderful. [Referring to the story]. This village-was it covered?

BP: Yes, the bulk of it was. That's how our 1954 lava flow was.

LM: This a'a flow in Keōpuka is an old one?

BP: 1300 years ago. The last flow in the northern part of South Kona. In that portion of Kona, that's the last flow. The Hulalalai flow in North Kona is right at Keauhou where the battleground is-that area.

LB: So that flow that is by the Kahikolu Church?

BP: That is the Ke'ehahoaloa flow.

LB: Okay.

BP: So those are the two most recent flows in our area. Of course the 1950 flows of Ka'apuna flow is Ki'ihale, Kauhale, Magoon, and the Hamakua. They're all of Medeiros'. Honokua-we were all at my aunt's.-my aunt Smith's. It was all overcast and we could all see that-my dad knew. We watched and then it overpassed and all of a sudden three hours later, we see the pink thing coming from down under. My dad knew that side of the island. He said it's going to Honokua. My aunt said "Oh my god, Connie lives there we better go." When there was a lava flow, the Kona people would grab things and they were going.

LB: That was in the 1950s.

BP: We all jumped in the cars and headed for Honokua. By the time we got there the lava was across the road. It was that fast it came down. Poor Connie has her little dog on the leash in her bathrobe and her pajamas. She got out by the "skin of her teeth".

LM: She didn't know it was coming so fast.

BP: Those people went to bed with the chickens and got up with the chickens in that area so they had no idea this lava flow was taking place. It just happened, we used to have two Hilo-Kona drivers, they both had station wagons, and carried light freight and people, and they were they main means of transportation between Hilo and Kona. Thank god that driver was late that evening because he had a lot of things to drop off. They carried letters, packages and delivered in the cane fields and up to Wood Valley, and made a lot of deliveries in Ka'ū, so he was late. When he came he saw this lava coming and tooted his horn and arouse the neighborhood otherwise, they would not have known.

LM: That's amazing!

LB: It is.

LM: That's relatively recent. There was no way of warning them.

BP: There was an article in the paper-which way do you go when you have these flows?

LM: This was in the paper yesterday?

BP: Yes. Speaking about these flows things have been quite detailed. I was in the National Guard and then the opportunity-they sent a plane, Lt. McCallis was the pilot and I went with him and the state highway department asked me to map these flows so they could get an estimate of the first and second that had already subsided but the heat creates quite a lot of stops. When we go over and that light aircraft, it goes up and down. So he says this is the big one, I'll fly across it. That light aircraft-I thought we'd never get out of there. He had a heck of a time with it. When we got over to the other side I told him not to fly back. Down at the ocean you had the worst hazard. There was no pattern of the these observation planes or anything. They were coming from all directions. You couldn't see to the north of it and we came down all of a sudden.
A big C-54 military plane comes cruising right in front of us. I said we need some kind of guidance down here. We should have a pattern-planes were coming from every direction. It is a wonder they didn't have crack-ups with the reduced visibility from the clouds, etc. That and the year before, 1948 or 1949, we had an eruption that was heading right down the slope. My cousin Bob had a plane and he came down and kept going straight-it would have come out between Hōnaunau and Keauhou.
Can you see that lava coming over the *pali* up above?

LM: What do you think of Hulalai-what do you think the chances are-its only been a little over a hundred years.

BP: It will be two hundred next year. She follows a two to three hundred year pattern so anytime now.

LM: I would hate to have a brand new house on the side of Hualalai. Were you born in South Kona?

BP: Actually, my mother was living in a cottage at the Parish homestead at that time. She'd married my father but in those days we didn't have the best doctors. A lot of the women who could afford it would go to Honolulu to have their children. I was born at my grandfather in Wailupe which is called Aina Haina today.

LM: Yes, that's it. Your mother was a Hind?

BP: Yes, so we had a home at the top of Ke'eaumoku Street and I was born there. Dr. Mildon? Who was later with Straub and specialized in childbirth and childcare. Three weeks later I was brought home to Kona and lived here ever since. Except for my tours at school and the military.

LM: And your children, are they here in Kona?

BP: I have a daughter that manages the Bank of Hawaii in central Kona. One daughter's up in Silverdale in Washington. She was a naval wife for many years and upon his retirement from the navy, they live in Silverdale which is across from Seattle.

LM: It would be hard to live away from Kona I would think.

BP: She comes home every chance..every excuse.

LM: We really appreciated the time you gave us.

BP: Kona has the best weather in the world. Today we have people that are going to try to keep. Because we have the best weather in the world, people would love to live here. There's going to be tremendous pressure from the outside, and I can see the difference off season. At Mauna Kea Beach if it wasn't for them our people from Kohala Sugar Company would not have a job. I was on the credit committee of the Farmer's Home Administration. We made a lot of loans either let them buy their homes and move them to the subdivision or they'd build ate new ones. We was scared. We wondered how we were going to collect the money. Mauna Kea came in and I got on the county transportation commission and made sure we had a bus that serviced the community from Kohala to Apuna and Mauna Kea. Kaunaoa Beach is where Mauna Kea Beach is today. So they saved them. When you have quality and can fulfill it with the local people that live here, you have no problems. When you get too big, and you have to bring outsiders, we don't have the same values any more.

LM: And that's when things change.

BP: We never had a disciplinary problem in our schools until that transpired. They don't have the same values.

LM: That's what I see too.

BP: Like this development here, I think the caliber of people they have, they have to have some financial means to build down there and there's gonna be very little drain on our welfare system. The only kind of service they'll probably require is somebody to do gardening and things of that nature. Most of them will be retired or semi-retired, and will not have children to be a burden on our school system. This kind of development is not too bad.

LM: It's amazing because Kailua is still so pleasant to people, that it hasn't changed before this.

BP: The only thing I regret about Kailua is what the expansion of Ali'i Drive has done to it. Take Oneo Bay which is between Huggles and what was formerly the Sprindrifter. That was a lovely beach. All the sand that built the Kona Inn came from there. The Kona Inn's employees quarters was across the street where that new development is gone in. The sand went right across. We drove the beach which was a gravel road (Alii Drive) when I was a boy. You had the beach there, and Alii Drive prior 1935 was only a one-lane road. The sea wall was way inland. You had a lovely beach–Niumalu Beach when I was a kid. Then in 1935 Franklin D. Roosevelt decided to widen it. With that some sand went and our old pier was a finger pier of pilings with a shed on it so they could store freight overnight before the boat came in. They had the steam engine on the end, and with the wrench and the hoist where they pick up the slings and put it in the whale boats to take to the mother ship. The water washed underneath between the beach in front of King Kamehameha Hotel and that upper. We shipped cattle on the *mauka* side of the wall. It was a lovely beach. Then Keolu Bay, lovely crescent shape and then go and widen the road to go in front of King Kamehameha and build that wall right over what was once the beach. They ruined that place. That is the part of Kona that kills me. Instead of realigning the road to go in the back of the village, we didn't have the foresight then, because the sand the beach are of more value than those trinket shops.

LM: It was about sunset and I was walking by that bay and there were local kids playing in the water. I thought the same thing. Why did they put pier right in the middle here. The kids were enjoying it and they were local kids, but I felt the same way.

BP: In 1952 when they built the wall, they even took that seawall out further. Whatever sand that was left was gone. The whole one land road could have serviced those

buildings there because you can't park there any way. I'd love to see that section just closed to traffic for the bulk of the day and then have hours like they do in parts or Carmel in California where you service your stores at night. The trouble is, you have people living there who have their own cars and maybe they could have a restriction where only residents could go inside.

LM: We've kept you a long time and we appreciate so much you giving us this time.

BP: Because of the weather, there'll always be a great yearn for development in our area. The main thing for us to do–we'll never be able to eliminate it, but to ensure that it is quality. Quality development and clientele that will add to your community then its alright.

LM: What do you think of these million dollar homes driving up the property taxes?

BP: I think that can be handled. People who have adjacent property, I've talked to the people and the council, (it should be grand fathered in) as long as you don't change your land use you can enjoy that.

LM: That would be the way to go. On Oahu lots of people lost their houses because the Japanese were buying all the property. [and they couldn't afford the increase in property tax].

BP: That's the safeguard they have to put in and another thing I'd like to do was to see a difference between "true agriculture and shibai agriculture".

LB: Yes.

BP: Who can buy land like up in Kau in north Kona., near the Huihui area. They were selling those lots two and a half acre lots $180,000-$200,000. If you're going to come in and plant your crop, etc. and your life tenure is only twenty years to recover it, he'll never be able to recover it on agriculture. I told them we need to differentiate between "true agriculture and hobby agriculture". I know when my father died, I got burned in the pocketbook because he started creating a trust, and everything prior to his death but he couldn't do everything. He started too late. You go down and get an "IRS jerk". They think every property owner out to get the government–its in their mind, they're going to get you. Most of them are resentful in the first place, jealous of anybody who has something. Our appraisal went up and he appraised the land on his present use–what his present capacity was and everything. You have this guy in Honolulu who was a lawyer at the IRS office in Honolulu. Now he has his own company advising how they can cheat. He comes in and picks up a land sale by the Bakers in Hamakua. Over there you have beautiful dirt and everything and he went and assessed our property. Right on the boundary of what we call "mud lane" the Kohala Hamakua boundary was. Taking from a different area and assessing us at that rate. You have to hire a lawyer. We fought and got it reduced 1/3 from his appraisal but it cost me a lot. I remember when I was the national councilman for the Hawaii Association for Soil and Water Conservation and I went to Washington and we had senators, etc. and I put my hand up and asked, what can we do to stop erosion? The first thing you people could do is put something that says "Tax Erosion". Look in America, look in California what the most beautiful farm lands have been. Best orchards, best artichoke land, best asparagus fields are all being sold because their flat and easy to develop. Why have they been sold? Because you tax the poor heirs. They can't begin to pay. We should have laws as long as the people keep it in agriculture, its taxed reasonably. Within a ten year period, if they sell it at a high press then you come in and nail them. Don't tax them out of business.

LB: It only makes sense. You can get a million dollars for a person to put a house on., sometimes people don't think

BP: When my Aunt Terri Robinson had a land, she created a wonderful trust. It ended in 1976 but we have lands on Oahu in the Waipahu, Kunia area and we share it with two other Robinson interests that were brothers of her husband. By golly, if we'd been forced into eliminating that land at that time, we'd been up against it because when you have to go through a fire sale you'll never get the true value in the first place. They're gonna be out for a bargain. Myself and trust officers from First Hawaiian Bank and my cousin put up the bond and created a limited partnership with the purpose of limitations. The laws are changed now. Now we have to keep the ___ going. Because of her foresight, we are benefitting 116 people. That woman, just before she died, loved to speak Hawaiian to all of us. We didn't know what she was talking about sometime. She said: " Malama ka 'āina o kou kupuna..." , which means you take care of the land of your ancestors. Don't drink foolishly. This was her advice. We paid dearly to keep it but Uncle Sam will try and tax it.

LM: Thank you again for your time.

Project 211
Keōpuka Interview
Toshio Shirai (TS)
Kazue Yoshiki (KY)
Tape 5
Interview conducted by Leann McGerty (LM) and Lei Benson (LB) at the home of Mr. and Mrs. Toshio Shirai in Keōpuka, Kona.

Toshio Shirai and his sister Kazue Yoshiki moved to Ka'awaloa as children in 1925. Mr. Shirai's father was a fisherman and trained his son, who also became a fisherman, in the waters of Kealakekua Bay and along the coast of Ka'awaloa and Keōpuka. Mrs. Yoshiki and her mother would then pack-up the fish, climb the hill, and sell the catch to the upland farms.

As was typical in Kona, all the family members participated in the harvesting of coffee a different farms throughout the picking season.

Both Mr. Shirai and Mrs. Yoshiki married Kona residents, raised their families, and are still living in the Kona region.

20 April 2000

We are in Kona, Hawaii and we're going to be interviewing Toshio Shirai and Kazue Yoshiki, his sister...

[Mr. Shirai is showing us a bulletin published by the Kona Historical Society containing histories of long time residence of Kona.]

LM: ...Oh, I see. To the Kona Historical Society, so you have been a featured member of their publication. Oh, that's wonderful! It's wonderful to see that their doing that too in Kona. Going around and talking to the families. You were born in 1918 in Ka'awaloa or...?

TS: No I was born in Ka'au. Today, it's called Kapāpala, Ka'au...

LM: ...and how many years did you stay there? Were you born there as well? [Speaking to Kazue Yoshiki.]

KY: I was born in Hilo.

LM: In Hilo?

TS: I moved to Hilo when I was about two years old...and she was born in Wainaku.

LB: Oh, I see...

TS: Hilo.

LM: Your family moved around. Why is that?

TS: Yeah...my father, I don't know...he was a [pause] just a drifter. He was more adventurer. But when we came back to Kona, that's when we got stuck.

LB: And you settled here.

LM: So your father did all sorts of things...did he do some farming, and then maybe some building or what?...when you say he did lots of things what sort of things did he do?

KY: He was selling sewing machines...Singer sewing machines. He used to repair watches, too, yeah? He was a fisherman, coffee farmer...and he used to raise vegetables, too.

LM: So he was a jack-of-all-trades and...sounds like he was good with his hands...you say fixing watches and dealing with sewing machines and things...that's interesting. So that kind of work took him all over the Big Island or at least along this coast, coastal area. Had he come from Japan himself or was he born in Hawaii?

KY: No, he came from Japan.

TS: No, this is uh...my parents came from...[showing LM family history article from Kona Historical Society].

LM: Oh, from Kumamoto, Japan

TS: That's right.

LM: And you are the oldest, you are the first born...*hiapo* in Hawaiian. I see. Nine children...your parents had nine children! So you were the first one and then...?

TS: She's the second [referring to Mrs. Yoshiki].

KY: I'm the next.

LM: You're the next one...and are all your brothers and sisters still here in Hawai'i?

TS: Yes, except we lost two. One brother and one sister and the rest is still here.

LM: Still here. So how old were you when you came to Kona...when you came to settle in Kona?

TS: Oh, I was young yet, before I attend school so I was about...I would say maybe five years old.

LM: So you would be about three years old...you were really a baby. Yeah...yeah. And your parents went directly to Ka'awaloa, did they?

TS: No, no. We were seasonal workers, yeah..When the coffee season starts and we used to go to that place...they had a house. During the coffee season, we stayed there and harvest the coffee.

LM: Could you live in the house even if it wasn't coffee season?

TS: Yes, the last house,"Uchida" house, yeah, we used to stay.

LM: You could stay all year round.

TS: But after coffee season, my father he like to be fisherman...

LB: I know.

LM: I was thinking, that must be why you went to Ka'awaloa for the fishing.

TS: That's when we used to live Ka'awaloa

LB: Oh how lucky.

LM: So he would pick coffee or work with coffee in season and then you would go down to Ka'awaloa and...Did you go back and forth like that a lot while you were growing up or did you settle down in Ka'awaloa?

TS: No, back and forth. Every year season time, we come coffee and after coffee season we come down Ka'awaloa.

LM: Were there a lot of families living down there?

TS: No, just three families, but one family moved away so we were the only two families left.

LB: What was the name of the other family?

TS: Ah...it's a Hawaiian family named ah...

LB: Keli'i?

KY: Kanī'au.

TS: Kanī'au.

LB: Oh, Kanī'au, okay. Uh huh.

LM: Oh, so this is Gordon's family then.

LB: Was it Mary Kanī'au and Martha Kanī'au?

KY: Adeline...

LB: And Adeline.

KY: The oldest is Anna, she died early. And Martha was married to...Martha yeah...was married to...I mean, uh...Henry.

LM: And they lived...Kanī'au lived down there, and you lived down there, and you mentioned one other family?

KY: Makua

LM: Makua...I've heard that [name] too. I've heard that name mentioned. Makua, but then they moved away. What...Do you know what...the Kanī'au family and the Makua family, when they were living in Ka'awaloa, were they also fishing or were they doing other things?

TS: Fishing.

LM: Fishing was really very good there. Right?

TS: That's the only reason. Only the thing to do...fishing. That was I used to do...go fishing...help my father. Soon I went to 6th grade, then he pulled me out of school and take me out to fishing.

LM: So then he was teaching you...teaching you all about fishing.

TS: I learn about fishing...and all my life I've been fisherman.

LM: What did you fish for in particular in Ka'awaloa?

TS: Oh, we had a canoe, so we used to go out and do bottom fishing.

LM: Oh, really? So right in Ka'awaloa and Kealakekua Bay?

TS: We used to go out in the bay.

LB: To the different *koa* (s)?

TS: He had the canoe so we used to take the canoe.

LM: The area that we're very interested in is the *ahupua'a*, the area right next to Ka'awaloa., Keōpuka.... you know...the old wagon trail that goes through that area?

TS: Yes. I have a map here. I just made this...This is the trail, real trail. [Mr. Shirai has drawn a map of the location of where he lived and other significant places in Ka'awaloa and shows the Ka'awaloa Road leading from Ethel Paris house to Ka'awaloa flats.]

LB: Yes, Ethel Paris's house...

TS: We used to live in this house [indicating a point on the map] and we moved to this house, the ending part, last part and my brother was born in this house. And this house didn't have no big water tank so we used to walk to the brackish water pool.

LB: Oh, and you would get water.

TS: Yeah.

LM: At Ka'awaloa?

TS: Ka'awaloa...this is Ka'awaloa.

LM: Toshio is pointing to a map that he has done and the brackish water pool is on the east side of Captain Cook's monument.

LM: Is that [it?]...there is a traditional Hawaiian place at Ka'awaloa called "Umi's Well" and it was supposed to have brackish water. I'm wondering if that was it. I think it was supposed to be in that area.

TS: Yes, they have one right there. It's a pool. I think the Hawaiians used to get water from there.

LM: That was used for a long time.

TS: Then we used to go right next to the ocean and the water was just coming out so we used that water.

LM: And you could drink that as well?...or just...

TS: Yeah, brackish water, but...on the way to this place there's lot of foundation...house foundation.

LB: Cement or just rocks?

TS: No, no not cement...pebbles; square and that was the house they had the grass root or whatever...

LM: Like platforms?

TS: These things are still there. I guess you folks heard of that.

LM: Yeah, we drove down there the other day and we came on the wagon trail and yes, we saw a lot of like pavement... *'ili'ili* stones. There was one building that was western like, very old, all fallen down. It was a western style building with mortar and basalt rocks...and I'm thinking it might have been an old church or an old...it had, I think like a little basement in it.

TS: Oh, oh, yeah, yeah, yeah.

LM: Do you know what that is? We didn't know what that was.

TS: I'm not sure, but she [referring to Mrs. Yoshiki, his sister] was trying to tell me that near the back of Captain Cook's monument and ah... there was a building there. She said she used to hear from the old families that was a small palace for the people.

LM: And there was a woman of very high status, a Hawaiian woman of very high status who lived down there...

LB: Chieftess Kapi'olani

LM: Yes Chieftss Kapi'olani...and so she...I bet you that was her house. I bet you that was her house!

TS: Is that place overgrown with weeds?

LM: Very overgrown...there's no roof, the walls are standing, there's no floors so you can see down inside. Small, but...not big at all, but .....

TS: Yeah, I know. I remember that place. And ah...yeah, it's overgrown that's why lot of things that you cannot see the foundation...certain places I notice get nice level, I don't

know, something like *heiau*...but it's smooth and way down where the lighthouse is, there's a big *heiau*. So you've been down all along there.

LM: We have walked through parts of it, but you know it's so overgrown that it's difficult, you know...you're looking at something, but you not really sure what you're looking at because [its all jumbled]...and also I guess they had a lot of cattle down there, so the cattle has destroyed a lot of the platforms; they've walked all over 'em so it's hard to tell...[what your looking at]. You have written down here that this was your house and formerly the post office [referring to the map Mr. Shirai drew].

TS: Yeah, I was told that. Before lot of people were living there and the ship used to come in once a month or so and they had mails. This building was a post office I was told. Those days I hear lot of people was living [down at Ka'awaloa].

LB: That's what I understand, too. When you were there, did the ship come and unload things?

TS: No, only the ship that came in was cattle ship. Mr. Arthur Greenwell used to ship cattle from there. He used to drive the cattle all the way down the trail. They had a cattle pen and the shoot going into the ocean...and the ship used to come and collect all the cattle.

LM: He would drive them down that steep road. Full of holes...all the way down that steep road [referring to the Ka'awaloa Road].

TS: Yes, that's right. They had a cattle pen over here and the next day the ship comes in and unload all the...

LM: So, you were down there in the 1920's. Is that correct? You were living down there in the 1920's?

TS: I think later than that.

LM: Later than that, 1930's?

KY: 1925.

TS: No, 1925

LM: ...And so,...So even at that early date, there was just the three families?

TS: That's right.

LM: Everyone else by that time had moved away?

KY: There was old Japanese man living there too.

LM: Do you remember his name?

KY: Oike...[he was a] fisherman

TS: He used to be a caretaker for this house [referring to a point on Mr. Shirai's map].

LM: Oh, that was the Greenwell's house, I see.

TS: That was a big building, four rooms, five rooms.

LM: I'm curious about some of the places you might have gone fishing. Did your father take you around the coast in the area of Keōpuka for any kinds of fishing? Do you recall? Did you go to any special areas for fishing other than...[Ka'awaloa].

TS: Shore fishing?

LM: Shore fishing, right.

TS: Yeah, yeah, all along that coast where the lighthouse is standing...all along that area.

LM: All along that area? Did your father...was he told of any places that might be traditionally important, like it's an old Hawaiian fishing place or, you know, that people used to go to this place...um...for a long time, for many years they've gone to this place? Do you recall him saying anything like that or would he just take you to the places?

TS: Yes, well...he used to take me all over that Ka'awaloa Point...all the way down to the point and he didn't mention.. certain spot they get certain fish...that's where the people sometimes make camp like and stay there.

LM: They would stay there for a while.

TS: Few days, you know. If that's enough fish, then they go home.

LM: What did you do for water? When you were out there, it's really...[dry] we drove by...

TS: Yeah, that's why we used to have the 50 gallon drum and that thing go dry and no rain and we have to go get the brackish water...brackish water, yeah.

LM: If you would go fishing for a couple of days, would you...you would take water with you or were there...you know...off the coast, were there areas of brackish water that you knew about?

TS: No, we'd take water with us. We don't stay out all day, see. Maybe four hours, five hours than come home.

LM: That's pretty hot, though. Really hot. There's some coconut trees down...we saw some coconut trees down by the coast. Now I'm not sure they were down there before.

TS: Where in ah...? [locating area on map].

LM: Going...when you go...follow the coast up here, as we were on the wagon road looking down towards the ocean, we actually could see some platforms, some rock platforms and some coconut trees, but we don't know when the coconut trees appeared.

TS: Yeah, that I remember some people planted that, you know. Long time ago.

LM: So they weren't always there then. Somebody planted them.

TS: But that was long time ago, when I was young boy yet. This place, did you see that Captain Cook's grave?

LM: I have not seen that particular [structure]...that's called the what, "puhi'olono" [Kupuhiolono]? I believe that's called Puhi'olono and that is where they took Cook, right? [Capt. Cook's body was said to have been taken to this *heiau* after his death]. I haven't seen that 'cause we haven't gone up that road.

LB: We haven't gone up that road. We drove up the road that went over here [referring to 4-wheel drive road extending eastwest through Keōpuka].

TS: That's jeep road.

LB: Did you ever go up that jeep road?

TS: No, that road I never go, I didn't go through there. But you have to get permission those days. That's Richard Greenwell's place.

LM: So, you had to have permission to...

TS: This trail we used to use, see; the main trail from David Paris lot.

LM: 'Cause everybody could use this road.

TS: Yeah.

LM: This wagon road, is this the [Old] Wagon Road...So, to go on the wagon road, to go into

Keōpuka, you had to have permission?

TS: No, no. That's all open. And there's another trail about one mile above this Captain Cook's...[referring to Kupuhiolono] You never seen this trail, eh?

LM: No, and I think Uncle Billy [referring to Bill Paris] mentioned this trail. This is a trail that is up above, going northsouth, up above Puhi'olono [Kupuhiolono]...but, we didn't see it. Did you use that trail at all?

TS: No, I didn't see, but I know that trail is there so I came half way. I didn't go right through. On the way, I saw a cave and way in the corner of the cave, I see writings...stoned by so and so and what year. So I want to go back to see that.

LM: Oh, really, Oh really.

TS: Yeah, it's right on this old trail. And this old trail lead to Nāpō'opo'o [referring on map to a trail that extends along the top of the cliffs of Pali Kapu o Keoua]. Nāpō'opo'o cliff coming down, cliff is so steep, that they had to make the road go. You can see that road sign, I mean the marks from Nāpō'opo'o Heiau [referring to Hikiau Heiau.]

LM: So this is going across...this is above all the cliffs.

TS: Above this cliff.

LB: You're talking about Nāpō'opo'o Heiau which is in the other side of Ke'alakekua Bay?

TS: That's right. Nāpō'opo'o.

LM: So here's Cook's *heiau* right here [referring to Kupuhiolono]. They have that here written in. That's where you have this and so the trail must come right across...

LB: Does it zigzag or does it...?

TS: It just follow the...[cliff line] No, I think pretty straight, you know. This is the cliff... Above the cliff and come to this place...the main trail. This is the main trail to the *heiau*.

TS: ...This map don't show that trail. The one I...

LM: Someone else mentioned it, I'm not sure if it was Uncle Billy or who, but somebody else did mention that [trail]....but you actually went on a part of it and saw this cave.

TS: Yes, the trail is there. You can... still passable.

LM: What was the writing on? Was it on a rock or metal or...

TS: It's a rock, smooth rock. They carved the rock with words. Can see the words clear. If I'm not mistaken, must be Captain Cook's time or something. I didn't see...

LM: It could be. It could be one of his men or Vancouver's [voyage], maybe or something...[at] that time.

TS: So I want to go back and see that wordings. That end of wall...cause it's carved in the rock.

LM: What are some of your childhood memories in Ka'awaloa. Did your mother have a garden or did you...?

TS: Yes, on the way this trail above David Paris place.

LB: Ethel Paris?

TS: Yeah, Ethel Paris. She used to lease out the land to five acre lots, I think. We had a lot and we used to grow vegetables.

LM: Oh, up *mauka*, then.

TS: *Mauka*, yeah, it's on the highway. Cause down below there's no water and cannot...no soil, eh. We used to walk down and used to come up.

LM: How often would you go up and tend..everyday would you go up and tend the garden or every couple of days..?

TS: Maybe few days..Matter of fact I used to walk to school from there.

LM: From the mauka land?

TS: No, from Ka'awaloa. She and I, we used to walk and...

LB: Up this road? Everyday? And where was school?

TS: Yeah, everyday...

KY: [to] Konawaena.

LB: Konawaena!

LM: How many miles is that?

TS: Gee, I don't know how many miles...

LM: Six miles, five miles...?

LB: Twice a day...cause you had to get home too.

KY: And we used to go Japanese school too. Right below Konawaena..

TS: Those days, they still had that Japanese language school.

LM: Konawaena, is that where the um....is that where...?

LB: Where we have our crew house. Konawaena is the next road that goes straight up.

LM: Oh! I know which one...

LB: By the stop light.

LM: Oh, my goodness! I can't imagine doing that!

KY: Barefoot, too.

LM: Everyday! What time would you wake up?

TS: We gotta get good early start or...

KY: Glakka used to get up.

TS: Five AM. Take almost one hour, no?

LM: Is that all?

TS: No, about hour and half. From there we had to walk to Kawai. But those days, walking was...

LM: Everybody did that. That's how you got to places.

TS: Hardly see any cars.

LM: What about horses?

TS: We had donkeys.

LM: Oh, that's good.

TS: I remember I used to come up with the donkey and tie the donkey on the roadside and go back up...

LM: And he would stay there all day?

TS: Well, we tie em up.

LM: So when your father told you not to go to school anymore, that must have been kind of good, yeah? You didn't have to make that walk anymore.

TS: Yeah, right. Those days we didn't think much about [?] so taught me how to fish. I'm happy in a way, I did all my fishing. 50 years. And same time we had coffee fields. Coffee season we pick coffee and off season, we go fish.

LB: You go fish...
LM: That's a good life.

TS: That's how we lived. Those days, not much cars, so every place you go is walking, walking.

LM: What did you grow on your *mauka* land? Was it coffee?

TS: More vegetables. That was the early days. Later days we came to coffee land. To Gaspar coffee land.

LM: Gaspar, we heard that name. Joe, his name is? Yeah and he...okay, [grew] coffee...

LB: We also heard that Henriques...

TS: Yeah, Frank Henriques.

KY: We heard about their coffee.

TS: We was right next to them.

LM: Oh, you were. So you were just *mauka* of Henriques.

TS: Yeah, yeah.

LM: Was he a rancher or what was he?

TS: Yeah, he's a rancher. He was a rancher. And we had the coffee field *mauka* owned by Joe Gaspar.

LB: Is that Joe Gaspar from Nāpō'opo'o?

TS: That's right.

LB: And he's still alive?

TS: Still alive. Past 90 I think.

LM: So, I think this is the land now you said your family rented from Ethel Paris. I think this is in Keōpuka, actually...the mauka section of it. Did you ever hear of anybody living down in this area? [referring to the *makai* section of Keōpuka]. It was always *mauka*, yeah? It wasn't down here on this coastal area.

TS: Most of the people were just farming and I know there's a big cement jet house with the foundation still there but I don't know people was living in there or it's a warehouse or...

LM: Warehouse, yeah, I'm thinking they had some storage places when they used to come once a month and unload stuff. So what was your life like as a child in Ka'awaloa. What did you, when you weren't fishing, what kinds of things did you do?

TS: Well, we were young kids. Just the two families would get together and just play around.

LM: Explore...? Lots of swimming...?

TS: Lots of swimming and diving. My son used to catch fish.

LM: And you said your brother was born in Ka'awaloa.

TS: One of my brothers...

LM: Did your mom have a doctor?

TS: No, no.

KY: No, I don't think so. My father was [the doctor].

LM: Was he? Wow! I guess by then he'd had lots of experience.

TS: Those days to go to the doctor, no more cars...

LB: You'd have to walk. Can you imagine pregnant and going to have a baby and walk from there all the way to the...Did they have a hospital?

TS: They had a hospital.

LM: The one that they still have?

TS: Well, that's a new one, but they had a smaller one.

LM: Same place, yeah.

LM: What did your mom do during the day besides taking care of all the children, of course with ah....cause that's [Ka'awaloa] pretty isolated, yeah?

KY: She used to sell the fish.

TS: I'd go out with my dad, come home with the fish then she goes out.

KY: My mother and I used to go. Way up the farms, yeah, each house we would sell fish.

LM: How did you keep the fish fresh?

TS: Walk all the way up.

KY: We used to pick that, ah...what you call that?

TS: Seaweed and monkey leaves.

KY: Leaves from the tree...

LB: Oh, and you cover it.

KY: Cover it...

LB: That's how you kept it chilled. How much did you sell your fish for?

KY: Three pounds for 50 cents, something like that.

LM: Can you imagine!

LB: What kind of fish?

TS: Bottom fish. Snapper.

LM: What is the Hawaiian name for snapper.

KY: *'Ula'ula, kanekane...*

TS: Menpachi, eh...?

KY: That's *ono.*

LM: And you did hand line, then

TS: Handline. We used to go do a lot of 'ōpelu fishing. 'Ōpelu was so cheap. Forty for dollar quarter. Forty pieces! Today you no can get one for dollar.

LM: Last night I bought a piece of *'ahi* this big [indicating with hands a small size]. It was beautiful, but it was only this big. It was five dollars. Five dollars!

LB: It was good, but.

LM: So what, your...did your brothers go with you fishing or just you and your dad?

TS: My brothers was too young.

LM: So you would go fishing early, you would come back with the fish and...

TS: My mother....

LM: Your mother...So everyday, she went up the hill as well? With the donkey...did you ride the donkey? Or did you have to walk?

KY: Sometimes [ride].

LM: Sometimes, you would, yeah...And then you went to all the farms?

KY: Yes.

LM: That sounds like a lot...[of work] What time did you get home at night? At dark?

KY: Yes, We would leave about 1 or 2 in the afternoon that's why. Hot sky.

LM: Ooooh, and you had to climb up the hill?

LB: What did you carry your fish in? Did you have *lauhala* bags or did you have...

KY: Box, eh.

TS: We had one square box and put lot of leaves in between, seaweed, keep the fish cool, right on the donkey.

LM: And they'd stay cool?

TS: Pretty much...

LB: What was the box made out of?

TS: Just a wooden box.

LM: Oh yeah. Wooden box.

TS: We had the screen on the side so the air circulate.

LM: So the air would go through and around...

TS: Those days we couldn't get ice....Hard to get ice.

LM: Lots of farms up on the road? How many farms would you go to? Five, six?

KY: All the coffee farms.

LM: From Ka'awaloa going Nāpō'opo'o or coming Captain Cook

LB: So you would go to school and then come back and then go up with your mom.

KY: No, I went [to school] up fifth grade, she let me so...

LM: So you could help you mom with all the children and the fish and everything. And washing clothes and everything was done in the brackish water. And what if you needed something that you had to buy something...some material or something, where would you go for that?

KY: We used to have a Captain Cook store. The building's still there, yeah? What building is that now?

LB: Is that down at Nāpō'opo'o? Oh, it's up *mauka.*

TS: They had a lot of small stores on the road.

LM: The Greenwell store wasn't still ....No, no, that was...that was all closed.

KY: There was one store right by the junction.

LM: So they would get like dry goods, materials and thread and things like that. And they could get pots and pans if you needed them or whatever you needed?

LB: Would you sew your own clothes?

KY: Not dresses, but I used to sew *kimonos* like that.

LM: And where'd you learn...from your mother?

KY: No, I went to a school.

LB: You went to sewing school? In Hilo or...

KY: In Kona.

LM: Did you live at home when you did that?

KY: No. After I got married.

LM: After you got married.

LM: So you both spent your whole life in Kona.

KY: Yes.

LM: Lots of changes, huh?

KY: Oh, yeah

LM: When was the last time you went down to Ka'awaloa?

KY: 1993 was the last time.

TS: When we hiked down.

LM: You hiked down?

KY: But we caught the boat to come up!

LM: That's the way to do it.

LM: So, did you ...[it] must have brought back many memories

KY: Yes, but, shore line is not as good...so many trees, overgrown trees.

LM: Before it was just all clear.

KY: More open...and the water is higher now.

LM: That's interesting.

KY: Did you notice that?

TS: In other words the sand all disappearing and the water came higher.

LB: Where were the sandy areas? Here's the monument [referring to map]. Were the sandy areas here near the brackish water?

TS: No sandy, no sandy shores.

KY: No, way down, way down [indicating western Ka'awaloa].

TS: Now the sand all disappear, the water came up higher, now...

LB: So you right on the ocean?

TS: Yeah, had lot of sand around there before, but today, not...very little bit.

LM: Is part of your old house there?

TS: No. No more nothing...

KY: And this is the front of the house [looking at photo of the1993 visit]. The bougainvillea is still there.

LB: And you remember the bougainvillea from when you were little?

KY: Yes, we used to go in there and play.

LM: This is sort of like a house. Looks like an arbor...

KY: Yeah, so we used to go in there and play.

TS: I bet couple building is over a hundred years. Long before we got there some...

LM: Could be....

TS: We went 1993?

KY: '93 and 1990, I think, when you went.

LB: '99 you went there?

TS: No, she [referring to Mrs. Yoshiki] went down to see the house, but the houses wasn't there already. So she took the picture and she pick up some nails.

KY: Bunch of old nails...

TS: That the only thing left. The wood is all gone.

LM: Oh, this is wonderful! [looking at wedding photo of a couple in traditional Japanese attire.] Is this your mother?

KY: That's me.

LM: This is you? Oh it's wonderful! The reason I said that [asked if it was her mother], of course, is because of the traditional [Japanese clothes] ...I mean, it's beautiful!

TS: 1937.

LM: It's beautiful. Is that here? Or did you marry in Japan? Here.

LB: Did you make your...Is that your wedding picture?

KY: Yes.

LM: You're so young!

KY: Yeah, I was...only sixteen.

LM: Did everyone get married young...at a young age then?

KY: Not all.

LM: It's a beautiful picture.

LB: Where did you meet you husband?

KY: He used to live in O'ola. I didn't know him...it was all matchmaking then. So I didn't know him until I got married to him...

LM: Oh, really!

LB: Were you scared?

KY: Yeah, I wasn't happy. I wasn't happy.

LB: They just put people together.

KY: Friends, my parents friends.

LM: So the first time you met him was on the day of the wedding or before?

KY: Oh, before.

LM: Handsome man. That's a beautiful picture.

TS: In those days they used to get out the costume.

LM: Did they find a bride for you?

TS: That's right.

LM: They did!?

TS: I was down Ka'awaloa and she [referring to Mrs. Shirai who also attended the interview] was way up the mountain.

LM: And you didn't know each other.

MS: [Mrs. Shirai] No, I lived way up *mauka* Captain Cook. Way down; the last house.

LM: Had you gone to school together or anything? Had you seen each other?

MS: No, no.

LB: You didn't know each other?

MS: We did not know. We were match made.

LB: Five miles apart maybe you were raised?

LM: So then, your parents would say, We have found you a good wife and you would maybe meet her a short time...

TS: No, that time now, we married, I didn't have my parents. My parents was gone. My parents died young. My mother died when she was 37.

LB: Oh, that's young.

TS: And my father died; he had a stroke at 45; five years slipped and he died. God bless. When I got married, I was 30 years old, no 29, to her and...

MS: Your parents were gone. We got married 1947.

LM: Did you have to raise the rest of the [siblings], I don't know how old the children were when your mom died...

KY: He raised all [indicating Mr. Shirai].

LM: Oh, you did?

LM: You had to raise all the younger brothers and sisters?

TS: We all gotta work together.

LB: Right!

TS: When coffee time comes, those days they even let the school know...children used to stay home and help the family. That's how it was.

LM: They arranged the school for that, yeah?

TS: Yeah.

KY: They had their vacation..

LM: So coffee time, everybody would go pick coffee and then the other times you would be fishing. And they would take the fish and sell it. When did you decide to leave Ka'awaloa?

TS: The family was getting to big, so we had to move to Joe Gaspar land.

LM: The *mauka* land; to your farm land. Did you build a house or was there a house?

TS: No the house was there already, so we just moved in and took over the farm. Those days, we don't have too much cash, so coffee season, harvest time, we get harvest money to pay up all the expense. Lots of time, not enough so we have to go out work again.

LM: We also heard, that there might have been some families growing grapes, and making wine. Does that sound familiar at all to you? One of the pieces of land in Keōpuka, had to be *mauka*, was bought by, this was in the 1800's, long before your time, but it was bought by something called the Kona, Kona Winery. It suggests that somebody had some grape plants down there and were growing grapes at least. I don't know maybe they weren't...when you were there they weren't making wine anymore, but maybe they were selling grapes? But you don't recall anything like that.

TS: Must be the Greenwell land, that land was cleared land.

LM: Okay, could be, could be.

TS: The Greenwell family sold all Kona Ranch. Three brothers, Arthur Greenwell, Maude Greenwell and what the...

KY: Robert.

TS: Robert.

LM: After your marriage, did you move to Kona or did you stay, I mean, I'm sorry, did you move to Kailua or did you...

MS: I lived Ho'onaunau all my life, and I still been there.

LM: And you still do, and so you could visit your family. You could visit your brothers and sisters after you were married. And everything, they weren't that far away.

LM: Keōpuka is an *ahupua'a* that really doesn't seem to have been used for very much except for fishing on the coast and maybe the *mauka* section for gardening or ranching. Gaspar, did he do any ranching or was it mostly coffee?

TS: Yeah, he has a 16 acre coffee land.

LM: Okay, it's coffee. I don't know if there was any ranching done *mauka* in Keōpuka or not, but it seems to me that's the only good agriculture land is going to be the land up near the road cause the rest is so dry and so...all a'a lava; pretty dry.. There are archeological sites down on the coast, down here. Platforms and things where there might have been some temporary shelters built for fishermen. And that's about all we can [see]...I don't know of any fresh water, no one knows of any, you don't and two other people we've talked to don't know of any brackish wells on that side. Certainly Ka'awloa side, but not on the other side. So it's difficult to get too much information about Keōpuka and it just maybe that there isn't very much. Several areas were claimed during the Mahele in the 1850's. Some of them were up by the road, but there's a big section that's in the right in the middle, a Hawaiian man named Awahua bought a huge land grant and I can't figure out why 'cause it's all a'a [lava in his grant area] and pahoehoe and I don't know what he was doing with that piece of land. There's a go up [part of his land is elevated] it's, you know, it's a pretty big piece of land. I can't think of what he would have been doing or growing in that area.

TS: Keōpuka?

LM: In Keōpuka, yeah.

TS: Down at the beach or what?

LM: No it was kind of like, okay let's say the beach goes around here, it's kind of like in the middle here...I'll show you, I have it [referring to map showing Land Grants of 1800s].

TS: This place is called Keōpuka [referring to where Mr. Shirai's house is presently located].

LM: Where we are now? This is the ahupua'a of Keōpuka. I'll show you. I think... I have... should be a map in here that shows exactly the size of his grant [looking through files]. These are archeological sites along the coast. And quite a number as you can see. And see they found; this is archeological sites like in the middle of the area and there's quite a number there too. Where is it? [referring to Land Grant map].

TS: Your friend Uncle Bill, is that Bill Paris?

LM: Yes.

TS: Oh, that man.....

[Locating map that shows Land Grants in Keōpuka].

LM: And Keōpuka, you have a Barrett [Grant] up here and a little tiny Paris [Grant]. Billy Paris, one of his ancestors bought a piece there. This is the old government road which I think is the Māmalahoa Highway now. And there's a Barrett and a Barrett and a Paris and a Cummings, but then look at this crooked area here. This Grant, Awahua, and so it's like in the [middle]...this is the old wagon road, I think, yeah.. And no, maybe it's not.

You know what, the wagon road would be down here, this might be the trail that you were referring to...

LB: The trail above Captain Cook's? [Kupuhiolono.]

LM: This could be the one that you were referring to.

TS: I notice that trail is all right through.

LM: I bet you that's what this is, because the wagon road is going to be much more *makai* and then join up and go down. But anyway, there's a large section which when we were driving down here and looking around, this is all a'a lava and I don't know why he would purchase a Grant that large. I can't figure out what he was doing with it. Do you have any ideas?

TS: Who bought that you said?

LM: His name was Awahua. And he was doing something with it, but we don't know what.

TS: This is the other temple. We're up here. That belongs to Cummings, eh, I understand?

LM: Oh, where we are now? Oh, so this is...That's wonderful. Alright...I believe that this is the section that used to be called "woodland". Is that [name] familiar at all to you, "woodland"?

TS: No...

LM: It was [Henry Nicholas] Greenwell, in his journals, that talked about this land and this land, Cummings land, and I believe that he used to call it "woodland" because of all the...because there were lots of trees through here. So, yeah, so we're right up here, that's great. [We are] right on Cummings [old] land [grant] right now.

MS: ...I think it was purchased by Dillingham

TS: Ah, yeah..Dillingham...

LM: They purchased it from Cummings?

TS: Cummings, yeah..

MS: ...from Dillingham...if there was another......

LB: Person in between...?

LM: Yeah...

MS: ...but...you know in our map it says it was Cummings

LM: That would have been the family that bought this from the government in the 1850's. Yep, that's interesting. They were up here in this area, I think on the "woodland" in this area [referring to map], they were harvesting *koa* in the 1850's. They were harvesting *koa* and they were take...There was an advertisement down in Kealakekua to the boats, to the ships saying that "we'll [the merchants] supply you with vegetables; we'll supply you with whatever you want" and they [the merchants] mentioned wood. They say wood that "we would deliver to your ships" so, I think a lot of that came from this area. [Pause] You know I can't think of anything else to ask about

TS: Well this section, I don't know

LB: Did you ever travel on that trail? [referring to the old wagon road *makai*.]

LM: On the lower one?

LB: On the lower road.

TS: We used to go over...

LB: did you go to Kailua this way, maybe?

TS: We didn't go right through. There's a beach, small beach at the end of this trail, eh? Nāwāwā.

LM: Right, Nāwāwā.

LB: Yes, yes, you would go to Nāwāwā?

TS: Yeah, we used to walk and we had a donkey before and the donkey used to run away so we had to go all the way...

LB: Go chase the donkey at Nāwāwā...?

TS: ...looking for the donkey.

LM: and he's sometimes go all the way to Nāwāwā?

TS: Yeah.

LM: ...Early on there was a schoolhouse at Nāwāwā.

LB: Were there families living at Nāwāwā when you were there?

TS: No I don't remember any families, but near the coastline there's a, you know, half cave-like roof stone kind, underneath was smooth, so people living there, I think, or camping, I don't know.

LM: Ah huh. Ah huh.

TS: Nice uh...nice shelter because the...it's covered and the bottom all smooth.

LM: Where was that?

TS: Nāwāwā Beach

LB: Did Nāwāwā beach have lots of *'ili'ili* stone at that time or was it sandy?

TS: No, no sand, though.

LB: Yeah, it was always water worn, the smooth ocean, water worn, okay. Cause it still is, they're huge. Some of them are huge. Various size

TS: Rocks.

LM: So as far as you remember then going on that wagon trail all the way down to Nāwāwā, you didn't see any families living permanently?

TS: No, No.

LM: Maybe, maybe in the cave temporary fishing and stuff but, not...[permanent]

TS: Yeah, yeah, that's what I think

LM: But not permanent... you were probably so busy as a child raising the chi....helping your mom and doing those things that um...your friends that you played with had to be just the people right down at Ka'awaloa? When you had a chance to do that. You didn't go places to make friends like kids do now?

TS: No.

LB: If you even had time to go and play. Cause you were always walking somewhere or...or helping your parents. Man, you must have been knocked out at night after walking all that distance!

LM: Yeah, get a good night's sleep every night. That's for sure.

LB: And would you get up that early at 4:00 in the morning, too? [asking Mrs. Yoshiki.]

LM: To help your mom?

KY: We have to make our own lunch, yeah?

LM: What would you take for lunch?

KY: Rice and fish. When we was up at the road up there, we had... [laughing] [already eaten half of the lunch].

LM: Oh, really? Yeah, yeah.

LB: I wanted to know about your school. Did you have one teacher for all the classes? Or did...How did your school work? Was it one building? When you got up to Konawaena school.

KY: No it had many buildings, but ah...if you were in the third grade, one teacher. But there were several teachers but only one class, yeah. Like third grade is one room.

LM: Teachers all lived there in Captain Cook or in...or in Konawaena?

KY: There had cottage, too...but some comes from the homes, yeah...

LM: ...Well, I appreciate very much you having us in your home and you taking the time to do this. It's easy to get...it's so interesting hearing about the different lifestyle and the way things were done that it's hard not to.....keep going and going and going and caught up in it, yeah? This is a wonderful thing that your grandson has done, isn't it? [referring to a book concerning his family that Mrs. Yoshiki's grandson had organized for a school assignment].

LB: It really is.

LM: It really is wonderful.

LB: Did...You didn't have electricity.

TS: Those days...no

LM: Yeah.

TS: No, no electricity

LM: Nobody did.

TS: Yeah, I think so.

LB: And when you moved up to Joe Gaspar's land, was it kerosene lamp still?

TS: That's right. Kerosene lamp, stove, no stove, too I think, no? Wood.

LB: Wood stove?

TS: Yeah.

LM: Where would you get the wood?

TS: We had lot of coffee [wood].

LB: Coffee land...

LM: Oh sure...yeah, sure...

LB: And what about iron. Would you use irons?

KY: Charcoal.

LB: Charcoal irons!

LM: Did you have a sewing machine?

LB: A pedal sewing machine?

KY: Hand.

LB: Oh it was hand.

KY: Yeah.

LB: So that's what you learned on? Was a hand sewing machine?

KY: Ah...by hand, I sewed.

LB: Oh, you sewed everything by hand. The *kimonos*?

KY: Yes.
[A conversation then follows concerning the release forms.]

Project 211
Keōpuka Interview
Frank Silva
Project 211, Tape 2
Interviews conducted by: Leann McGerty(LM) and Lei Benson (LB) while driving with Frank Silva (FS) through Ono'uli and Keōpuka Ahupua'a.

Frank Silva was born in 1924 in Kealakekua, Kona, Hawai'i Island. Professionally he was a Cowboy on Greenwell's Ranch beginning in the 1950s until retirement. Frank's father and grandfather arrived from Portugal in late 1800s and also worked for the Greenwells'. Different members of his family have long been involved in Kona activities from working on the railroad to cattle slaughtering and maintaining the local meat market.

Taped interview on March 22, 2000:

[Tape picks up as Frank, Lei, and Leann are driving down into Ono'uli to gain access to the Old Wagon Road that crosses Keōpuka.]

LM: So you were saying that sheep were mostly in Keōpuka?

FS: No, cattle. When we shipped cattle that was in Kahaloa [Ka'awaloa] and we would take it from up mountain to Keōpuka across to Kahaloa [Ka'awaloa]. They took all the old shoots down already.

LM: The old road we're going to drive back up [referring to a steep east/west road extending up the slope of Keōpuka to Māmalahoa Highway], is that the one you went down with the cattle?

FS: No, the whole Keopuka road for cattle was no road. It was just a horse trail.

LM: So the road that we're gonna go down to get down there is by the market. Does it have a name? [Referring to old meat market and slaughter house used in the 1920s and beyond].

FS: The paddocks have all different names but that's in the Kealakekua area, we'll go down through Onouli.

LM: Okay, good. I'm trying to figure out the best way to do this.

FS: They would choose whatever reserved animals they want for breeding and all the rest would come down here and we'd raise them down the beach here. All of the market cattles would be raised down here.

LM: So what time period would your uncles would be butchering them?

FS: They left here about the 1920s.

LM: You said the other day that you'd been on the ranch for fifty years, since the 1950s.

FS: Yes, those days were all horse work. No roads, everything was on the horse and mules.

LM: I'm really interested in you telling us again how the water was brought from the brackish pools down here. [At the coast].

FS: Before that there used to be catchment. There used to be water holes up in the mountain. They used to hold pretty good and I heard they had better rains in those days. The herds were not that big and the water holes would take care of them pretty well. Then they started building water tanks, then as the herds got bigger, they built larger water tanks and catchment sheds and fifty thousand gallon tanks, and finally even that was not quite enough so then they started the pump system. That's when the put the pump from the beach to the mountain about seven pumps all the way up.

LM: What time period is that about?

FS: In the 1950s the pumps came in. That was the one that pumped the water right up to the mountain and had gravity flow right back to the beach. We have tanks down here, we'll test one later on. Water tanks all over that would supply every paddock, every trough everywhere.

LM: So this is just to supply water to the cattle? You weren't growing any crops up there?

FS: No, the only thing here was cattle.

LM: And the dairy that was up there, I read the other day that Greenwell started one of those butter dairies are what we are talking about.

FS: Up in Pulehua. [Pu'ulehua or Pulelehua].

LM: So that was up about four thousand feet?

FS: Yes

LM: And they had all the buildings and everything?

FS: Pulehua was built in the 1800s. The only thing left from Pulehua is the butter house.

LM: That is still standing. The fire took everything else.

LB: Was the butter house a small house?

FS: Yes, just a small square house about 12 X 15, still standing.

LM: So the water that they would get from the coast, these were like springs?

FS: The natural water holes, when it would rain it would fill up and some of the ground was so water logged it would keep seeping water. If we had dry weather a big herd of cattle wouldn't last too long. In those days the herd was small and the rains were better so we had water just about all year long in those holes.

LM: Do you have any idea, like in the 1860s when there was some crop growing in Keōpuka, how would they get water?

FS: The old Greenwell not as ranchers, they were farmers. They started orange farms. The orange didn't take that much water. If they did water, it was just water from the tanks.

LM: And they would plant the oranges up slope where they would get water.

FS: This was all orange here, near Māmalahoa Highway. We used to fifteen, twenty miles a day, today we go three miles they ask you, "Why don't we truck the horses." They don't want to ride anymore. I can't understand it. Such a beautiful life. These young kids don't want to do anything. We used to ride twenty five thirty miles a day. They say, "This is modern now." These cowboys today, I call them the "young and the sick." They used to call me "makule." Yes, the "old and the strong." You are the "young and the sick."

LM: How often would you drive the cattle to Ka'awaloa?

FS: That would be only when they'd ship things on the boat. In my time that was through. The wharfs and the piers had all the cattle pens but in those days they used to do it a few times a year, when they'd ship cattle. Most of it was done in Kailua. When I got here we were still shipping from Kailua.

LM: How would you drive them down?

FS: Right here was our shipping pens. We'd truck them from here to Kailua. At Kailua, they had pens, they had another pen in the water to drive the cattle right here. We'd drive the cattle to the pen in the ocean and the cattle would be tied to the tug boats and they'd take them to the ship outside. People up Kalawa'a and Palani ranch, they'd drive their cattle all the way down to Kailua. We used to drive cattle from Honolua to Honokohau all on the road. Our ranch was from the mountain to the beach so we'd mostly drive in the pasture.

LM: Did you ever drive them down the beach road and across to Kailua that way?

FS: No, we'd never drive to Kailua from here. Any animal from here to be shipped to Honolulu by boat would be loaded here by the market on the trucks and taken down to Kailua. The ones who used to drive was Palani and Huihui and Koloa, they'd drive their cattle down to Kailua through the roads.

LM: This was all coffee too? [Referring to area just below Māmalahoa Highway].

FS: Yes.

LB: It's so beautiful.

FS: Too bad the rain is not helping much. Just a few years back from this wall down was still pasture. That's where we had the dairy cattle all in this area here.

LB: Was there a paddock for the cattle?

FS: We had three paddocks in this area, dairy paddocks, and the rest was all sheep and beef cattle.

LM: So now we're in the Ahupua'a of Kealakekua, is that correct?

FS: Yes.

LB: So these are all the original walls?

FS: Very old.

LM: Lei's referring to the walls as we descend towards the ocean. [Referring to stacked basalt walls the majority of which are extending in an east/west].

LB: On the north side of the road.

FS: These walls were built years ago.

LM: Beautiful walls, aren't they?

LB: Around seven courses high. Who lives there?

FS: That's Jean's house. That's a good person to talk to. She does know a lot. [Referring to Jean Greenwell].

LM: She does know a lot. This obviously was all Greenwell and still is, right?

FS: These are all Greenwell's right to the beach. They just bulldozed all the coffee because it was diseased. They had to treat the soil.

LM: They're going to replant?

FS: Yes.

LM: Before what was this, an *'ōhi'a* forest?

FS: No, *'ōhi'a* grew up in the mountain.

LM: What would have been here before? Do you have any idea?

FS: It was just pasture.

LM: Before the pasture, what was it?

FS: Oranges were grown here.

LM: This is where Greenwell had his oranges in the 1800s.

FS: There were some oranges that died because it was disease. Nowadays, it kills the oranges.

LM: We have macadamia nut here too?

FS: This was planted just a few years ago, probably five years ago. Before we'd bring our butchered cattle here, near the market. Then, pick them up and take it to the market.

LM: The market just as we turned down the road off of Māmalahoa Highway?

FS: I used to slaughter there two days a week, cowboy the rest of the week at the beginning...

[A discussion follows regarding slaughtering cows and present residents of the area.]

LM: ...Were these walls put up to protect the coffee?

FS: No, these were built in the cattle days.

LM: The walls are all left over.

FS: Some of these walls must be over a hundred years old. They had quite a few orange trees in this area. They all died because of disease.

LM: Is that honey down there?

FS: Yes, about three places has these.

LM: Is it *kiawe* honey or coffee honey or just mixed?

FS: I guess there's coffee in everything.

LM: Is this land still Greenwell? [Referring to Greenwell's ranch lands.]

FS: Yes. This area belongs to Norman's family. Norman, Henry and Jack. When they gave up the ranch they sold all the mountain area then they divided this. Henry had all the north side, Norman had the middle, Jack had down this way.

LM: Which one did you work for?

FS: Everyone...

[Discussion on present land ownership and plants in the area.]

FS: ...This place is just made of walls. It had all different paddocks. In those days we'd separate heifers from steers, size for size. The bigger ones would stay from the railroad up here, closer to the market. The smaller ones we'd take to the beach area so they can grow up down there.

LM: Was there enough water and grass?

FS: We had water lines going all the way down.

LM: Was there enough grass?

FS: In the old days no, this was solid lantana and cactus. It was hard to drive cattle even. We couldn't raise much cattle in those days. Those days from the road down the beach, we were lucky if we could keep five hundred head of cattle. Then they got the tractors in. They got big chains–ninety pounds one link. It knocked all the lantana and *panini* and everything else. That's how they cleared all this land. Cowboys would come on their horse with bags of seeds and throw these all over the place–that's how the grass started.

LM: So when they would do that chain dragging if there had been traditional walls and mounds, they would get flattened?

FS: Yes. They didn't break stone walls because they needed the walls. Whatever small in between they did.

LM: So some of these stone walls might be old Hawaiian walls that they added on to?

FS: Yes, a lot of them. A lot was built in the ranch time.

[Discussion follows on location and names of paddocks in Ono'uli Ahupua'a.]

FS: ...My hands have scars from the lantana thorns. We used to come out here, our arms bleeding. The poor horses used to get them too. Their noses all dripping blood.'

LM: So all the way to the coast was lantana and cactus? [Referring to area east of old railroad bed to coast].

FS: Yes.

LM: Then it was chain dragged. When did the chain dragging happen?

FS: Around '54 or '55. That tree would grow maybe a foot or two and it'll stop and send roots down to the ground. Then they start branching out more. More trees would come out and the roots would start tangling around that tree, and eat the whole tree up. That was an *inea* tree...

[Further discussion on cattle an horses.]

LM: ...These are all from plantation days. [Referring to basalt rock mounds and platforms.]

LB: Did they make these?

FS: Yes, to get the rock off the ground so they could plant cane.

LM: So they had cane even though it was pretty dry?

FS: In those days I guess you had better weather and that's the reason they gave up too. They found out the weather was not good for cane.

LM: So all these rock piles are from the clearing for the cane?

FS: Yes, the mules used to plow and then the men would pick up all the rocks and pile them all up. They usually would pick a spot of solid rock where they couldn't work.

LM: So Lei, I wonder how many cane rock piles we have marked as [archaeological] features.

FS: Hundreds

LM: Sometimes when they have been flattened out they look like platforms.

FS: Yes. I know. When the archeologist first started coming here, we had the weed men working down here using knapsacks and fifty gallon poison and poisoned all the bad weeds. In fact this house is where they used to live–it was a small shack in those days. They'd build a small rock pile to put a fifty gallon drum on, so they could fill up their knapsacks. The first time the archaeologists came around they had this pointed out as the Hawaiian grave.

LM: Its kind of hard to tell.

FS: It looks the same the way they built it. Just a small little pile of rocks.

LB: CeeCee used to live here and then when she moved out Willie moved in. [Referring to house next to railroad bed].

FS: Yes, we know. In the old days this was the weed man house. This is all what they added. The green section there was the first thing here.

LM: What did he do for water? It was after you had the pumps going?

FS: No, he's got the water pipes coming from up there right here. When the weed man used to live here, the small little tank was their water...

LM: ...What was this used for? [Referring to a corral].

FS: For shipping cattle for slaughter, we'd bring a hundred in and pick the best. When we bring the cattle down from the mountain, we'd work them here in this pen.
They got the smaller ones to go to the beach and different, different paddocks.
This is how we worked it.

LM: When we get down to the railroad firm.

FS: This is the railroad, not the wall. If you stop up here and we can see. It's high over there and it goes right over there. It goes about a quarter mile that way. See this other section here? This one is a railroad and the lower one is the intersection.

LB: We should get a shot of that.

LM: Yes, we should get a shot of that.

FS: There's another one that side by Ilikai pen. Gordon asked me one time, "What was this? Did somebody build rocks here? That was much lower. That was where the trains used to pass. He didn't know that.

LB: We're on Oceanside property and on Lot 194 and the elevation is seven hundred and seven feet above sea level.

LM: This is right next to the railroad. This is Ono'uli Ahupua'a...

[A discussion of unrelated anecdotes and our orientation/location followed].

FS: ...The people who'd ship cattle to Ka'awaloa, they'd put a pig in the ground, *kalua* the pig, leave it overnight, and the next day after shipping, the cowboys would all sit down and
eat. This is the road that goes across.

LB: This is the old government road?

FS: Yes

LM: Okay I want to take a picture.

LB: And this is the Kuakini Wall.

LM: I'll write in Keōpuka.

FS: Then he sold to Kato. Kato Dairy and then Greenwell took over.

LM: So all the land is around six hundred feet elevation on the Keopuka side was Jagger's and that [referring to Jagger's land] went up to the highway? Māmalahoa?

FS: Yes. Up to St. John's Catholic Church.

LM: They had a dairy somewhere on that land.

FS: Yes, where Bones Riding Academy is? Right there. [Referring to a present day business located on Māmalahoa Highway]...

[Trying to locate Old Government Road in Ono'uli].

FS: ...They just made this recently for Oceanside [referring to a dirt road]. Alae salt is down

there. The Hawaiians use that with the regular salt. It's the red mineral. There was a lot there but so many people
come get that it's scare. It used to be thick.

LM: Is this on the Ono'uli side, Lei or the Keōpuka?

FS: It would be on the Ono'uli side.

LM: Call it the Alae Cave? [Referring to State Site 16468].

FS: The Hawaiians probably call it something else.

LM: But it was something that was used traditionally too.

FS: Yes.

LM: Where is it located, on the coast?

LB: Bill Fortini was doing the excavation on this cave. They're not cultural.

LM: Where there other things inside?

FS: People told me that they had a canoe in this cave. I've never been in the cave so I don't know.

LM: So this Alae Cave comes out where, along the coast?

FS: Below the ridge. Before there was a *heiau* here. Way back when I first came to this ranch. It went straight into the ocean.

LB: On the Keōpuka side?

LM: There was a *heiau* on the Keōpuka side?

FS: No, it was on this side.

LM: It was on the Ono'uli side but right on the boundary, right off the wall. How high are we about Lei, do you have any idea?

LB: The ocean's right there, probably 100 feet.

LM: So we're right above.

LB: Yes, there's a cliff...

[After discussion on opening gate, we cross over into Keōpuka].

LM: ...So now we are in Keōpuka.

FS: Up here we used to go on a horse. There was a lot of rock piles from old Hawaiian days. Nothing that was something sacred. A lot of beach rocks, placed all over, there's a lot of that placed in here.

LM: There's an old map from the 1820s and it shows a lot of habitation along this coast.

LB: I'll really go high. This is as far as I can. [Referring to 4-wheel drive maneuvers on Old Wagon Road].

LM: Was this area chain dragged too?

FS: No.

LM: So there could be quite a bit left of structures and things. Little remnants of things. The cattle look pretty healthy don't they?

FS: Yes, considering the weather they look very good...

[Discussion regarding working horses on lava.]

LM: ...Stepping stones here! [Referring to large water-worn boulders place across a'a lava flows for stepping stone trails in traditional times].

FS: In the old days, when the ship came in and brought things people would come on horse wagons and haul freight.

LM: So it's like curbing. [Referring to the waterworn stepping stones that have been moved to the sides of the wagon road, forming curbing].

LB: They look like platforms down there. We're entering the pāhoehoe lava flow.

LM: I'll get a couple of pictures here.

LB: The army built it?

FS: So some of these fox holes and square rockpiles were for the army.

LM: I think those platforms have been there for a long time. I think they've been noted but let me take a picture.

LB: Look at this beautiful curbing!

FS: ...a big pig right outside the road. We couldn't carry him so we tied him up, drag him to the road and had two guys brought the mules down. We had the mules with a sled and took them all the way to Capt. Cooke's monument. Henry Greenwell had a boat he brought from Napopo, brought the ranch truck down, came across with the boat right against the ramp and rolled the pig inside. We brought the pig to Napopo, all the Hawaiians helped us put it on the truck and took it to the meat market. He was over four hundred pounds.

LB: So what did you do, *kalua* it?

FS: Those days the ranch would sell it in the market.

LM: So this is the road you went on, at least part of it.

FS: That's where we took the cattle to ship.

LM: On this wagon road?

FS: Yes, from where I showed you they'd bring them down. The pens are all still there, the stone wall pens.

LM: So you would come down Kealakekua, cross Ono'uli and then to Keōpuka, all the way over to Ka'awaloa.

FS: Yes.

LM: Okay, great.

FS: They'd leave the cattle here overnight and ship it the next day.

LB: And the boats would come right in the barges?

FS: Those old boats like the Homu'ula and the poi liners (small boats).

LM: Lots of *noni* around here. I see a lot of little table ___ too, but rough country.

LB: Hot.

FS: Yes it is. In the old days we had frisky colts, we'd ride them till we could handle them pretty good and bring them here. We'd ride them on the sand, take them in the water, and take them up the old Ethel Paris road. That would fix them...[Ethel Paris Road is the old dirt road that leads form highway down to Ka'awaloa].

LB: ...Where there any watering holes around here?

FS: No. Water holes are all over that side. In Ka'awaloa there's some water holes.

LB: How about the fishing? The fishermen would come down here often?

FS: Yes. They camped down here. They come down this road, they come down through here.

LB: What road did they come down? The one by Bones' house?

FS: Yes. The King's Trail, because he comes down there. He uses it the most.

LM: But that's not the real name.

LB: That's only his name.

FS: It is really known in Kona as the Ethel Parish Road.

LM: So the King's Road is the old Ethel Parish Road.

FS: Some people call it the Ka'awaloa Road, I think it should be the Ka'awaloa Road because it was owned by Ka'awaloa in the old days-the horse wagon days.

LM: That's right. How do fishermen get down here now?

FS: Through that road. They need to have a permit. Some people walk.

LB: I see people at the top of Nāpō'opo'o Road, at the intersection, and they're walking down.

FS: Yes.

LM: That's where it comes out-the old Ka'awaloa Road.

LB: There's *uhaloa*, that's a native too.

FS: There's a lot of *uhaloa* on these rocks.

LM: Which one is that?

LB: Right there. That's a real scrawny one.

FS: They use that for toothache, sore throat, etc.

LM: *Uhaloa*?

FS: There used to be a lot of that weed that they call fish poison. I think they died off. I don't see them anymore.

LM: Like the red berries, *akia* is the name. I see coconut palms down the shore.

FS: I think Henry Greenwell and his second wife Patsy planted them. Even along here, they planted coconut. This is a hell of a road. Imagine driving cattle across here...

[Discussion follows about which road to exit by].

LM: ...Your father drove the wagons across here? What was he carrying in the wagons?

FS: The ship would come in and bring produce or freight, whatever for the people and they'd come down on the wagons and get them. This road and the road up there. That was the road my mother cautioned me about.

LM: Frank is referring to the Paris Road We're driving into Ka'awaloa.

LB: In a shady, shady area.

[Arrive at Ka'awaloa at which point the conversation turns to other topics.]

Pau

APPENDIX B
Interview Releases

INFORMATION RELEASE FORM

I, the undersigned participated in an interview with Scientific Consultant Services, Inc. in March of the year 2000. Scientific Consultant Services, Inc., Senior Archaeologist, Leann McGerty, assisted by Leina'ala Benson, conducted the interview on the Island of Hawai'i, State of Hawai'i.

I understand that the information I have provided to Scientific Consultant Services, Inc., shall be submitted as a part of an environmental impact statement required for proposed land use in the *ahupua'a* of Keōpuka.

I have read the transcript of the interview and the information is true and accurate to the best of my knowledge. By signing this release form, I am providing my approval for the release of the information to Scientific Consultant Services, Inc. For the purpose outlined above.

Date of recorded interview 22 · March · 2000

Print Name: FRANK SILVA

Signature: Frank Silva

Release Dated: 4 / 18 / 2000

Page #3. the horses cattle would be tied to the tug boats? its the cattle would be tied to the tug boats.
Page #14. the name is Henry Greenwell, not Andrew.

INFORMATION RELEASE FORM

I, the undersigned participated in an interview with Scientific Consultant Services, Inc. in April of the year 2000. Scientific Consultant Services, Inc., Senior Archaeologist, Leann McGerty, assisted by Leina'ala Benson, conducted the interview on the Island of Hawai'i, State of Hawai'i.

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I have read the transcript of the interview and the information is true and accurate to the best of my knowledge. By signing this release form, I am providing my approval for the release of the information to Scientific Consultant Services, Inc. For the purpose outlined above.

Date of recorded interview 20 · April · 2000

Print Name: Toshio Shirai

Signature: Toshio Shirai

Release Dated: 6/9/2000

INFORMATION RELEASE FORM

I, the undersigned participated in an interview with Scientific Consultant Services, Inc. in March of the year 2000. Scientific Consultant Services, Inc., Senior Archaeologist, Leann McGerty, assisted by Leina'ala Benson, conducted the interview on the Island of Hawai'i. State of Hawai'i.

I understand that the information I have provided to Scientific Consultant Services, Inc., shall be submitted as a part of an environmental impact statement required for proposed land use in the *ahupua'a* of Keōpuka.

I have read the transcript of the interview and the information is true and accurate to the best of my knowledge. By signing this release form, I am providing my approval for the release of the information to Scientific Consultant Services, Inc. For the purpose outlined above.

Date of recorded interview: March 28, 2000

Print Name: William J. Paris Jr

Signature: William J. Paris Jr.

Release Dated: May 25, 2000

INFORMATION RELEASE FORM

I, the undersigned participated in an interview with Scientific Consultant Services, Inc. in April of the year 2000. Scientific Consultant Services, Inc., Senior Archaeologist, Leann McGerty, assisted by Leina'ala Benson, conducted the interview on the Island of Hawai'i. State of Hawai'i.

I understand that the information I have provided to Scientific Consultant Services, Inc., shall be submitted as a part of an environmental impact statement required for proposed land use in the *ahupua'a* of Keōpuka.

I have read the transcript of the interview and the information is true and accurate to the best of my knowledge. By signing this release form, I am providing my approval for the release of the information to Scientific Consultant Services, Inc. For the purpose outlined above.

Date of recorded interview: 20 April 2000

Print Name: KAZUE YOSHIKI

Signature: Kazue Yoshiki

Release Dated: May 10 2000

APPENDIX J

Traffic Impact Analysis Report

A TRAFFIC IMPACT ANALYSIS REPORT FOR KEOPUKA LANDS

By:

M&E Pacific, Inc.
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May 17, 2000

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A TRAFFIC IMPACT ANALYSIS REPORT FOR KEOPUKA LANDS

This report describes the methodology and results of a study conducted to determine the traffic impacts of a proposed agricultural development in South Kona, Hawaii.

PROJECT DESCRIPTION

Pacific Star, LLC proposes to develop the Keopuka Lands project on 660 acres of agricultural lands in South Kona, Hawaii. The project site is located on property identified as Tax Map Key (3) 8-1-07:01, 54 and 55, as shown on Figure 1. The property stretches from the sea to the vicinity of Mamalahoa Highway, but would not have acces to the highway. Exclusive access to the site would be from the proposed Mamalahoa Highway Bypass roadway, which would bisect the project into a large makai parcel and a smaller mauka parcel. Access onto Mamalahoa Highway would be reserved for emergency purposes or as an alternate service entrance.

The Keopuka Lands project would include approximately 125 agricultural lots ranging in size from one to five acres, an 18 hole golf course with clubhouse and related uses, and a 100 room lodge. The lot sizes would be varied to allow additional open space uses, including golf course and common areas. A buffer of open space would be provided along the south boundary with the Kealakekua Bay State Park. Public access along the shoreline and existing government roads and trails would be provided. The mauka portion of the project would be developed as a macadamia orchid. This area would provide agricultural uses and income to the owners of lots on the makai portion of the property. The existing soils limit agricultural opportunities of the makai parcel.

Development of the agricultural lots is expected to begin in 2005 with five lots, and continue at about ten lots per year until completion. The golf course is expected to be in play by about 2007. Construction of the first phase of the lodge is expected to begin in 2006 with 50 rooms. The second increment of 50 rooms is expected to be added after 2010.

Based on the above development schedule, this study assumed two study years: 2010 and 2015; representing the first and second phases of the project. The land uses for the first phase included: 65 occupied agricultural lots, the golf course, and a 50 room lodge. The second phase would represent build-out with 125 agricultural lots, the golf course, and a 100 room lodge.

The only access to the project site would be via the proposed Mamalahoa Highway Bypass roadway. This study utilizes data from "A Traffic Analysis for an Environmental Impact Statement for the New Highway, North and South Kona, Hawaii" prepared by M&E Pacific, Inc., in 1997 for the proposed roadway. Since the proposed project would not have vehicular access without the proposed roadway, a "no highway" scenario was not analyzed.

This study analyzed the same study area and intersections as the previous study for consistency. The study area generally was bordered by Kamehameha III Road to the north, Kauakini Highway/Mamalahoa Highway to the east, Napoopoo road to the south, and the Mamalahoa Highway Bypass roadway to the west. The previous study analyzed seven intersections as shown on Figure 1:

1. Kuakini Highway at Kamehameha III Road
2. Kuakini Highway at Mamalahoa Highway
3. Mamalahoa Highway at Halekii Street
4. Mamalahoa Highway at Konawaena School Access Road
5. Mamalahoa Highway at Napoopoo Road
6. Kamehameha III Road at Alii Highway
7. Bypass Road at Halekii Street

EXISTING CONDITIONS

A review of the existing roadway and traffic conditions was made.

A. Roadway Conditions

Kuakini Highway and Mamalahoa Highway are the main north-south roadway on the Kona coast. It is primarily a two-lane arterial with left turn lanes at selected intersections. The two highways intersect near the town of Honalo, where the Mamalahoa Highway goes on a mauka alignment as the Old Mamalahoa Highway. The Kuakini Highway continues north to the town of Kailua. This intersection is not signalized and the right and left turn approaches of Old Mamalahoa Highway are separated by an island.

The Alii Highway currently begins as a continuation of Alii Drive north of the Keauhou Shopping Center. It continues south past the Kamehameha III Road intersection and terminates by the Keauhou-Kona Golf Course. It is a two lane undivided highway with traffic signals and lane channelization at the Kamehameha III Road intersection. Alii Drive and Alii Highway currently provide a makai travel route between Kailua and Keauhou.

Kamehameha III Road is a two-lane undivided roadway that provides a connection between the mauka Kuakini Highway and the makai Alii Highway. The Kuakini Highway intersection is signalized and channelized. Walua Road, which serves a residential area, is the mauka approach to the intersection.

Halekii Street is a two-lane mauka-makai connector roadway between Mamalahoa Highway and the Kona Scenic subdivision. Its intersection with Mamalahoa Highway is channelized with traffic signals installed subsequent to the completion of the previously cited highway study. The roadway also serves a post office and commercial center on the southwest corner of the intersection. This roadway would be extended makai to connect with the proposed Mamalahoa Highway Bypass roadway.

The Mamalahoa Highway at Konawaena School Access Road intersection is signalized, and has separate turning lanes.

Napoopoo Road is a substandard roadway that provides access to the makai communities. Its intersection with Mamalahoa Highway is at an up grade, stop sign controlled, at a nonright angle, and has space for separate left and right turn lanes. At this point Mamalahoa Highway is at about a 4 percent up grade to the south and there are no turning lanes in either direction.

B. Traffic Volumes

Traffic turning movement counts were taken at the six existing study intersections during the morning and afternoon peak periods on Thursday, March 23, 2000. Traffic turning movement counts require workers to station themselves by each study intersection and record each vehicle movement as through or turning movements by 15 minute intervals. The worksheets for the traffic counts are included in the Appendix. The traffic counts at the Kuakini Highway/Kamehameha III Road intersection did not include Walua Road. Therefore, the traffic volumes into and from this approach were taken from "Traffic Impact Study Villages of Hokukano, North and South Kona, Hawaii" (November 1995) by Parsons Brinckerhoff Quade and Douglas, Inc (PBQD). The resultant peak hour movements are summarized on Figure 2, with traffic volumes rounded to the nearest five vehicles per hour. The northbound direction of travel predominates in the morning peak while the opposite direction is heavier during the afternoon.

Comparison of these counts with those taken in 1997 for the previously cited highway study showed mixed trends. During the morning peak, there was a decrease or no change in southbound traffic on Kuakini and Mamalahoa Highways from Kamehameha III Road to Halekii Street. This could be attributed to the opening of Kealakehe High School which has reduced student traffic from the north. However, there was a large increase in traffic volumes turning into and out

of the Konawaena School Road which school officials could not explain. Northbound traffic volumes have increased ranging from 12% at the two north intersections to 33% at the Halekii Street intersection. Traffic volumes on Mamalahoa Highway at Napoopoo Road increased about 9% in both directions of travel.

Traffic trends also showed a mixed trend during the afternoon peak. Southbound traffic volumes on Kuakini and Mamalahoa Highways decreased at the Kamehameha III Road, Halekii Street and Napoopoo Road intersections but increased at the other two. However, northbound traffic volumes increased from 10% to 18% along the same route.

Levels of service for the two sets of traffic volumes (1997 and 2000) are compared on Table 1. The concept of level of service is explained in the latter "Level of Service Analysis" section. There generally has not been any change in levels of service with the following five exceptions. The westbound right turn from Mamalahoa Highway to Kuakini Highway went from level B to C in the morning peak due to higher northbound traffic volumes. Higher northbound afternoon volumes also caused the southbound left turn from Kuakini Highway into Old Mamalahoa Road to decrease from level A to B. On the other hand, the left turn from northbound Mamalahoa Highway into Napoopoo Road improved from level B to A due to lower afternoon southbound volumes. Likewise, the signalized intersection level of service for the Kuakini Highway/Kamehameha III Road intersection improved from level D to C in the afternoon due to lower southbound volumes. Finally, the morning level of service at the Mamalahoa Highway/Konawaena School Road decreased from B to C due to the higher turning volumes. A comparison of the Mamalahoa Highway/Halekii Street intersection could not be made since traffic signals were installed subsequent to the previous study.

The State Department of Transportation takes metered traffic counts every two years at selected roadway sections on Hawaii. Traffic counts were taken at four of the six existing study intersections:

Kuakini Highway at Kamehameha III Road
Kuakini Highway at Mamalahoa Highway
Mamalahoa Highway at Napoopoo Road
Kamehameha III Road at Alii Highway

The daily traffic volumes for the latest available ccunts taken in 1998 are shown on Figure 3 rounded to the nearest hundred. These daily traffic volumes showed different trends when compared to their respective 1996 traffic volumes. Volumes on Kuakini Highway decreased 15% north of but increased 10% south of Kamehameha III Road. Volumes increased by 5% at the Kuakini/Mamalahoa Highway intersection. Volumes on Mamalahoa Highway did not change north of Napoopoo Road but decreased 6% south of the intersection. Traffic volumes on Alii Drive/Highway increased by 30% while those on Kamehameha III Road decreased by 12%.

TRAFFIC FORECASTS

Access to the proposed project would be exclusively from the proposed Mamalahoa Highway Bypass roadway. The roadway will be built by the developers of The Villages of Hokukano (now, Hokulia) as a condition for approval of the project. Therefore, there would be no reason to analyze a no-bypass highway alternative. Also, the traffic forecasts for the highway project from the previously cited M&E Pacific study could be used as the basis for this study. Specifically, the total traffic forecasts from Figures 11 and 12 for the years 2010 and 2015, respectively, were used as the ambient traffic forecasts for this study. These forecasts included traffic generated by the proposed Villages of Hokukano project. The traffic which would be generated by the Keopuka Lands

project were then added to these ambient traffic forecasts to calculate total traffic forecasts.

Comparison of the 1997 and 2000 existing traffic volumes indicated that the previously calculated traffic forecasts for the years 2010 and 2015 were reasonable. Although the volume of north-south corridor traffic is expected to increase, traffic volumes on Kuakini and Mamalahoa Highways can be expected to decrease due to traffic diversion to the new bypass roadway. The only change that needed to be made was to increase the turn volumes at the Konawaena Road intersection during the morning peak to match the most recently counted volumes. The adjusted ambient forecasts used in this project are shown on Figures 4 and 5 for the years 2010 and 2015, respectively. The traffic volumes were rounded to the nearest five vehicles per hour.

The traditional three step procedure of trip generation, distribution and assignment was used to forecast future traffic which would be generated by proposed project. The trip generation step forecasts the number of new trips which would be produced in the two peak hours. The trip distribution step allocates these new trips by direction of travel. Finally, the trip assignment step assigns the project-generated trips to specific turning movements on the roadway system.

The traffic generation rates used by PBQD in their previously cited study were also used for this study. The Villages of Hokukano proposed the same land uses as this project: single family residential lots, golf course, and lodge facility but with more residential lots. The results of trip generation analysis are shown on Table 2.

The proposed project is expected to generate 72 inbound and 42 outbound trips in the year 2010 morning peak hour. There would be 52 inbound and 93 outbound trips in the afternoon peak. The golf course would be the largest trip generator in the first phase of the proposed project. With full build out by 2015, there would be 91 inbound and 74 outbound trips in the morning peak and 93 inbound and 125 outbound trips in the afternoon peak. The agricultural lots are expected to generate slightly more trips than the golf course at full build out.

The project-generated trips were then distributed to the study area street network using similar distribution percentages as the previously cited highway study. The results of the trip distribution analysis are summarized on Table 3. The large proportion of trips would either go north to Alii Highway or remain internal to the project.

The results of the trip assignment on the study area roadway system are shown on Figures 6 and 7 for the years 2010 and 2015 respectively. The traffic assignment volumes were not rounded.

Total Forecast Volumes

The traffic assignment forecasts from Figures 6 and 7 were added to the ambient traffic forecasts from Figures 4 and 5 to obtain the total traffic forecasts. These are shown on Figures 8 and 9 for the years 2010 and 2015, respectively. The traffic volumes were rounded to the nearest five vehicles per hour except for volumes less than five vehicles.

LEVEL OF SERVICE ANALYSIS

The traffic volumes in themselves do not give an indication of the quality of traffic flow. The Transportation Research Board has addressed this matter by developing the concept of level of service. Their Highway Capacity Manual, Special Report 209 (Third Edition, 1994) has separate procedures for calculating levels of service at signalized and unsignalized intersections. Traffic improvements are generally required for level of service F conditions, while level of service D or better are desired for areas such as the study area.

The methodology for signalized intersections calculates levels of service for turning movement lane groups, approaches and intersections as the whole based on the average delay. It utilizes factors such as roadway geometry, traffic volumes, and signal timing parameters in its calculations as desribed in the Appendix.

The methodology for unsignalized intersections calculates levels of service for movements from the side streets and left turns from the through lanes, based on the average delay. It utilizes traffic volume and roadway geometry factors in its calculations, as described in the Appendix.

The above methodologies were used on the existing year (2000) traffic volumes, and ambient and total forecast volumes for the years 2010 and 2015. Per the recommendations of the previous study, the Kuakani Highway/Mamalahoa Highway intersection was assumed to be unsignalized while the bypass roadway/Napoopoo Road/Mamalahoa Highway and bypass highway/Halekii Street intersections were assumed to signalized for the forecast conditions. The Keopuka Lands project intersection on the bypass roadway was analyzed as both unsignalized and signalized.

Current roadway laneage was assumed for existing intersections. Separate lanes were assumed for each through and turning movement at the bypass roadway/Napoopoo Road/Mamalahoa Highway and bypass highway/Halekii Street intersections. For the proposed project intersection on the bypass roadway, separate left and right turn lanes were assumed on the bypass roadway approaches primarily for safety reasons. The approach serving the makai parcel of the proposed project was assumed to be two lanes while the mauka property approach was only one lane.

The results of level of service for unsignalized and signalized intersections analyses are shown on Table 4. In general, traffic conditions on Kuakini Highway and Mamalahoa Highway are expected to improve by the year 2010 as through traffic is diverted to the bypass roadway. This analysis focuses on changes between the ambient and total forecast conditions.

There were no changes recorded at the Kuakini Highway/Kamehameha III Road intersection since the trip assignment assumed that no Keopuka Lands trips would travel through this intersection. Levels of service at the Kuakini Highway/Mamalahoa Highway, Mamalahoa Highway/Halekii Street, Mamalahoa Highway/Konawaena School Road, and Mamalahoa Highway/Napoopoo Road/bypass roadway intersections did not change since few project-generated trips were assigned at these locations. Hence, traffic from the proposed project is not expected to have an adverse impact at these intersections.

The most heavily impacted intersection is expected to be the Alii Highway/Kamehameha III Road intersection, where almost half of the project-generated trips was assigned. This intersection is already expected to be at level of service E during both peak hours in the year 2015 under ambient conditions. The additional traffic in the afternoon peak could create a level of service F condition. To mitigate this problem, the previous study recommended providing two through lanes in each direction of Alii Highway at the intersection to get the vehicles across, and then narrowing down to one lane again. Assume completion by 2010.

Levels of service at the bypass roadway/Halekii Street intersection are not expected to change despite the increase in traffic on the bypass roadway from the proposed project. Hence, there would not be any adverse traffic impact from the proposed project.

The levels of service at the proposed project intersection with the bypass roadway are C or higher, indicating acceptable conditions. Hence, the

intersection does not have to be signalized. If this intersection were signalized, it would be operating at level of service A.

CONCLUSIONS

1. The proposed Mamalahoa Highway Bypass roadway is expected to divert traffic from Kuakini Highway and Mamalahoa Highway, and eliminate or delay the need for several highway improvements on the existing facilities.

2. The proposed Keopuka Lands project is not expected to have an adverse traffic impact on the adjacent roadway system and would not require additional mitigating actions. Any necessary improvements such as installing traffic signals at currently unsignalized intersections when warranted or widening Alii Highway at Kamehameha III Road would be due to increases in ambient traffic and therefore, not the responsibility of this development.

3. The intersection of the proposed project and the bypass roadway would not have to be signalized.

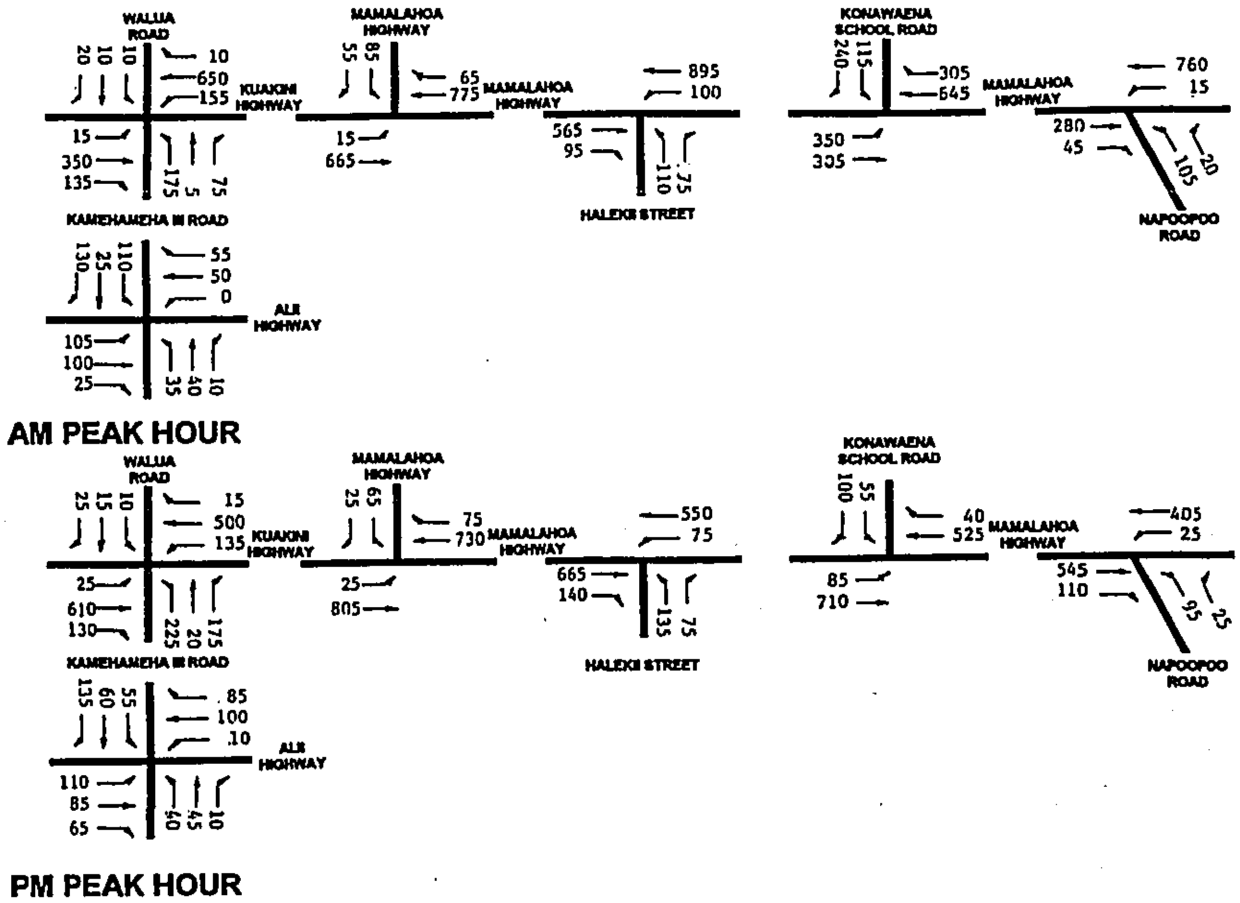


FIGURE 2
EXISTING TRAFFIC VOLUMES

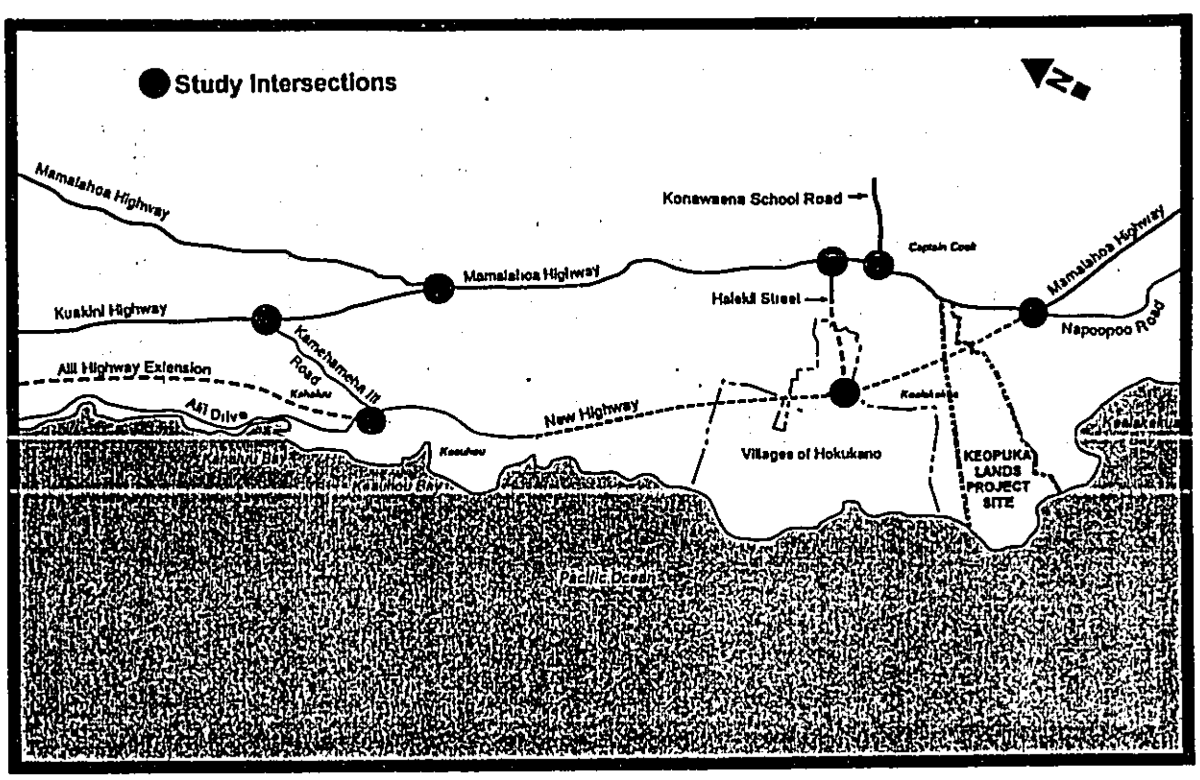


FIGURE 1

LOCATION MAP
Not to Scale

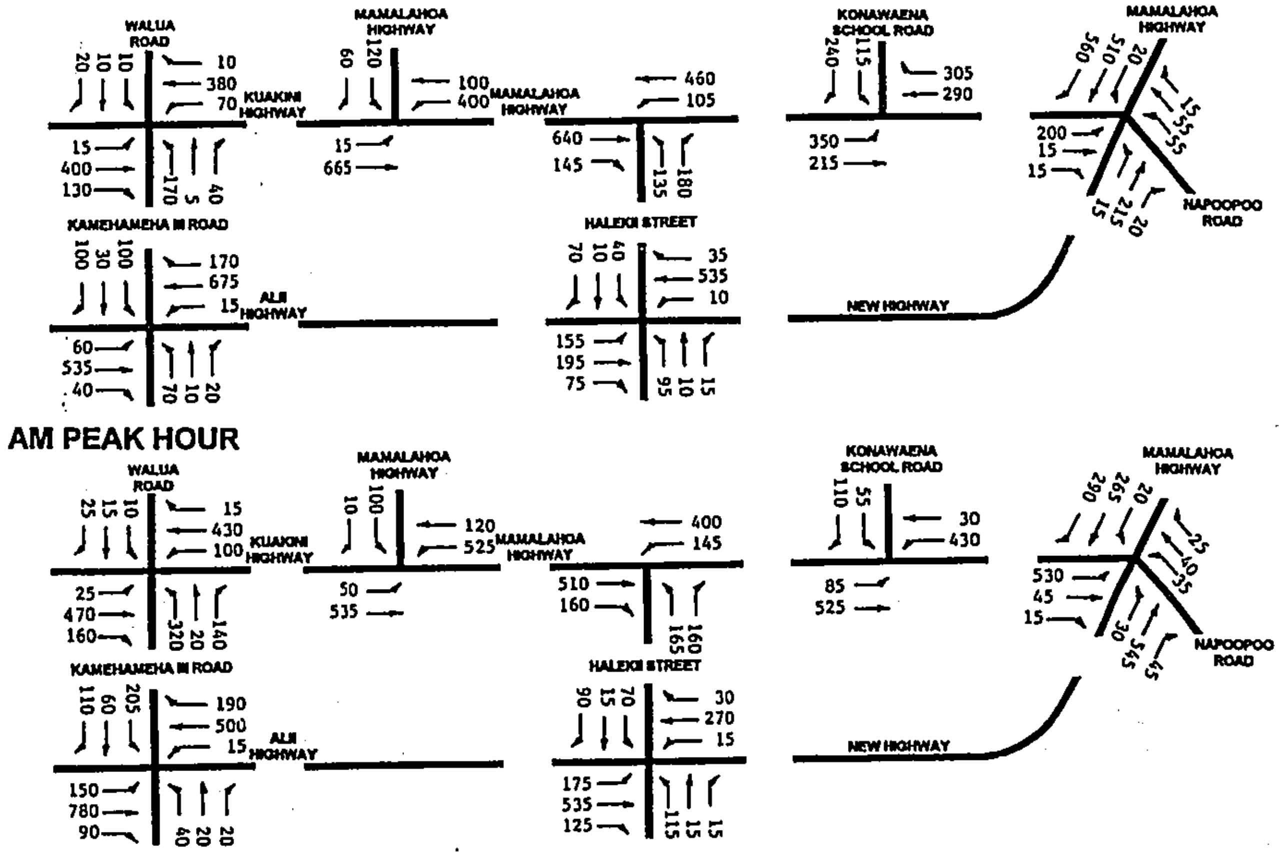


FIGURE 4
YEAR 2010 AMBIENT TRAFFIC FORECAST
Source: A Traffic Analysis for an Envrironmental Impact Statement for the New Highway, North and South Kona, Hawaii (June 1997)

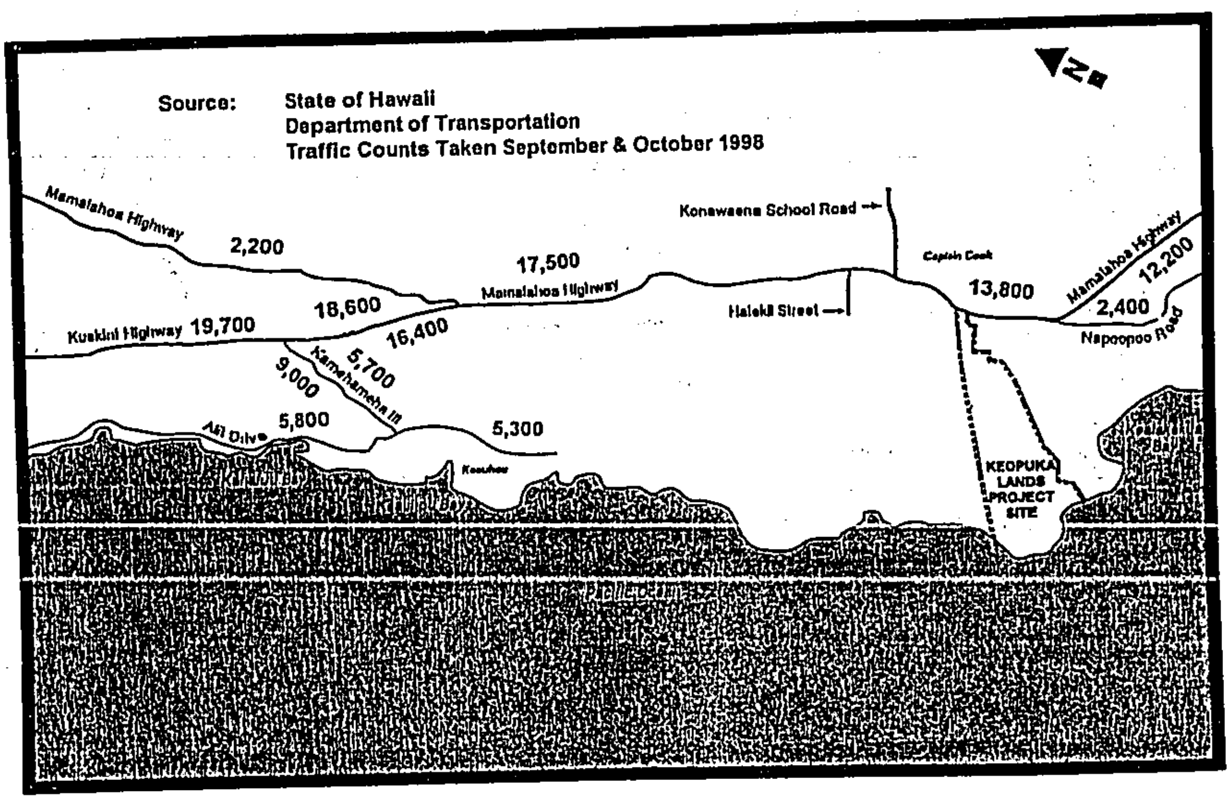


FIGURE 3

EXISTING TWO-WAY DAILY TRAFFIC VOLUMES

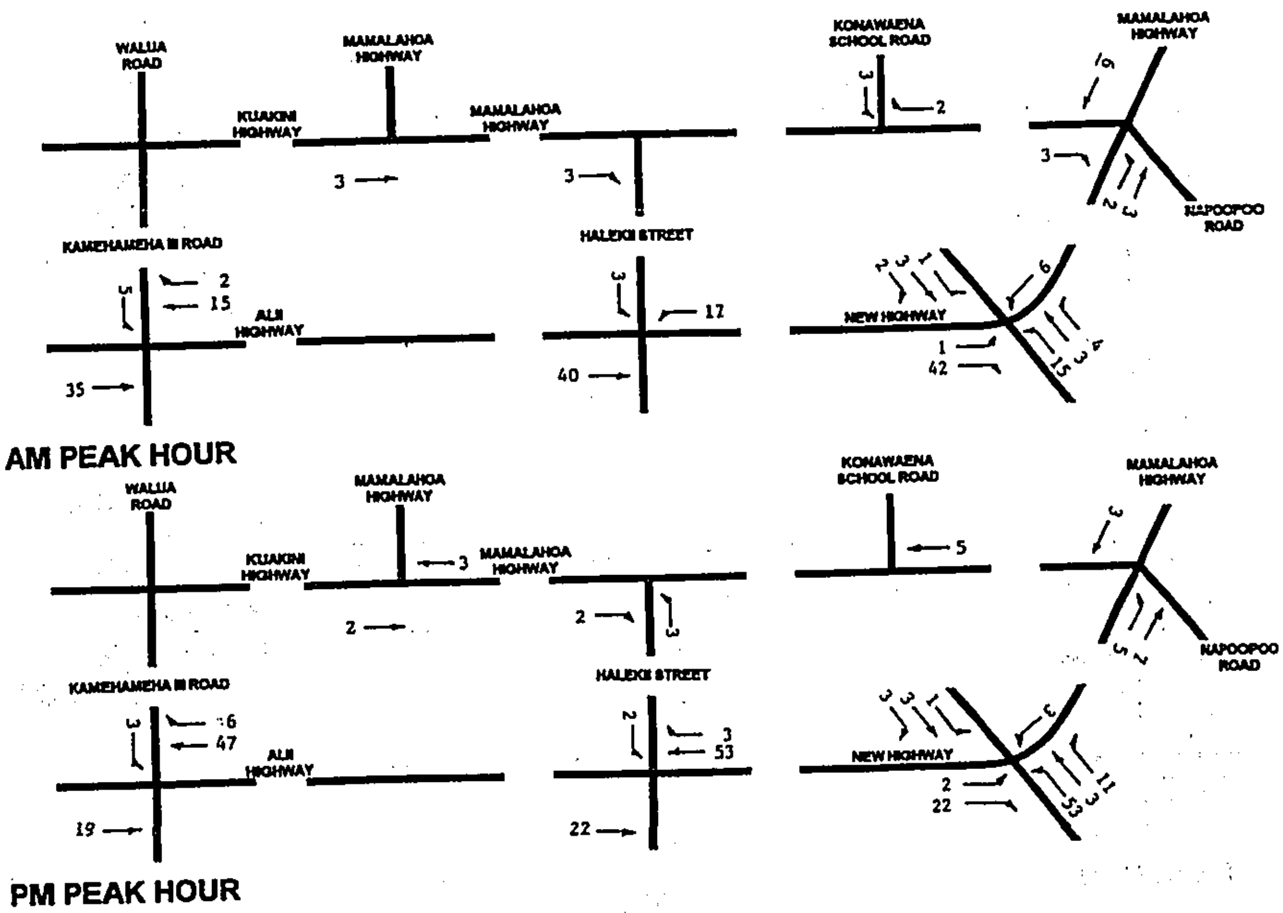


FIGURE 6
YEAR 2010 TRIP ASSIGNMENT FOR KEOPUKA PROJECT

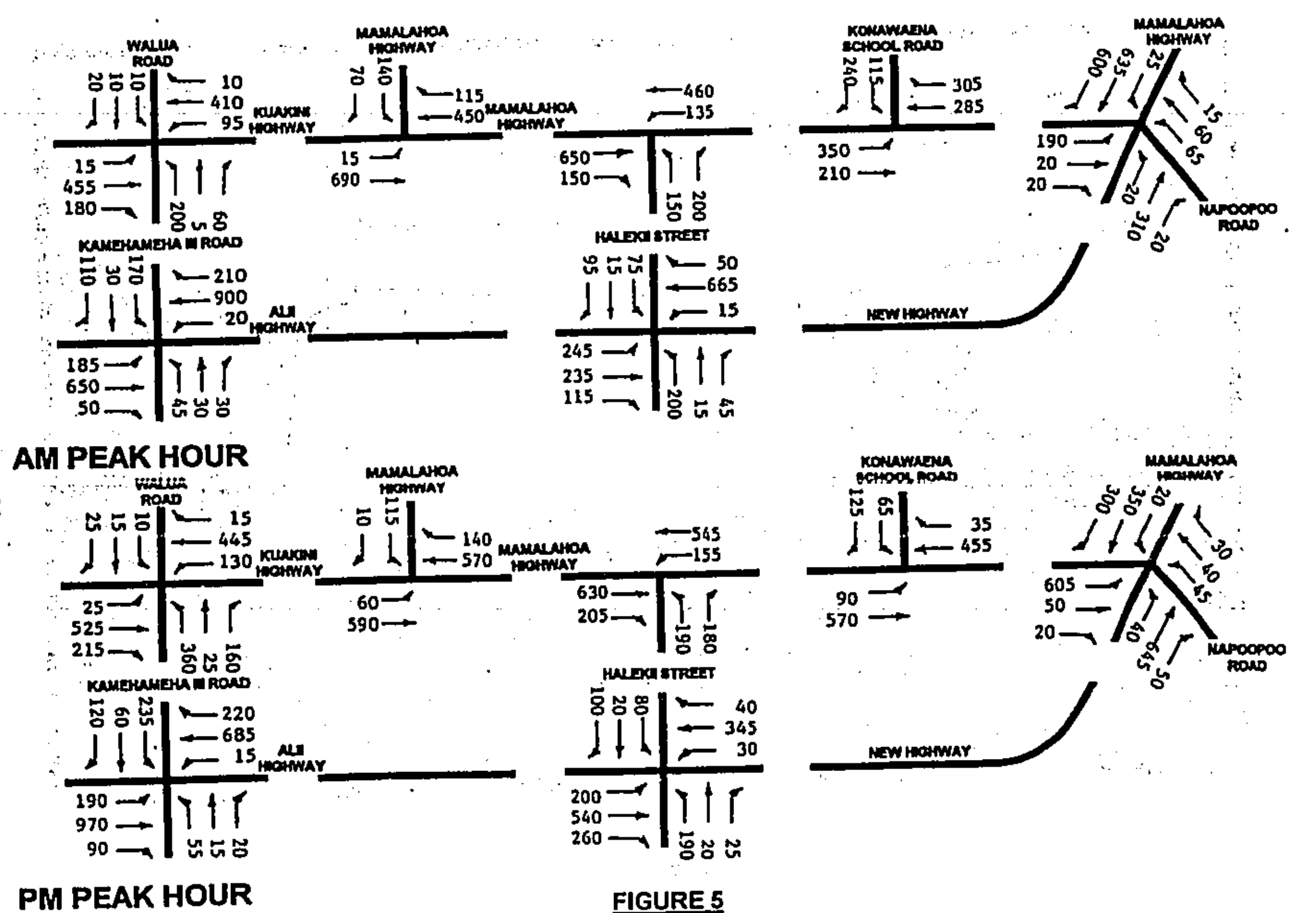


FIGURE 5
YEAR 2015 AMBIENT TRAFFIC FORECAST
Source: A Traffic Analysis for an Environmental Impact Statement for the New Highway, North and South Kona, Hawaii (June 1997)

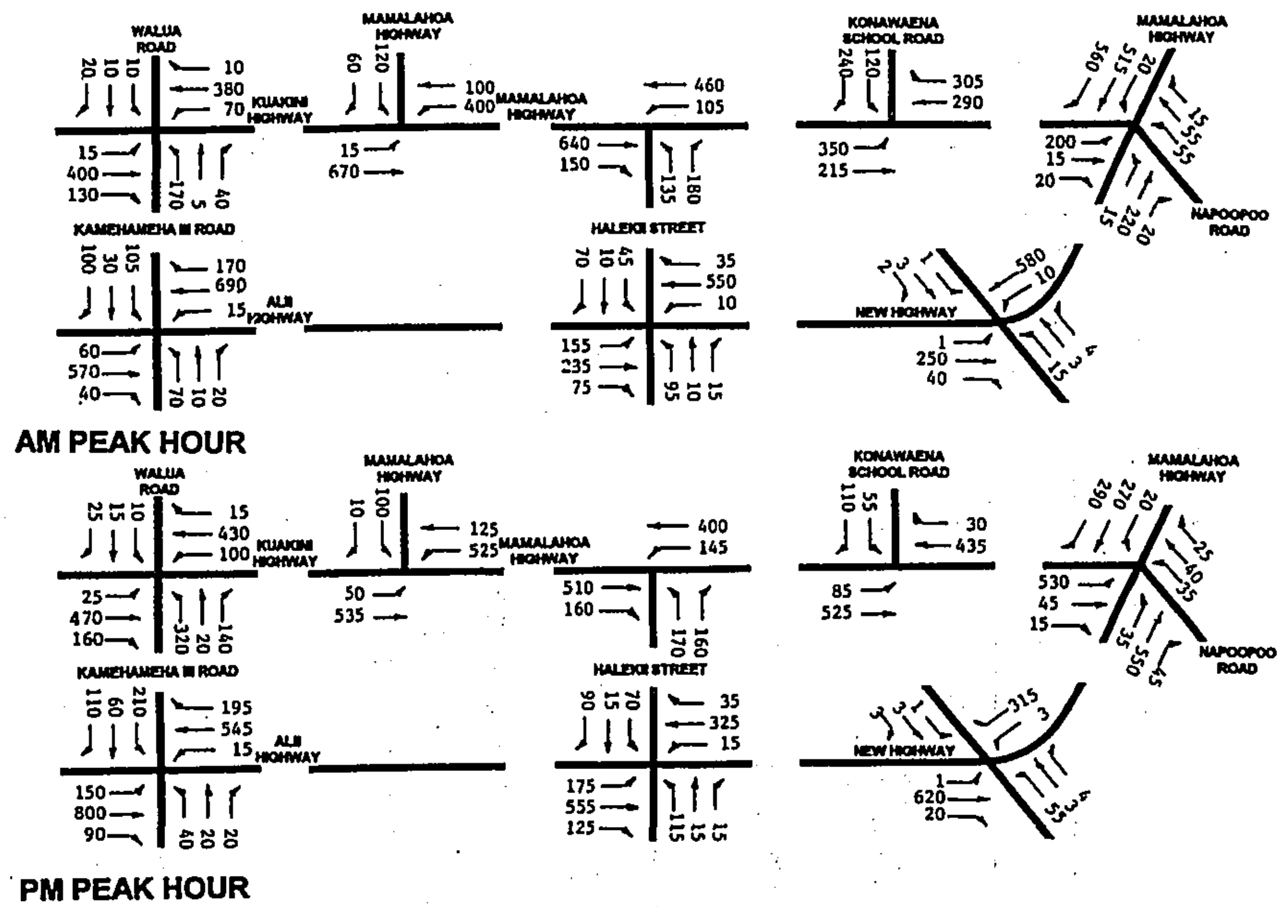


FIGURE 8
YEAR 2010 TOTAL FORECAST

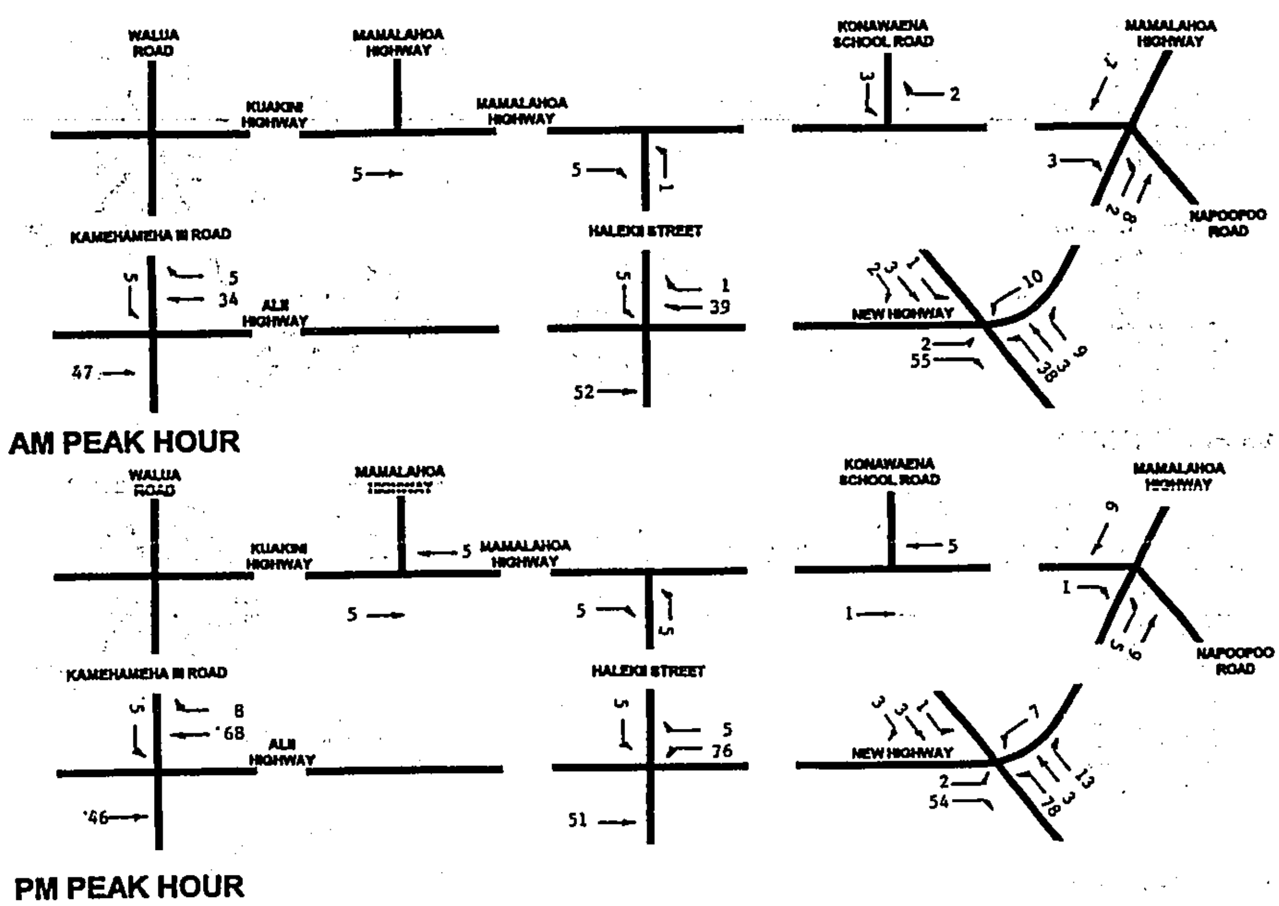


FIGURE 7
YEAR 2015 TRIP ASSIGNMENT FOR KEOPUKA PROJECT

TABLE 1

COMPARISON OF EXISTING LEVELS OF SERVICE

DESCRIPTION	LEVELS OF SERVICE 1997* AM	1997* PM	2000 AM	2000 PM
UNSIGNALIZED INTERSECTIONS				
Mamalahoa Highway/Kuakini Highway				
Mamalahoa Highway Westbound Right	B	B	C	B
Mamalahoa Highway Westbound Left	F	F	F	F
Kuakini Highway Southbound Left	B	A	B	B
Mamalahoa Highway/Halekii Street				
Halekii Street Eastbound Left	F	F		
Halekii Street Eastbound Right	B	B		
Mamalahoa Highway Northbound Left	B	B		
Mamalahoa Highway/Napoopoo Road				
Napoopoo Eastbound Left	F	F	F	F
Napoopoo Eastbound Right	A	B	A	B
Mamalahoa Highway Northbound Left	A	B	A	A
SIGNALIZED INTERSECTIONS				
Kuakini Highway/Kamehameha III Road	C	D	C	C
Mamalahoa Highway/Halekii Street			B	B
Mamalahoa Highway/Konawaena School Road	B	B	C	B
Alii Drive/Kamehameha III Road	B	B	B	B

*Source: M&E Pacific, Inc., "A Traffic Analysis For An Environmental Impact Statement For The New Highway, North and South Kona, Hawaii"

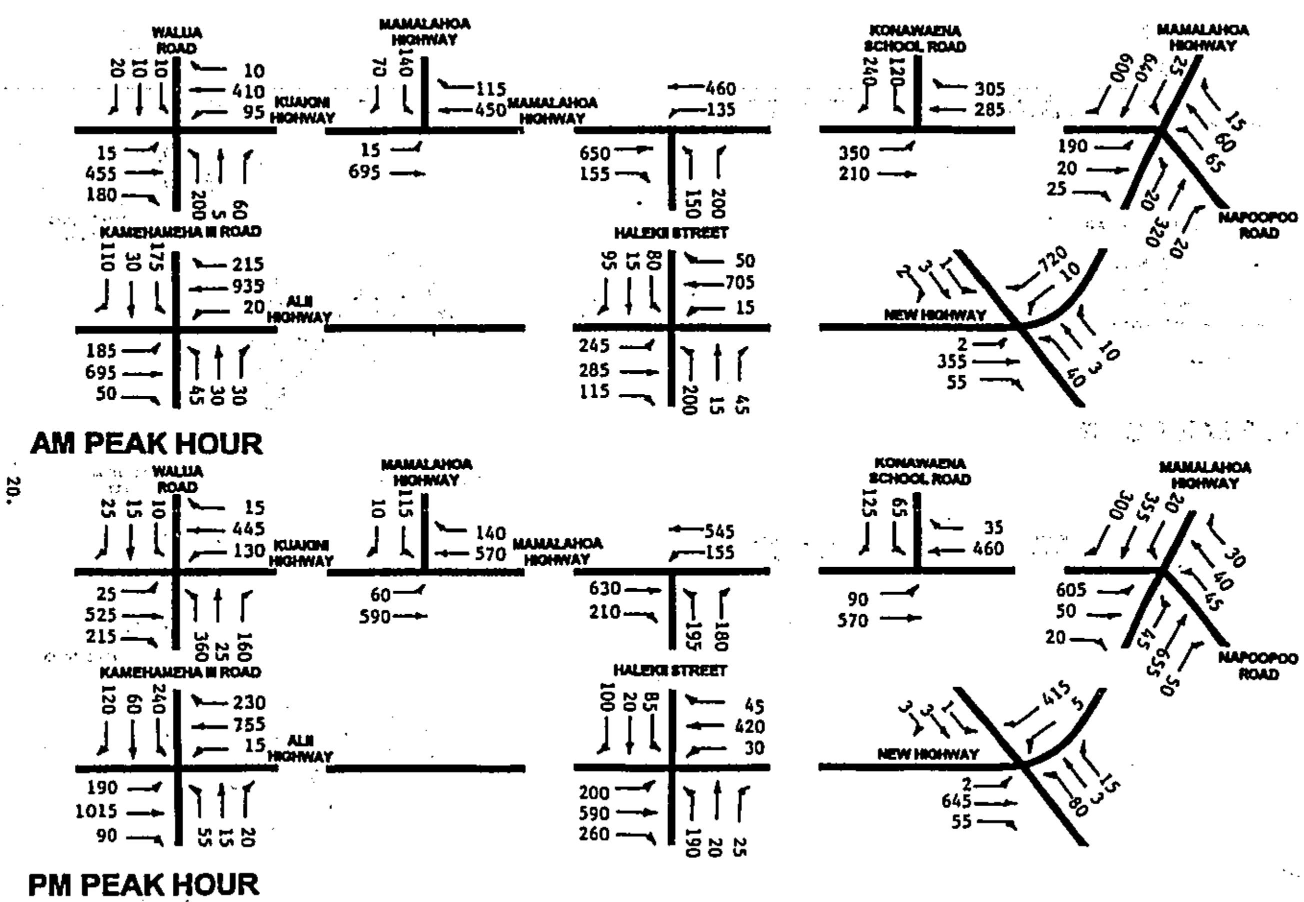


FIGURE 9
YEAR 2015 TOTAL FORECAST

TABLE 2

TRIP GENERATION FOR KEOPUKA

LAND USE	PEAK HOUR	QUANTITY	INBOUND RATE	INBOUND TRIPS	OUTBOUND RATE	OUTBOUND TRIPS
2010						
Agricultural Lots	AM PM	65 Units	0.15 0.54	10 35	0.42 0.29	27 19
Golf Course	AM PM	1 Course		52 8		8 59
Lodge	AM PM	50 Rooms	0.20 0.18	10 9	0.13 0.30	7 15
Total	AM PM			72 52		42 93
2015						
Agricultural Lots	AM PM	125 Units	0.15 0.54	19 67	0.42 0.29	53 36
Golf Course	AM PM	1 Course		52 8		8 59
Lodge	AM PM	100 Rooms	0.20 0.18	20 18	0.13 0.30	13 30
Total	AM PM			91 93		74 125

Source of Trip Generation Rates: Parsons, Brinckerhoff, Quade & Douglas, Inc., "Traffic Impact Sudy Villages of Hokukano, North and South Kona, Hawaii (November 1995)

TABLE 3

TRIP DISTRIBUTION FOR KEOPUKA

YEAR AND PEAK HOUR	DIRECTION OF TRAVEL						
	NORTH TO ALII DRIVE	NORTH TO KAMEHAMEHA III ROAD	NORTH TO MAMALAHOA HIGHWAY	SOUTH TO KEALAKEKUA	SOUTH OF NAPOOPOO ROAD	INTERNAL	TOTAL TRIPS
2010							
AM Inbound	35	5	3	3	6	20	72
AM Outbound	15	2	0	2	3	20	42
PM Inbound	19	3	2	0	3	25	52
PM Outbound	47	6	3	5	7	25	93
2015							
AM Inbound	47	5	5	3	7	24	91
AM Outbound	34	5	1	2	6	24	74
PM Inbound	46	5	5	1	6	30	93
PM Outbound	68	8	5	5	9	30	125

APPENDIX A

TRAFFIC TURNING MOVEMENT COUNTS

AM COUNT: 6:30 a.m. – 8:30 a.m.

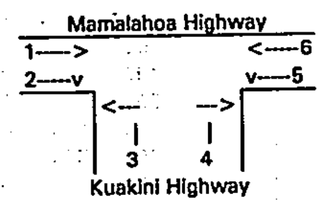
PM COUNT: 3:30 p.m. – 5:30 p.m.

TABLE 4

LEVEL OF SERVICE ANALYSIS

Description	2000		2010				2015			
	EXISTING		AMBIENT		TOTAL		AMBIENT		TOTAL	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
UNSIGNALIZED INTERSECTIONS										
Mamalahoa Highway/Kuakini Highway										
Mamalahoa Highway Westbound Right	C	B	A	B	A	B	B	B	B	B
Mamalahoa Highway Westbound Left	F	F	F	E	F	E	F	F	F	F
Kuakini Highway Southbound Left	B	B	A	A	A	A	A	A	A	A
New Highway/Keopuka Access Road										
Keopuka Eastbound Left & Through					C	C			D	D
Keopuka Eastbound Right					A	B			A	B
Keopuka Westbound Left, Through & Right					B	B			C	B
New Highway, Northbound Left					A	A			A	A
New Highway, Southbuond Left					A	A			A	A
SIGNALIZED INTERSECTIONS										
Kuakini Highway/Kamehameha III Road	C	C	B	C	B	C	B	D	B	D
Mamalahoa Highway/Halekii Street	B	B	B	B	B	B	B	B	B	B
Mamalahoa Highway/Konawaena School Road	C	B	B	B	B	B	B	B	B	B
Mamalahoa Highway/Napoopoo Road	NA	NA	B	D	B	D	C	D	C	D
Alii Highway/Kamehameha III Road	B	B	C	D	C	D	E	E	E	F
New Highway/Halekii Street	NA	NA	B	B	B	B	B	B	B	B
New Highway/Keopuka Access Road	NA	NA	NA	NA	A	A	NA	NA	A	A
NA = Not Applicable										

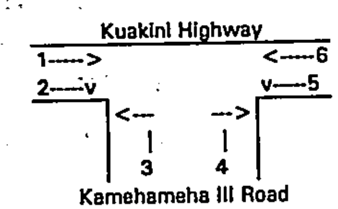
TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands



LOCATION: Mamalahoa Highway/Kuakini Highway
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER:
RECORDER:

TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45	8	10	4	99	189	8	318
6:45-7:00	10	13	4	76	159	9	271
7:00-7:15	15	11	2	95	203	8	334
7:15-7:30	23	18	2	131	225	13	412
7:30-7:45	21	15	4	175	205	12	432
7:45-8:00	20	9	3	186	187	18	423
8:00-8:15	23	11	4	171	156	24	389
8:15-8:30	17	13	1	133	181	22	367
6:30- 8:30	137	100	24	1066	1505	114	2946
7:15- 8:15	87	53	13	663	773	67	1656
3:30- 3:45	22	3	1	173	183	13	395
3:45- 4:00	16	3	10	184	147	23	383
4:00- 4:15	10	8	3	202	183	14	420
4:15- 4:30	16	5	6	205	206	15	453
4:30- 4:45	20	2	6	211	182	17	438
4:45- 5:00	13	10	5	196	155	15	394
5:00- 5:15	18	6	10	192	186	30	442
5:15- 5:30	14	5	5	201	159	22	406
3:30- 5:30	129	42	46	1564	1401	149	3331
4:15- 5:15	67	23	27	804	729	77	1727

TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands

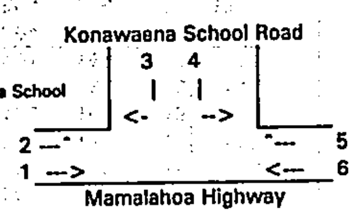


LOCATION: Kuakini Highway/Kamehameha III Road
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER: Clear
RECORDER: D. F. Lynch

TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45	73	29	16	10	16	160	304
6:45-7:00	65	40	16	15	34	157	327
7:00-7:15	76	26	33	15	30	164	344
7:15-7:30	51	39	67	14	36	166	373
7:30-7:45	61	30	38	16	31	158	334
7:45-8:00	111	39	32	22	40	164	408
8:00-8:15	128	28	39	22	46	163	426
8:15-8:30	101	34	33	36	17	147	368
6:30- 8:30	666	265	274	150	250	1279	2884
7:15- 8:15	351	136	176	74	153	651	1541
3:30- 3:45	139	30	70	42	36	144	461
3:45- 4:00	150	31	72	39	40	111	443
4:00- 4:15	138	29	71	45	32	120	435
4:15- 4:30	156	29	47	47	41	123	443
4:30- 4:45	146	30	51	39	41	120	427
4:45- 5:00	137	46	52	40	37	119	431
5:00- 5:15	171	25	75	49	45	137	502
5:15- 5:30	138	30	34	44	51	98	395
3:30- 5:30	1175	250	472	345	323	972	3537
4:15- 5:15	610	130	225	175	164	499	1803

TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands

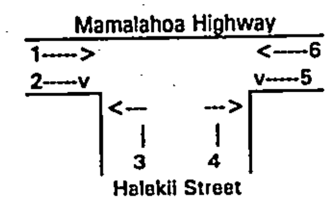
LOCATION: Mamalahoa Highway/Konawaena School
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER: Sunny, Light Clouds
RECORDER: Thomas Lemanski



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45	50	8	10	2	12	213	295
6:45-7:00	61	14	9	6	19	150	259
7:00-7:15	60	29	21	9	37	164	320
7:15-7:30	68	78	39	24	67	183	459
7:30-7:45	78	96	59	27	81	144	485
7:45-8:00	74	75	71	35	99	187	541
8:00-8:15	85	101	72	30	56	133	477
8:15-8:30	64	72	31	14	32	124	337
6:30- 8:30	540	473	312	147	403	1298	3173
7:15- 8:15	305	350	241	116	303	647	1962
3:30- 3:45	145	13	26	19	9	139	351
3:45- 4:00	167	19	18	17	9	120	350
4:00- 4:15	177	27	29	17	9	176	435
4:15- 4:30	169	9	19	9	10	116	332
4:30- 4:45	200	26	23	18	10	115	392
4:45- 5:00	165	25	31	13	9	119	362
5:00- 5:15	197	20	13	18	4	135	387
5:15- 5:30	184	16	26	13	11	111	361
3:30- 5:30	1404	155	185	124	71	1031	2970
4:00- 5:00	711	87	102	57	38	526	1521

TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands

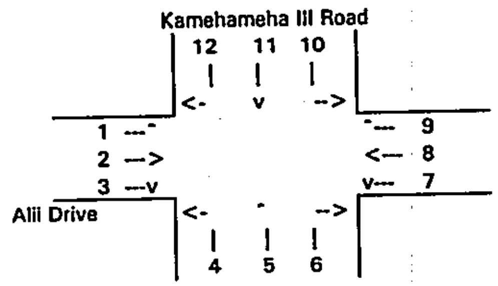
LOCATION: Mamalahoa Highway/Halekii Street
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER:
RECORDER:



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45	68	13	14	10	38	247	390
6:45-7:00	72	18	29	14	16	159	308
7:00-7:15	80	17	25	18	10	175	325
7:15-7:30	100	6	25	21	10	235	397
7:30-7:45	150	17	34	28	19	274	522
7:45-8:00	144	29	13	19	24	225	454
8:00-8:15	140	25	24	9	31	190	419
8:15-8:30	132	23	41	19	28	206	449
6:30- 8:30	886	148	205	138	176	1711	3264
7:30- 8:30	566	94	112	75	102	895	1844
3:30- 3:45	120	46	32	22	14	137	371
3:45- 4:00	146	35	39	16	18	140	394
4:00- 4:15	170	40	24	13	19	150	416
4:15- 4:30	180	30	34	25	20	130	419
4:30- 4:45	150	34	34	18	18	150	404
4:45- 5:00	165	38	43	17	17	120	400
5:00- 5:15	160	33	43	30	17	128	411
5:15- 5:30	140	33	32	30	18	16	269
3:30- 5:30	1231	289	281	171	141	971	3084
4:00- 5:00	665	142	135	73	74	550	1639

TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands

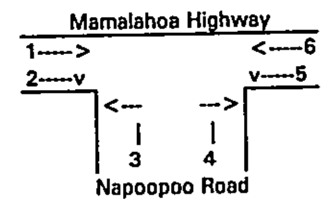
LOCATION: Alii Drive/Kamehameha III Road
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER:
RECORDER:



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
6:30-6:45	9	6	0	3	2	0	0	4	5	11	2	11	53
6:45-7:00	15	7	3	7	10	1	0	4	7	17	5	30	106
7:00-7:15	16	22	4	8	16	0	2	12	10	18	6	21	135
7:15-7:30	23	45	5	4	13	3	0	16	7	24	0	30	170
7:30-7:45	24	15	6	8	8	2	0	9	21	22	5	28	148
7:45-8:00	24	22	7	8	9	2	0	12	15	31	11	34	175
8:00-8:15	34	19	6	15	11	3	0	14	13	32	9	29	185
8:15-8:30	28	23	12	10	7	2	1	17	12	15	3	24	154
6:30-8:30	173	159	43	63	76	13	3	88	90	170	41	207	1126
6:30-7:30	63	80	12	22	41	4	2	36	29	70	13	92	464
7:15-8:15	105	101	24	35	41	10	0	51	56	109	25	121	678
3:30- 3:45	33	16	11	7	7	3	0	22	22	16	7	30	174
3:45- 4:00	16	17	16	7	8	2	4	27	19	16	10	29	171
4:00- 4:15	24	25	22	8	6	1	2	26	27	17	6	31	195
4:15- 4:30	26	16	16	6	6	1	0	8	18	18	12	18	145
4:30- 4:45	33	23	13	11	22	1	2	31	23	15	16	36	226
4:45- 5:00	21	18	7	11	6	3	1	19	14	16	14	20	150
5:00- 5:15	28	23	22	7	8	3	3	26	24	14	12	41	211
5:15- 5:30	28	23	21	10	11	3	2	26	25	11	19	37	216
3:30- 5:30	209	161	128	67	74	17	14	185	172	123	96	242	1488
3:30- 4:30	99	74	65	28	27	7	6	83	86	67	35	108	685
4:30- 5:30	110	87	63	39	47	10	8	102	86	56	61	134	803

TRAFFIC TURNING MOVEMENT COUNT
Keopuka Lands

LOCATION: Mamalahoa Highway/Napoopoo Road
DATE: March 23, 2000, Thursday
TIME: 6:30a-8:30a/3:30p-5:30p
WEATHER: Fair
RECORDER:



TIME PERIOD	MOVEMENT NUMBER 1	2	3	4	5	6	TOTAL
6:30-6:45	37	8	8	27	4	200	284
6:45-7:00	30	9	15	1	2	125	182
7:00-7:15	36	7	26	1	4	134	208
7:15-7:30	63	4	21	1	5	205	299
7:30-7:45	77	13	33	8	3	196	330
7:45-8:00	53	9	22	4	2	201	291
8:00-8:15	88	21	27	7	4	157	304
8:15-8:30	46	11	19	2	3	108	189
6:30- 8:30	430	82	171	51	27	1326	2087
7:15- 8:15	281	47	103	20	14	759	1224
3:30- 3:45	151	37	33	10	5	114	350
3:45- 4:00	179	18	23	4	9	112	345
4:00- 4:15	87	21	25	7	7	88	235
4:15- 4:30	130	33	16	3	5	89	276
4:30- 4:45	148	22	25	8	5	77	285
4:45- 5:00	159	30	23	4	8	110	334
5:00- 5:15	153	25	24	4	4	83	293
5:15- 5:30	132	17	15	4	4	94	266
3:30- 5:30	1139	203	184	44	47	767	2384
3:30- 4:40	547	109	97	24	26	403	1206

ABSTRACT OF METHODOLOGY

for the

CAPACITY ANALYSIS FOR SIGNALIZED INTERSECTIONS

ABSTRACT OF METHODOLOGY
for the
LEVEL OF SERVICE ANALYSIS OF SIGNALIZED INTERSECTIONS

A very complex methodology is used to determine the capacity and level of service of signalized signals. The procedure is divided into the five modules shown on Figure 9-3. The input data required for the analysis is shown on Figure 9-4. The level of service criteria is shown below:

LEVEL OF SERVICE (LOS)
CRITERIA FOR SIGNALIZED INTERSECTIONS

Level of Service	Stopped Delay Per Vehicle (Seconds)
A	≤ 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	≥ 60.0

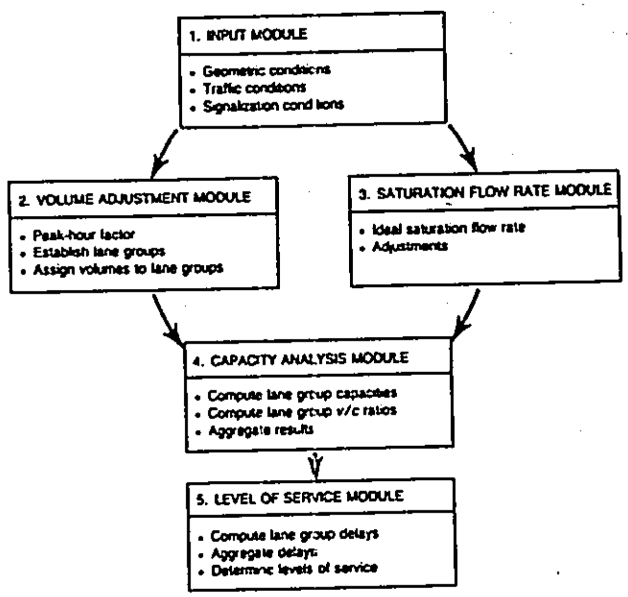


Figure 9-3. Operational analysis procedure.

2.

TYPE OF CONDITION	PARAMETER	SYMBOL
Geometric conditions	Area Type	CBD, Other
	Number of Lanes	N
	Average Lane Widths, ft.	W
	Grades, %	%G
	Existence of Exclusive LT or RT Lanes	None
	Length of Storage Bay, LT or RT Lane	L_s
	Parking Conditions	Yes, No
Traffic conditions	Volumes by Movement, vph	V
	Ideal Saturation Flow Rate by Mov't, pcphgpl	s_o
	Peak Hour Factor	PHF
	Percent Heavy Vehicles	%HV
	Conflicting Pedestrian Flow Rate, peds/hr	PEDS
	Local Buses Stopping in Intersection	N_B
	Parking Activity, pkg maneuvers/hr	N_m
	Arrival Type (1-6)	AT
	Proportion of Vehicles Arriving on Green	P
Signalization conditions	Cycle Length, sec	C
	Green Time, sec	G
	Yellow change interval	Y
	All-red clearance interval	AR
	Actuated or Pretimed Operation	A or P
	Pedestrian Push-Button?	Yes, No
	Minimum Pedestrian Green	G_p
	Phase Plan	None

Figure 9-4. Input data needs for each analysis lane group.

3.

APPENDIX B

ABSTRACT OF METHODOLOGY

for the

CAPACITY ANALYSIS FOR SIGNALIZED AND UNSIGNALIZED INTERSECTIONS

ABSTRACT OF METHODOLOGY

for the

CAPACITY ANALYSIS FOR UNSIGNALIZED INTERSECTIONS

ABSTRACT OF METHODOLOGY
for the
LEVEL OF SERVICE ANALYSIS OF UNSIGNALIZED INTERSECTIONS

This abstract summarizes the procedures for analyzing the capacities of unsignalized intersections. These procedures are described in the Highway Capacity Manual, Special Report 209 (Third Edition, 1994) by the Transportation Research Board (TRB). This manual "is a collection of techniques for estimating highway capacity that have been judged, through consensus, as the best available at the time of publication." This manual does not set legal standards for highway design but the procedures have become widely accepted and used in the traffic engineering profession.

The capacity analysis procedure is based on a German method originally published in 1972 and translated in 1974, and modified for U. S. conditions by the TRB in 1985, and new data reflected in 1994. It is intended for two-way STOP- and YIELD-controlled intersection and calculates the capacities of movements which cross or turn through the major traffic stream. The capacity of each movement is based on two factors: the gap distribution in conflicting traffic streams and the gap acceptance behavior of drivers at such intersections.

The basic steps in methodology are as follows:

1) Define intersection geometry and traffic volumes.

2) Determine the "conflicting conflicts" through which every minor street movement and major street left turn must cross.

3) Determine the size of the gap in the conflicting stream needed by vehicles in each movement crossing a conflicting traffic stream.

4) Determine the capacity of the gaps in the major traffic stream to accommodate each of the subject movements that will utilize these gaps.

5) Adjust the capacities to account for impedance and the use of shared lanes.

6) Estimate average delay and determine level of service for each movement.

Tables and charts, as well as computer programs, have been developed to facilitate using this methodology.

INTERSECTION DATA

Key geometric factors include: number and use of lanes, channelization, percent grade, curb radii and approach angle, and sight distances. One hour volumes are specified by movement and converted to passenger cars per hour using the passenger car equivalents in TABLE 10-1.

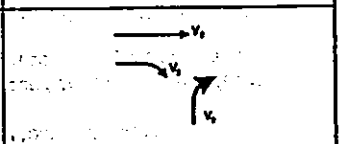
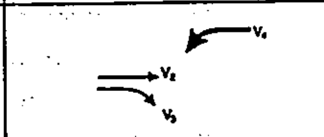
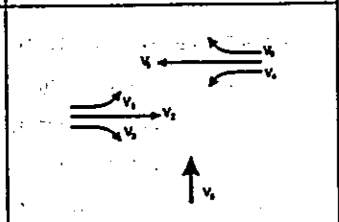
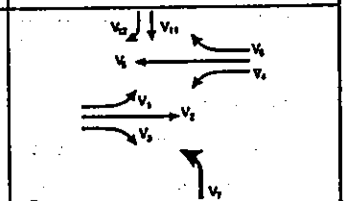
TABLE 10-1. PASSENGER-CAR EQUIVALENTS FOR TWSC INTERSECTIONS

	GRADE (%)				
TYPE OF VEHICLE	-4	-2	0	+2	+4
Motorcycles	0.3	0.4	0.5	0.6	0.7
Passenger Cars	0.8	0.9	1.0	1.2	1.4
SU/RVs[a]	1.0	1.2	1.5	2.0	3.0
Combination Vehicles[b]	1.2	1.5	2.0	3.0	6.0
All Vehicles[c]	0.9	1.0	1.1	1.4	1.7

[a] Single-unit trucks and recreational vehicles.
[b] Includes tractor-trailer combinations and buses.
[c] If vehicle composition is unknown, these values may be used as an approximation.

CONFLICTING TRAFFIC

The conflicting movements and turning movement faces is summarized on Figures 10-3(a) and 10-3(b). The right turn movement from the minor street faces the least number of conflicting movements, the left turn movement from the minor street the most.

Subject Movement	Conflicting Traffic, $V_{c,x}$	Illustration
1. RIGHT TURN from minor street ($V_{c,9}$)	$1/2(V_3)^{①} + V_2^{②}$	
2. LEFT TURN from major street ($V_{c,4}$)	$V_2 + V_3^{③}$	
3. THROUGH MOVEMENT from minor street ($V_{c,8}$)	$1/2(V_3)^{①} + V_2 + V_1 + V_6^{⑤} + V_5 + V_4$	
4. LEFT TURN from minor street ($V_{c,7}$)	$1/2(V_3)^{①} + V_2 + V_1 + 1/2(V_6)^{⑤} + V_5 + V_4 + 1/2(V_{11} + V_{12}^{④})$	

① Where a right-turn lane is provided on major street, and/or where V_3 is STOP-/YIELD-controlled, eliminate V_3

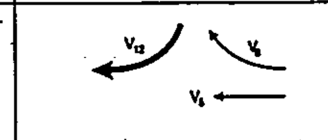
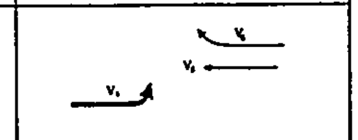
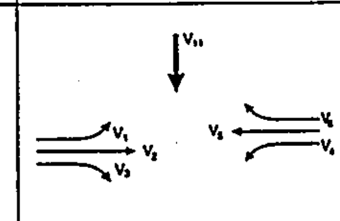
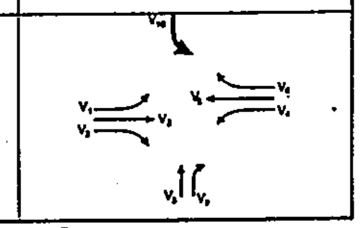
② V_2 includes only the volume in the right hand lane.

③ Where the right-turn is STOP- or YIELD-controlled, eliminate V_3, V_6

④ V_{12} should be eliminated on multi-lane major streets.

⑤ Where a right-turn lane is provided on major street, and/or where V_6 is STOP-/YIELD-controlled, and/or on multi-lane major streets, eliminate V_6

Figure 10-3(a). Definition and computation of conflicting traffic volumes for two minor approaches.

Subject Movement	Conflicting Traffic, $V_{c,x}$	Illustration
5. RIGHT TURN from minor street ($V_{c,12}$)	$1/2(V_6)^{❶} + V_5^{❷}$	
6. LEFT TURN from major street ($V_{c,1}$)	$V_5 + V_6^{❸}$	
7. THROUGH MOVEMENT from minor street ($V_{c,11}$)	$1/2(V_6)^{❶} + V_5 + V_4 + V_3^{❺} + V_2 + V_1$	
8. LEFT TURN from minor street ($V_{c,10}$)	$1/2(V_6)^{❶} + V_5 + V_4 + 1/2(V_3)^{❺} + V_2 + V_1 + 1/2(V_8 + V_9^{❹})$	

❶ Where a right-turn lane is provided on major street, and/or where V_6 is STOP-/YIELD-controlled, eliminate V_6

❷ V_5 includes only the volume in the right hand lane.

❸ Where the right-turn is STOP- or YIELD-controlled, eliminate V_6, V_3

❹ V_9 should be eliminated on multi-lane major streets.

❺ Where a right-turn lane is provided on major street, and/or where V_3 is STOP-/YIELD-controlled, and/or multi-lane streets, eliminate V_3

Figure 10-3(b). Definition and computation of conflicting traffic volumes for two minor approaches.

CRITICAL GAP SIZE

"The 'critical gap' is defined as the median time headway between two successive vehicles in the major traffic stream that is accepted by drivers in a subject movement that must cross and/or emerge with the major street traffic." It is dependent upon a number of factors, including:

1) The type of maneuver being executed.
2) STOP or YIELD sign control.
3) The average running speed on the major street.
4) The number of lanes on the major street.
5) The geometrics and environmental conditions at the intersection.

The value of the critical gap is selected from TABLE 10-2. The basic critical gap is selected and adjustments and modifications made.

TABLE 10-2. CRITICAL GAPS t_c AND FOLLOW-UP TIMES t_f FOR TWSC INTERSECTIONS

VEHICLE MANEUVER	CRITICAL GAP t_c TWO-LANE MAJOR ROAD	CRITICAL GAP t_c FOUR-LANE MAJOR ROAD	FOLLOW-UP TIME t_f (SEC)
Left turn, major street	5.0	5.5	2.1
Right turn, minor street	5.5	5.5	2.6
Through traffic, minor street	6.0	6.5	3.3
Left turn, minor street	6.5	7.0	3.4

NOTE: The critical gap and follow-up time values presented in this table reflect data obtained on roadways where the average approach speed of the major street through vehicles approximated 30 mph. In cases where no better data are available, these same values may be used to approximate t_c and t_f for roadways with approach speeds other than 30 mph.

POTENTIAL CAPACITY FOR MOVEMENT

"The potential capacity is defined as the 'ideal' capacity for a specific movement," and is selected from Figures 10-4 and 10-5. It is based on the conflicting traffic volume and movement type. The result is read in passenger cars per hour.

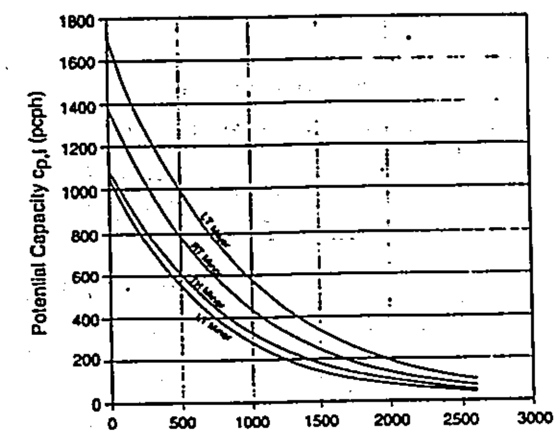


Figure 10-4. Potential capacity based on conflicting volume and movement type (two-lane roadways).

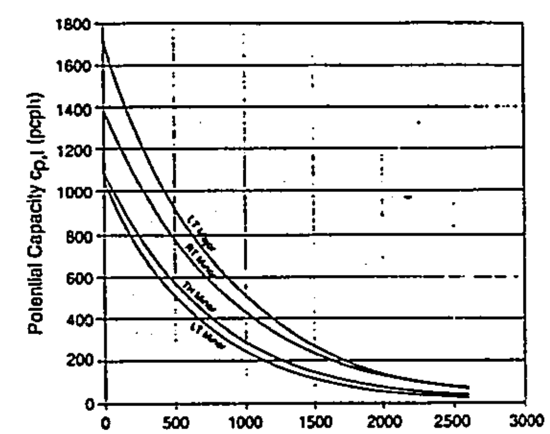


Figure 10-5. Potential capacity based on conflicting volume and movement type (four-lane roadways).

IMPEDANCE EFFECTS

The methodology assumes that vehicles use gaps at an unsignalized intersection in a prioritized manner. Thus, when traffic becomes congested in a high-priority movement, it can reduce the potential capacity of lower priority traffic movements. Given the priority of gap usage:

1) Left turn from the major street impede both through movements and left turns from the minor street.

2) Through movements from the minor streets impede left turns from the minor street.

The impact of impedance is addressed by multiplying the potential capacity of a movement by a series of impedance factors for each higher priority impeding movement. Impedance factors are derived using Figure 10-6.

SHARED LANE CAPACITY

The methodology has assumed to this point that each minor street movements has an exclusive lane. In reality, most minor street approaches have two or three movements sharing one lane. An equations used to compute the capacity of the shared lane.

LEVEL OF SERVICE CRITERIA

The above computations yield a capacity solution for each lane in the minor street approaches and for left turn movements from the major streets. The movement capacity and conflicting volumes for each movement are used to calculate the average total delay (seconds/vehicle) per Figure 10-7.

The level of service based on the average total delay is summarized on Table 10-3.

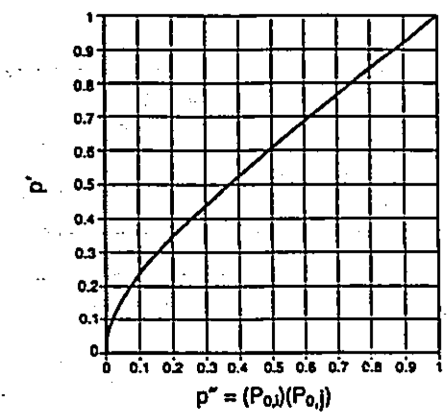


Figure 10-6. Adjustment to the major left, minor through impedance factor (2).

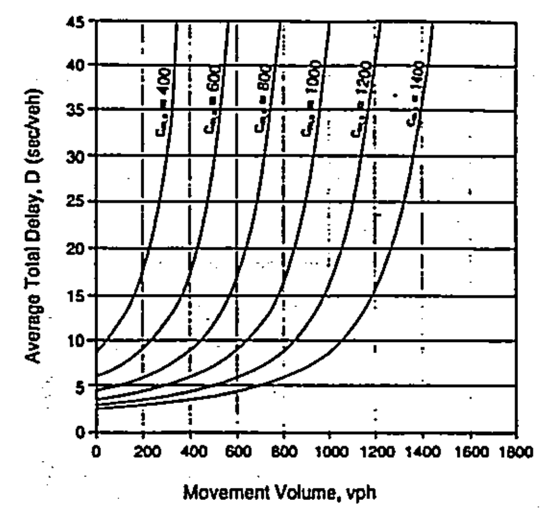


Figure 10-7. Average total delay based on conflicting volume and movement capacity (15-min analysis period).

TABLE 3 - LEVEL OF SERVICE CRITERIA

Level of Service	Average Total Delay (Seconds/Vehicle)
A	≤ 5
B	5.1 to 10.0
C	10.1 to 20.0
D	20.1 to 30.0
E	30.1 to 45.0
F	> 45

APPENDIX K

Noise Quality Report

Project No. 00-12

NOISE QUALITY IMPACT STUDY
KEOPUKA LANDS
SOUTH KONA, HAWAII

June 2000

Prepared for
PBR HAWAII
Hilo, Hawaii

CONTENTS

1.0 SUMMARY

1.1 The project area and vicinity are currently exposed to daytime ambient noise levels of 44 to 52 dBA, with the dominant noise sources being wind, birds, and an occasional small aircraft flyover. Along the mauka most edge of the Keopuka Lands, the ambient noise levels are greater than 52 dBA due to the proximity to Mamalahoa Highway.

1.2 The noise levels interior to the project site will increase from existing levels due to the construction of the Mamalahoa Highway Bypass.

1.3 Traffic noise levels, due to the project, are not expected to significantly increase along the existing roadways in the vicinity of the project.

1.4 The dominant noise sources during project construction will probably be earth moving equipment, such as bulldozers and diesel powered trucks. Noise from construction activities will occur on the subject property. The noise from construction activities could impact nearby residences to the east of the project site along Mamalahoa Highway and Kealakekua Bay State Park. Noise from construction activities should be short term and must comply with State Department of Health noise regulations.

1.5 Residential homes and other noise sensitive areas closer than 150 feet to the Mamalahoa Highway Bypass will experience noise levels that exceed Hawaii Department of Transportation (HDOT), Federal Housing and Urban Development (HUD), and Environmental Protection Agency (EPA) design goals and criteria.

2.0 PROJECT DESCRIPTION

The Keopuka Lands Development is to be comprised of approximately 660 acres located in Keopuka, South Kona, Hawaii (Figure 1). Approximately 125 acres of land mauka of the Mamalahoa Highway Bypass will be developed as large agricultural lots (five+ acres). The remaining parcels, makai of the Mamalahoa Highway Bypass, will include the development of a residential community and an 18 hole golf course.

3.0 NOISE STANDARDS

Various local and federal agencies have established guidelines and standards for assessing environmental noise impacts and set noise limits as a function of land use. A brief description of common acoustic terminology used in these guidelines and standards is presented in Appendix A.

3.1 U.S. Federal Highway Administration (FHWA)

The FHWA defines four land use categories and assigns corresponding maximum hourly equivalent sound levels, L_{eq}, for traffic noise exposure [Reference 1], which are listed in Table 1. For example, Category B, defined as picnic and recreation areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals, has a corresponding maximum exterior L_{eq} of 67dBA and a maximum interior L_{eq} of 52 dBA. These limits are viewed as design goals, and all projects meeting these limits are deemed in conformance with FHWA noise standards.

3.2 Hawaii Department of Transportation (HDOT)

The HDOT has adopted FHWA's design goals for traffic noise exposure in its noise analysis and abatement policy [Reference 2]. According to the policy, a traffic noise impact occurs when the predicted traffic noise levels "approach" or exceed FHWA's design goals or when the predicted traffic noise levels "substantially exceed the existing noise levels." The policy also states that "approach" means at least 1 dB less than FHWA's design goals and "substantially exceed the existing noise levels" means an increase of at least 15dB.

3.3 U.S. Department of Housing and Urban Development (HUD)

HUD's environmental noise criteria and standards in 24 CFR 51 [Reference 3] were established for determining housing project site acceptability. These standards are based on day-night equivalent sound levels, L_{dn}, and are not limited to traffic noise exposure. However, for project sites in the vicinity of highways, the L_{dn} may be estimated to be equal to the design hour $L_{eq(h)}$, provided "heavy trucks (vehicles with three or more axles) do not exceed 10 percent of the total traffic flow in vehicles per 24 hours and the traffic flow between 10:00 p.m. and 7:00 a.m. does not exceed 15 percent of the average daily traffic flow in vehicles per 24 hours." For these same conditions, L_{dn} may also be estimated as 3 dB less than the design hour L_{10}.

HUD site acceptability criteria rank sites as Acceptable, Normally Unacceptable, or Unacceptable. "Acceptable" sites are those where exterior noise levels do not exceed an L_{dn} of 65 dBA. Proposed housing projects on "Acceptable" sites do not require additional noise attenuation other than that provided by customary building techniques. "Normally Unacceptable" sites are those where the L_{dn} is above 65 dBA, but does not exceed 75 dBA. Housing on "Normally Unacceptable" sites requires some form of noise abatement, either at the property line or in the building construction, to ensure the interior noise levels are acceptable. "Unacceptable" sites are those where the L_{dn} is 75 dBA or higher. The term "Unacceptable" does not necessarily mean that housing cannot be built on those sites. It means that more sophisticated sound attenuation will likely be needed.

3.4 U.S. Environmental Protection Agency (EPA)

The U.S. EPA has identified a range of yearly day-night equivalent sound levels, L_{dn}, sufficient to protect public health and welfare from the effects of environmental noise [Reference 4]. The EPA has established a goal to reduce exterior environmental noise to an L_{dn} not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to an L_{dn} not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

3.5 State Department of Health (DOH)

The State DOH defines three classes of zoning districts and specifies corresponding maximum permissible sound levels due to stationary noise sources such as air-conditioning units, exhaust systems, generators, compressors, pumps, etc., and equipment related agricultural, construction, and industrial activities [Reference 5]. These levels are enforced for any location at or beyond the property line and shall not be exceeded for more than 10% of the time during any 20-minute period. The specified noise limits which apply are a function of the zoning and time of day as shown in Figure 2. With respect to mixed zoning districts, DOH specifies the primary land use designation shall be used to determine the applicable zoning district class and the maximum permissible sound level.

The State Department of Health defines a heavy vehicle as a vehicle which has a manufacturer's gross vehicular weight rating of ten thousand pounds or greater. Such vehicles shall not be operated on any trafficway in such a manner that it emits noise in excess of the limits specified in Reference 6. If these limits will be exceeded a permit from the DOH director is required.

3.6 City and County of Honolulu Land Use Ordinances (LUO)

The City and County of Honolulu LUO [Reference 7] noise regulations differ from the DOH noise regulations in that maximum permissible octave band sound pressure levels are specified instead of A-weighted sound pressure levels. Also, there is no specified period of time associated with the exceedence of these levels. The LUO noise regulations which are presented in Figure 3, are the LUO noise regulations are theoretically enforced by the Building Department, however, since they do not have noise measurement capabilities, noise complaints are usually handled by the DOH.

4.0 EXISTING ACOUSTICAL ENVIRONMENT

4.1 General

Ambient noise level measurements were conducted on April 13, 2000 to assess the existing acoustical environment at the project site and in the surrounding areas as illustrated in Figure 4. Noise level measurements were taken using a Larson-Davis Laboratories, Model 800B Sound Level Meter. The noise measurement results discussed below are expressed in terms of the equivalent sound level, L_{eq}, and in units of A-weighted decibels.

The measured ambient noise levels, expressed in terms of equivalent sound levels, L_{eq}, and in units of A-weighted decibels, ranged between 44 and 52 dBA which is typical for quiet suburban and rural areas. However, noise levels exceeding these ambient levels, 69 dBA, were measured along the mauka most portion of the project site. These higher levels were due to the proximity of Mamalahoa Highway, 15 feet from the right-of-way, and are not typical of the project site. Measurement Locations 1 and 2 were 15 minute L_{eq}'s while Location 3 was a 5 minute L_{eq}.

5.0 POTENTIAL NOISE IMPACT DUE TO THE PROJECT AND NOISE MITIGATION

5.1 Project Construction Noise

Development of project areas will involve excavation, grading, and construction of new buildings and infrastructure. The various construction phases of the project may generate significant amounts of noise, which may impact residences and other noise sensitive areas, i.e., the residences east of the project along Mamalahoa Highway and Kealakekua Bay State Park. The actual noise levels produced will be a function of the methods employed during each stage of the construction process. Typical ranges of construction equipment noise are shown in Figure 5. Earthmoving equipment, e.g., bulldozers and diesel-powered trucks, will probably be the loudest equipment used during construction, assuming that pile driving will not be required.

In cases where construction noise exceeds, or is expected to exceed the DOH's "maximum permissible" property line noise levels [Reference 5], a permit must be obtained from the DOH to allow the operation of vehicles, construction equipment, power tools, etc., which emit noise levels in excess of "maximum permissible" levels. Specific permit restrictions for construction activities are:

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels . . . before 7:00 a.m. and after 6:00 p.m. of the same day, Monday through Friday."

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels . . . before 9:00 a.m. and after 6:00 p.m. on Saturday."

> "No permit shall allow any construction activities which emit noise in excess of the maximum permissible sound levels on Sundays and on holidays."

In addition, construction equipment and on-site vehicles or devices whose operations involve the exhausting of gas or air, excluding pile hammers and pneumatic hand tools weighing less than 15 pounds, must be equipped with mufflers, and construction vehicles using trafficways must satisfy the DOH's vehicular noise requirements [Reference 6].

5.2 Project Generated Traffic Noise

Traffic noise levels corresponding to the morning and afternoon peak hour travel periods were calculated at five locations as shown in Figure 6. The traffic noise levels with the project constructed were estimated using the Federal Highway Administration Traffic Noise Prediction Model [Reference 8] in conjunction with existing and predicted future peak hour traffic volumes without the project [Reference 9]. The results are presented in Table 2.

From the results of Table 2, traffic noise level increases, with and without the project, were calculated and are presented in Table 3. As can be seen, the predicted maximum traffic noise level increase along the assessed roadways due to the project is 0.4 dB at Location 2. The minimal change in noise levels perceptible to the average listener is generally taken to be 3 dB, therefore, the increase in traffic noise due to the project will not be significant. Thus, no perceptible change will occur due to the project. The traffic noise levels presented in Tables 1 and 2 are those expected at a distance of 100 feet from the roadway centerlines at each location. Although distances closer than 100 feet will experience higher traffic noise levels, the relative difference between the future traffic noise levels with and without the project should be the same at any distance.

6.0 POTENTIAL NOISE IMPACT ON THE PROJECT AND NOISE MITIGATION

6.1 Traffic

Traffic noise levels at the proposed Keopuka housing closest to the Mamalahoa Highway Bypass (Location 5) is expected to be 66.2, at 100 feet from the centerline of the roadway, during the afternoon peak hour. This level is in excess of HDOT, HUD, and EPA goals and criteria as discussed in Sections 3.2, 3.3 and 3.4.

HUD has established Site Acceptability Standards for exterior noise exposure at housing areas. These standards are based on L_{dn} levels and identify the need for noise abatement. Traffic noise from adjacent roadways and the internal roadways within each parcel should be considered in determining the use for lands contiguous to these roadways. Effective noise mitigation measures might include:

- Constructing noise barrier walls and/or earthen berms along the Mamalahoa Highway Bypass;
- Air-conditioning the homes closest to the Mamalahoa Highway Bypass and using exterior wall constructions which exhibit high noise reductions;
- Acoustically soften interior spaces by the addition of thick carpeting with a padding underlayment, an acoustical tile ceiling, louvered closet doors, etc.; or,
- Locating homes greater than 150 feet from the ceterline of the Mamalahoa Highway Bypass.

In addition to the above measures, other steps can be taken to reduce the traffic noise such as:

- Reducing the speed limit on Mamalahoa Highway Bypass,
- Adding signalization, if not already planned, at the entrance to the Keopuka development, or
- Reducing the elevation of the Mamalahoa Highway Bypass roadway relative to adjacent lands.

Typical exterior-to-interior noise reductions for naturally ventilated homes, i.e., with open windows, are approximately 9 dB. Adding absorption to interior spaces, (acoustically softening), can further reduce the noise levels 1 to 5 dB, depending upon the absorption initially present, and the amount of absorption added to the space. Air-conditioned or mechanically ventilated homes exhibit higher exterior-to-interior noise reductions because windows can be closed. Noise reductions achieved by several types of building constructions are presented in Table 4 [Reference 10]. Estimating the noise reduction provided by a barrier, however, is more difficult to generalize. Factors such as distances to roadways and setbacks, intervening ground conditions, barrier construction, barrier height, roadway elevations, etc., will

determine the noise reduction afforded by a traffic noise barrier. The degree of difficulty in obtaining specific reductions in sound levels, as determined by the Federal Highways Administration [Reference 10], are presented in Table 5.

Reductions in traffic noise due to alterations of the traffic flow or roadway positions are also dependent on very specific conditions. For example, reducing the average speed of automobiles by 5 mph will reduce the traffic $L_{eq(h)}$ by nearly 2 dB for automobiles initially moving at 35 mph. However, a 5 mph reduction in the average speed for automobiles initially traveling at 55 mph will only produce a little more than 1 dB reduction in the traffic $L_{eq(h)}$.

Similarly, the effect of adding signalization to roadways on traffic noise will vary. The reduction of traffic noise will be greater for areas nearer to signalized intersections than for areas farther away, and as the traffic volume increases, this reduction will be noticed at greater distances from the intersections along these roadways.

REFERENCES:

1. *Department of Transportation, Federal highway Administration Procedures for Abatement of Highway traffic Noise*, Title 23, CFR, Chapter 1, Subchapter J, Part 772, 38 FR 15953, June 19, 1973; Revised at 47 FR 29654, July 8, 1982.

2. *Noise Analysis and Abatement Policy*, Department of Transportation, Highways Division, State of Hawaii, June 1977.

3. *Department of Housing and Urban Development Environmental Criteria and Standards*, Title 24, CFR, Part 51, 44 FR 40860, July 12, 1979; Amended by 49 FR 880, January 6, 1984.

4. *Toward a National Strategy for Noise Control*, U.S. Environmental Protection Agency, April 1977.

5. Chapter 46, *Community Noise Control*, Department of Health, State of Hawaii, Administrative Rules, Title 11, September 23, 1996.

6. Chapter 42, *Vehicular Noise Control for Oahu*, Department of Health, State of Hawaii, Administrative Rules, Title 11, November 6, 1981.

7. *Section 3.11 Noise Regulations*, Land Use Ordinance, City and County of Honolulu, Oahu, October 22, 1986.

8. *Federal Highway Administration's Traffic Noise Model*, FHWA-RD-77-108; U.S. Department of Transportation, December 1978

9. Peak Hour Traffic Data, M&E Pacific, Inc., April 11, 2000 and June 1997.

10. *Highway Traffic Noise Analysis and Abatement Policy and Guidance*, U.S. Department of Transportation, Federal Highways Administration, June 1995.

11. *Environmental Noise Assessment, Mamalahoa Highway Bypass, Island of Hawaii*, D.L. Adams Associates, Ltd., August 1997,

TABLE 1

FEDERAL HIGHWAYS ADMINISTRATION RECOMMENDED EQUIVALENT HOURLY SOUND LEVELS BASED ON LAND USE [REFERENCE 5]

Activity Category	$L_{eq(h)}$	Noise Reduction Exterior-to-Interior
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	---	Undeveloped Land
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

TABLE 2

EXISTING AND PROJECTED FUTURE PEAK HOUR TRAFFIC NOISE LEVELS (L_{eq} in dBA) AT 100 FEET FROM THE ROADWAY CENTERLINES

	Location 1		Location 2		Location 3		Location 4		Location 5	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Existing Level (Calculated)	56.9	57.2	66.6	66.9	60.6	60.9	59.9	59.9	—	—
Future Without Project* (2010)	57.1	59.1	65.6	65.4	59.6	59.7	58.2	58.5	64.7	65.4
Future Without Project* (2015)	59.0	59.9	65.8	66.0	60.3	60.8	58.4	59.1	65.8	66.3
Future With Project (2010)	57.1	59.0	65.5	65.8	59.8	59.7	58.2	58.8	64.9	65.4
Future With Project (2015)	59.0	59.6	65.8	65.8	60.1	60.1	58.2	59.2	66.1	66.2

* Source for Locations 1 through 4:
Environmental Noise Assessment, Mamalahoa Highway Bypass, D.L Adams Associates, Ltd., August 1997,

TABLE 3

PROJECTED FUTURE PEAK HOUR TRAFFIC NOISE LEVEL INCREASES (L_{eq} in dBA) AT 100 FEET FROM THE ROADWAY CENTERLINES

	Location 1		Location 2		Location 3		Location 4		Location 5	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Future Increase Without Project (2010)	0.2	1.9	-1.0	-1.5	-1.0	-1.2	-1.7	-1.4	—	—
Future Increase Without Project (2015)	2.1	2.7	-0.8	-0.9	-0.3	-0.1	-1.5	-0.8	—	—
Future Increase With Project (2010)	0.2	1.8	-1.1	-1.1	-0.8	-1.2	-1.7	-1.1	0.2	0.0
Future Increase With Project (2015)	2.1	2.4	-0.8	-1.1	-0.5	-0.8	-1.7	-0.7	0.3	-0.1
Increase Due to the Project (2010)	0.0	-0.1	0.1	0.4	0.2	0.0	0.0	0.3	0.2	0.0
Increase Due to the Project (2015)	0.0	-0.3	0.0	-0.2	-0.2	-0.7	-0.2	0.1	0.3	-0.1

Note: A negative number indicates a decrease in traffic noise level.

TABLE 4

BUILDING NOISE REDUCTION FACTORS [REFERENCE 12]

Building Type	Window Condition	Noise Reduction Exterior-to-Interior
All	Open	10 dB
Light Frame	Ordinary Sash (closed)	20 dB
	Storm Windows	25 dB
Masonry	Single Glazed	25 dB
	Double Glazed	35 dB

TABLE 5

ROADWAY BARRIER ATTENUATION [REFERENCE 12]

Reduction in Sound Level	Degree of difficulty to Obtain Reduction
5 dBA	Simple
10 dBA	Attainable
15 dBA	Very Difficult
20 dBA	Nearly Impossible

APPENDIX A

ACOUSTICAL TERMINOLOGY

Sound Pressure Level

Sound or noise consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. It is measured in terms of decibels (dB) using precision instruments known as sound level meters. Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/Pref) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and Pref is the reference pressure, 20 micropascals, which is approximately the lowest sound pressure that can be detected by the human ear. For example, if P is 20 micropascals, then SPL = 0 dB, or if P is 200 micropascals, then SPL = 20 dB. The relation between sound pressure in micropascals and sound pressure level in decibels (dB) is shown in Figure A-1.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound levels, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined level of 53 dB, not 100 dB; two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of a sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 5 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

The human ear is more sensitive to sound in the frequency range of 250 Hertz (Hz) and higher, than in frequencies below 250 Hz. Due to this type of frequency response, a frequency weighting system, was developed to emulate the frequency response of the human ear. This system expresses sound levels in units of A-weighted decibels (dBA). A-weighted sound levels de-emphasizes the low frequency portion of the spectrum of a signal. The A-weighted level of a sound is a good measure of the loudness of that sound. Different sounds having the same A-weighted sound level are perceived as being about equally loud. Typical values of the A-weighted sound level of various noise sources are shown in Figure A-1.

Statistical Sound Levels

The sound levels of long-term noise producing activities, such as traffic movement, aircraft operations, etc., can vary considerably with time. In order to obtain a single number rating of such a noise source, a statistically-based method of expressing sound or noise levels developed. It is known as the Exceedence Level, L_n. The Exceedence Level, L_n, represents the sound level which is exceeded for n% of the measurement time period. For example, $L_{10} = 60$ dBA indicates that for the duration at the measurement period, the sound level exceeded 60 dBA 10% of the time. Commonly used Exceedence Levels include L_1, L_{15}, L_{50}, and L_{90}, which are widely used to assess community and environmental noise. Figure A-2 illustrates the relationship between selected statistical noise levels.

Equivalent Sound Level

The Equivalent Sound Level, L_{eq}, represents a constant level of sound having the same total acoustic energy as that contained in the actual time-varying sound being measured over a specific time period. L_{eq} is commonly used to describe community noise, traffic noise, and hearing damage potential. It has units of dBA and is illustrated in Figure A-2.

Day-Night Equivalent Sound Level

The Day-Night Equivalent Sound Level, L_{dn}, is the Equivalent Sound Level, L_{eq}, measured over a 24-hour period. However, a 10 dB penalty is added to the noise levels recorded between 10 pm and 7 am to account for people's higher sensitivity to noise at night when the background noise level is typically lower. The L_{dn} is a commonly used noise descriptor in assessing land use compatibility, and is widely used by federal and local agencies and standards organizations. Qualitative descriptions, as well as local examples of L_{dn}, are shown in Figure A-3.

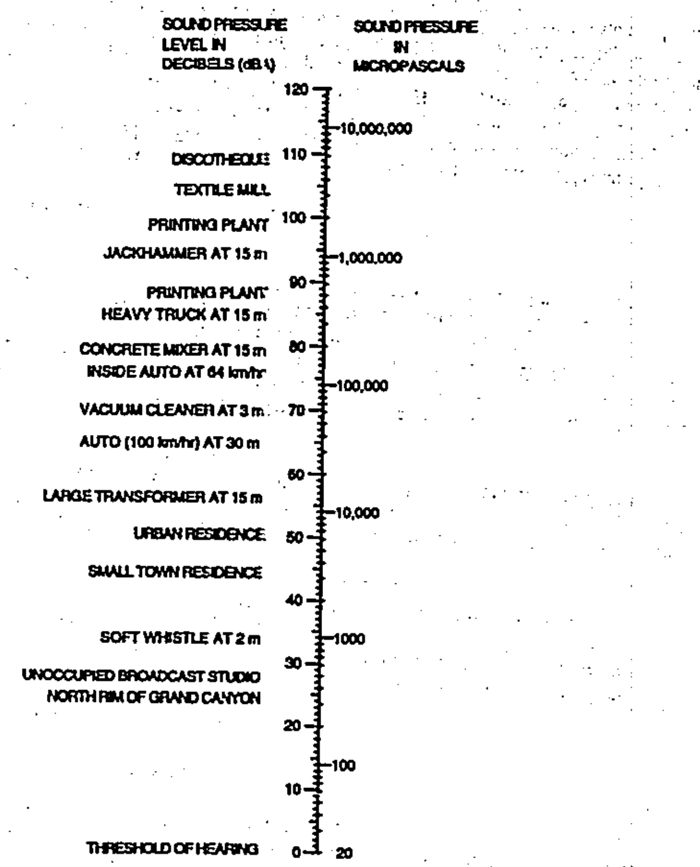


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FIGURE A-1 - THE RELATION BETWEEN SOUND PRESSURE, P, AND SOUND PRESSURE LEVEL, SPL. ALSO SHOWN ARE TYPICAL VALUES OF A-WEIGHTED SOUND LEVELS OF VARIOUS NOISE SOURCES.

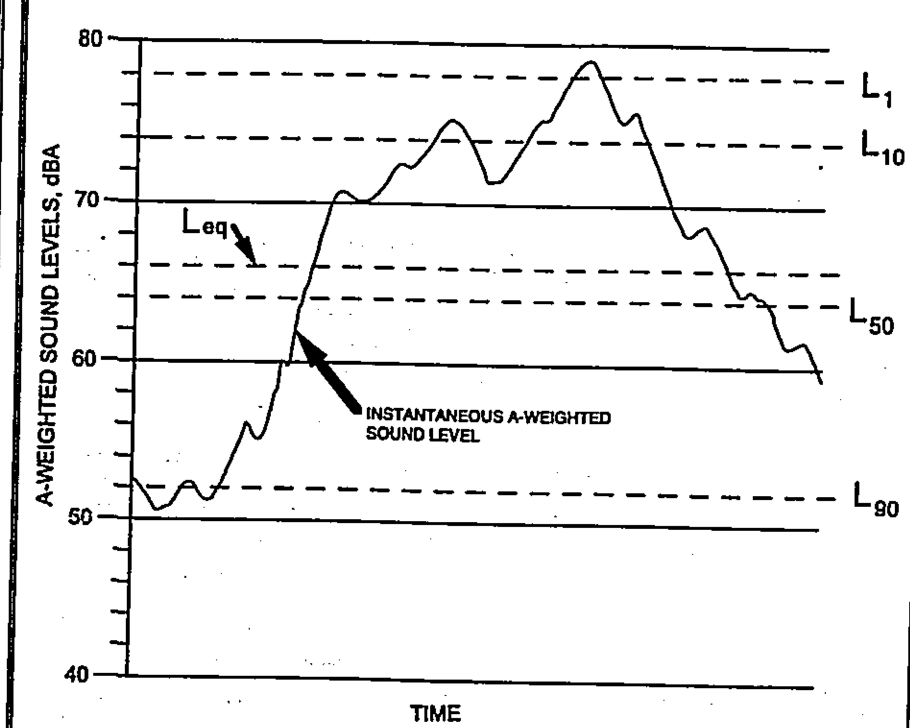

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FIGURE A-2 - COMPARISON OF AN INSTANTANEOUS SOUND LEVEL AND THE CORRESPONDING STATISTICAL SOUND LEVELS

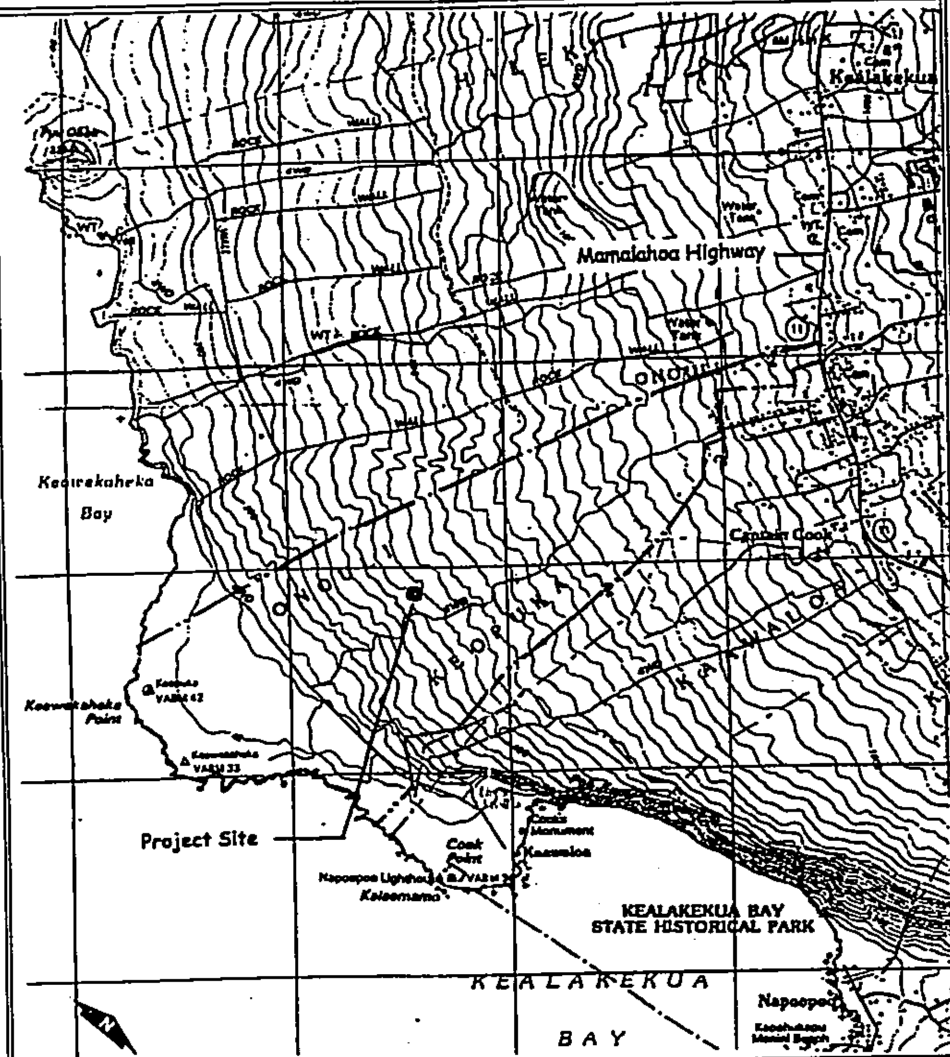

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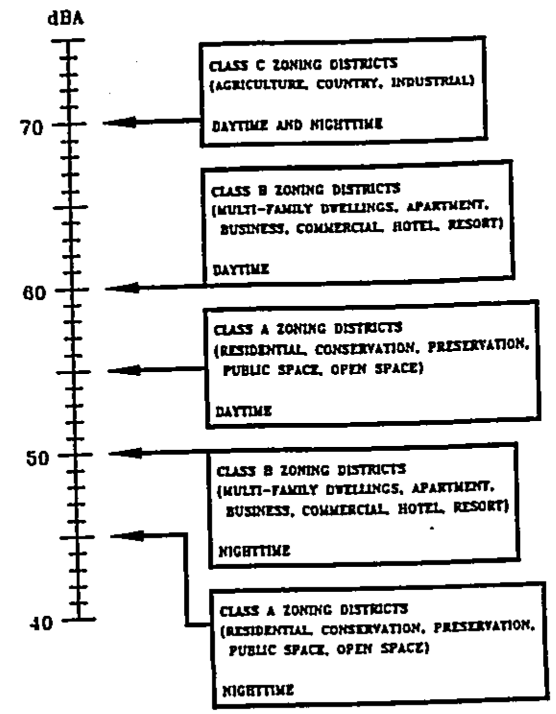
FIGURE 1 - PROJECT LOCATION AND STUDY AREA



NOTE: SOUND LEVELS INDICATED BY ZONING DISTRICT ARE THE "MAXIMUM PERMISSIBLE" SOUND LEVELS DUE TO EXCESSIVE NOISE SOURCES SUCH AS STATIONARY MECHANICAL EQUIPMENT AND EQUIPMENT RELATED TO AGRICULTURAL, CONSTRUCTION AND INDUSTRIAL ACTIVITIES THAT SHALL NOT BE EXCEEDED FOR MORE THAN 10% OF THE TIME WITHIN ANY 20-MINUTE PERIOD DURING THE TIME PERIOD SHOWN (DAYTIME: 7:00 A.M. TO 10:00 P.M., NIGHTTIME: 10:00 P.M. TO 7:00 A.M.)

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FIGURE 2 - MAXIMUM PERMISSIBLE SOUND LEVELS FOR VARIOUS ZONING DISTRICTS

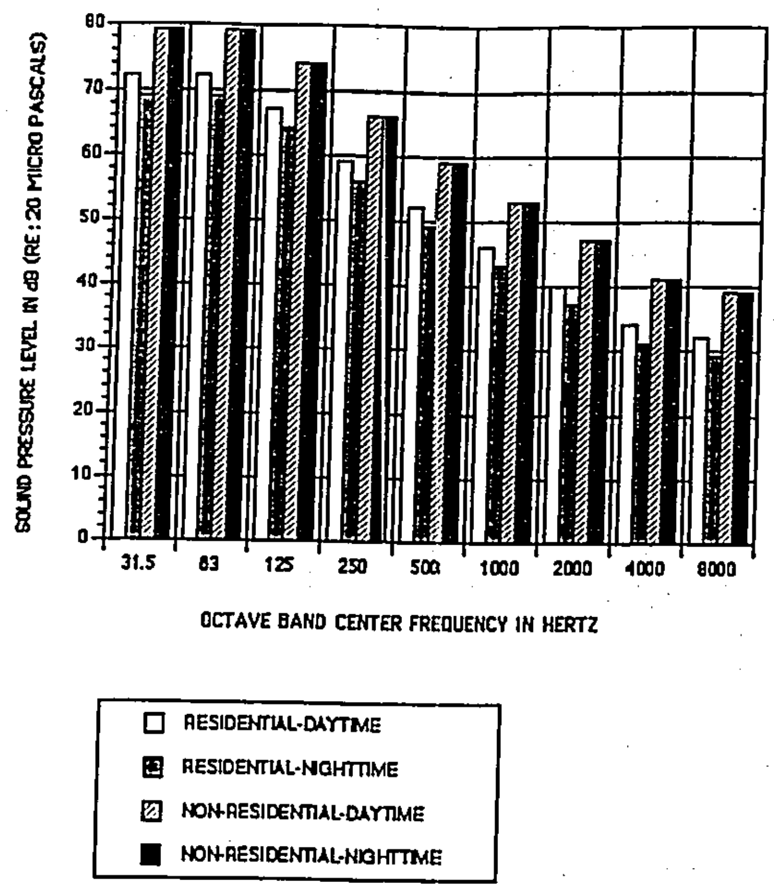

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FIGURE 3 - LUO NOISE REGULATION

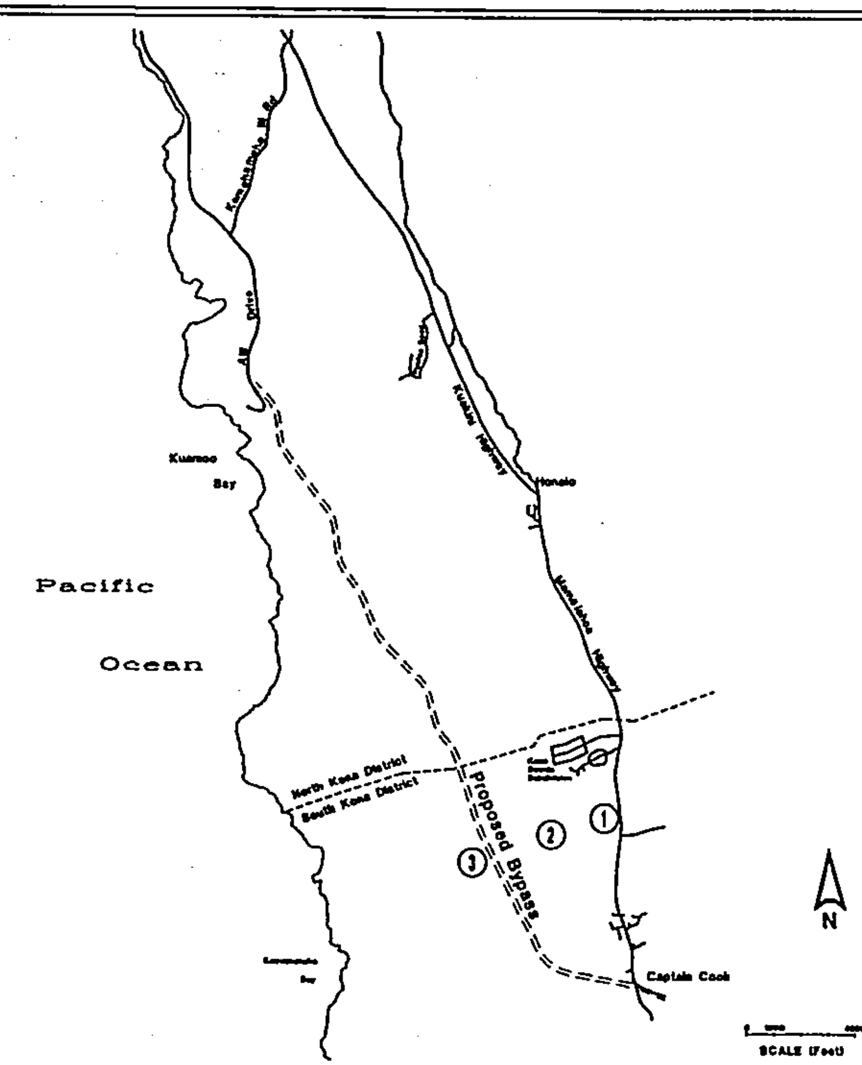

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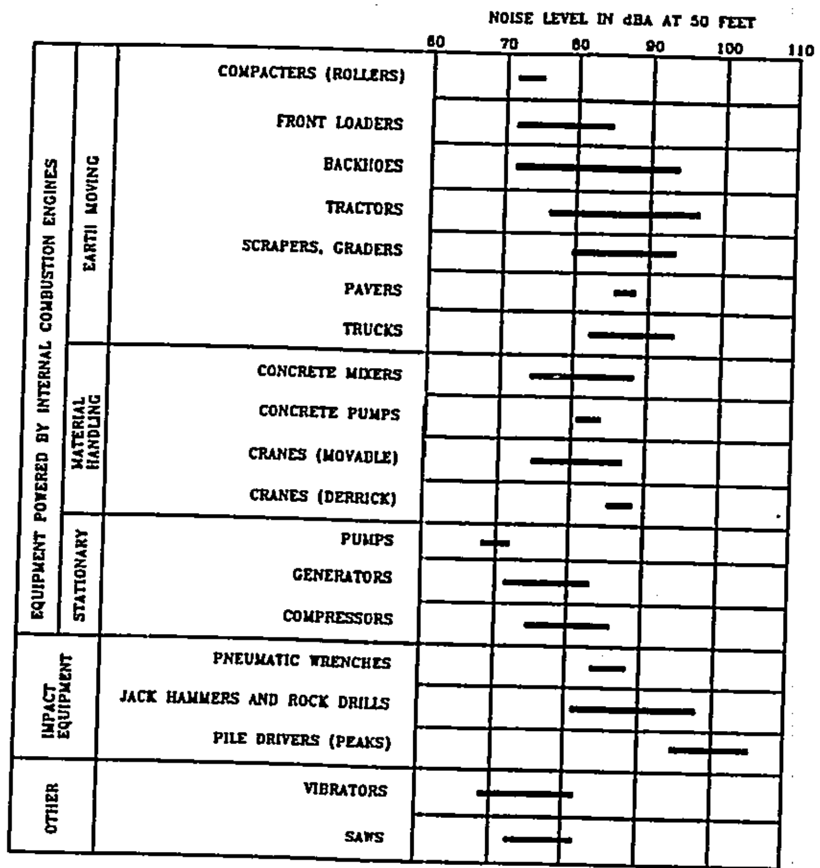
FIGURE 4 - LOCATIONS OF NOISE MEASUREMENTS



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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FIGURE 5 - TYPICAL SOUND PRESSURE LEVELS FROM CONSTRUCTION EQUIPMENT

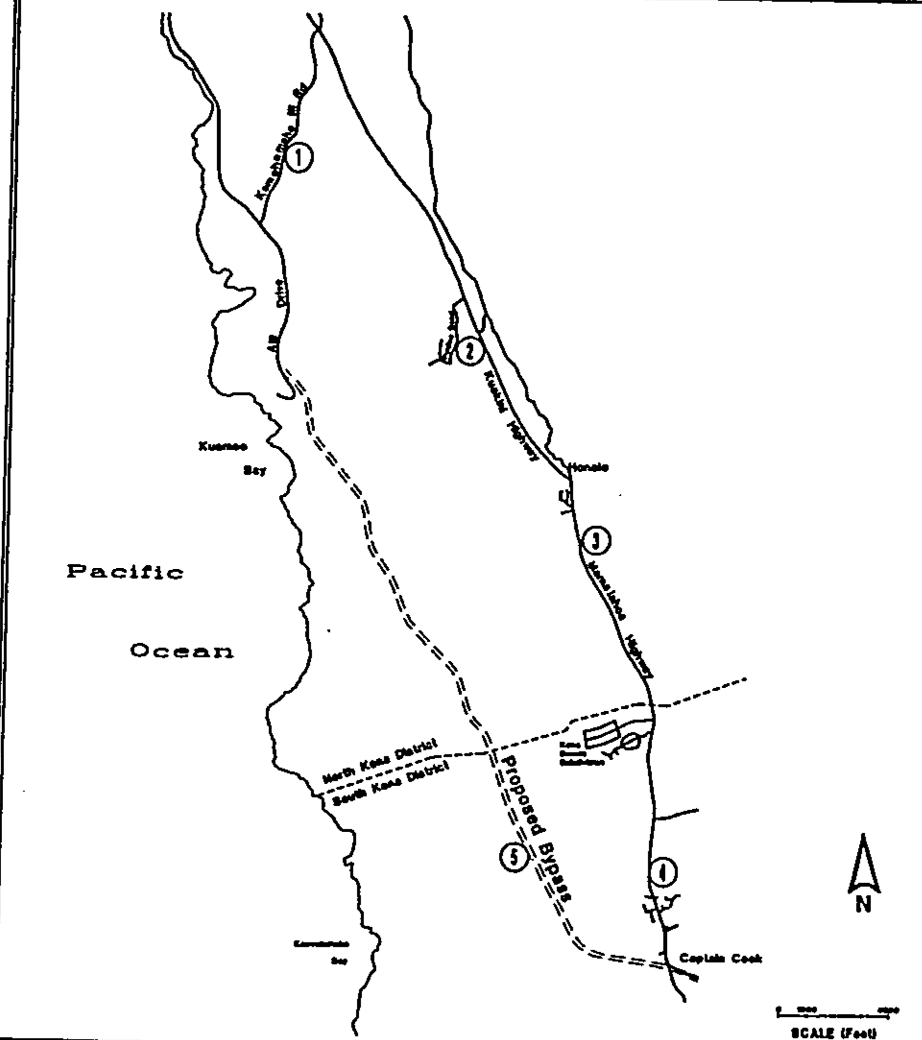

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FIGURE 6 - TRAFFIC NOISE ASSESSMENT LOCATIONS

APPENDIX L

Air Quality Report

DRAFT

AIR QUALITY STUDY
FOR THE PROPOSED
KEOPUKA LANDS PROJECT

SOUTH KONA, HAWAII

Prepared for:

Pacific Star, LLC

April 2000

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FIGURES

TABLES

TABLES (cont.)

1.0 SUMMARY

Pacific Star, LLC is proposing to develop the Keopuka Lands Project on a 660-acre site located in South Kona on the island of Hawaii. The project site is situated makai of State Highway 11 (Mamalahoa Highway) near Captain Cook. The proposed development will consist of 125 agricultural lots ranging in size from one to five acres, an 18-hole golf course with clubhouse and related uses and a 100-room lodge. Development is expected to occur in phases between 2005 and 2015. This study examines the potential short- and long-term air quality impacts that could occur as a result of construction and use of the proposed facilities and suggests mitigative measures to reduce any potential air quality impacts where possible and appropriate.

Both federal and state standards have been established to maintain ambient air quality. At the present time, seven parameters are regulated including: particulate matter, sulfur dioxide, hydrogen sulfide, nitrogen dioxide, carbon monoxide, ozone and lead. Hawaii air quality standards are more stringent than the comparable national standards except for those pertaining to sulfur dioxide and particulate matter.

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its leeward and near coastal situation and by nearby mountains. Winds are predominantly light and variable, although kona storms generate occasional strong winds from the south or southwest during winter. Temperatures in the project area are generally very consistent and moderate with average daily temperatures ranging from about 60°F to 80°F. The extreme minimum temperature recorded at nearby Kainaliu is 48°F, while the extreme maximum temperature is 89°F. Average annual rainfall in the area at the elevation of the project site amounts to about 38 inches with each month typically contributing between about 2 and 4 inches.

Except for periodic impacts from volcanic emissions (vog) and possibly occasional localized impacts from traffic congestion, the present air quality of the project area is believed to be relatively good. The little air quality data that are available for the area from the Department of Health indicate that (despite the vog) concentrations are well within state and federal air quality standards.

If the proposed project is given the necessary approvals to proceed, it is inevitable that some short- and long-term impacts on air quality will occur either directly or indirectly as a consequence of project construction and use. Short-term impacts from fugitive dust will likely occur during the project construction phase. To a lesser extent, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles may also affect air quality during the period of construction. State air pollution control regulations require that there be no visible fugitive dust emissions at the property line. Hence, an effective dust control plan must be implemented to ensure compliance with state regulations. Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Paving and landscaping of project areas early in the construction schedule will also reduce dust emissions. Monitoring dust at the project boundary during the period of construction could be considered as

a means to evaluate the effectiveness of the project dust control program. Exhaust emissions can be mitigated by moving construction equipment and workers to and from the project site during off-peak traffic hours.

After construction, motor vehicles coming to and from the proposed development will result in a long-term increase in air pollution emissions in the project area. To assess the impact of emissions from these vehicles, an air quality modeling study was undertaken to estimate current ambient concentrations of carbon monoxide at several intersections in the project vicinity and to predict future levels both with and without the proposed project. During worst-case conditions, model results indicated that present 1-hour and 8-hour carbon monoxide concentrations are probably well within both the state and the national ambient air quality standards. In the year 2015 without the project, carbon monoxide concentrations were predicted to increase at all the locations that were studied. Concentrations would likely remain well within the national standards but may exceed the more stringent state standards near some high-volume intersections, such as Kamehameha III Road at Alii Drive and Mamalahoa Highway at Napoopoo Road. With the project in the year 2015, carbon monoxide concentrations were estimated to increase very slightly at some locations compared to the without-project case. Due to the very small impact the project is expected to have, implementing mitigation measures for traffic-related air quality impacts is probably unnecessary and unwarranted. It should be noted that, because the state standards for carbon monoxide are set at such stringent levels, it is likely that the standards are currently exceeded at many locations in the state that have even moderate traffic volumes.

Pesticides will be used to maintain golf course grasses. If applied during low wind conditions using proper application techniques, contamination of nearby, downwind areas by airborne drift should not be a problem. Use of shrouded spray equipment fitted with computerized flow controllers, maintaining a buffer distance of at least 100 feet between target spray areas and populated locations, and planting vegetation screens along populated areas of the golf course perimeter would provide added measures of protection.

Depending on the demand levels, long-term impacts on air quality are also possible due to indirect emissions associated with a development's electrical power and solid waste disposal requirements. Quantitative estimates of these potential impacts were not made, but based on the estimated demand levels and emission rates involved, any significant impacts are unlikely. Nevertheless, incorporating energy conservation design features and promoting conservation and recycling programs within the proposed development could serve to further reduce any associated impacts and conserve the island's resources.

2.0 INTRODUCTION

Pacific Star, LLC is proposing to develop the Keopuka Lands Project on 660 acres of land in the South Kona District on the island of Hawaii. As indicated in Figure 1, the project site is located makai of State Highway 11 (Mamalahoa Highway) near Captain Cook. The proposed development will consist of 125 agricultural lots ranging in size from one to five acres, an 18-hole golf course with clubhouse and related uses and a 100-room lodge. Access to the project will be provided from the proposed Mamalahoa Highway Bypass roadway, which will bisect the project into a large makai parcel and a smaller mauka parcel.

Development of the project is expected to occur in phases between 2005 and 2015.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short-term and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities. Measures to mitigate these impacts are suggested where possible and appropriate.

3.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, national and state AAQS have been established for particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. The state has also set a standard for hydrogen sulfide. National AAQS are stated in terms of both primary and secondary standards for most of the regulated air pollutants. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow a specified number of exceedances each year.

The Hawaii AAQS are in some cases considerably more stringent than the comparable national AAQS. In particular, the Hawaii 1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit, and the state 1-hour limit for ozone is more than two times as stringent as the national 1-hour standard. The national 1-hour ozone standard will be phased out (pending court appeal) the next few years in favor of the new (and more stringent) 8-hour standard.

The Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make the state standards essentially the same as the national limits. In 1993, the state also revised its particulate standards to follow those set by the federal government. During 1997, the federal government again revised its standards for particulate, but the new standards have been challenged in federal court. To

date, the Hawaii Department of Health has not updated the state particulate standards.

4.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

The site of the proposed project is located near the midpoint of the western coast of the island of Hawaii. The topography of Hawaii Island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through the saddle between the Kohala Mountains and Mauna Kea and reach some areas to the lee. Due to wind shadow effects caused by the terrain, winds in the project area are predominantly light and variable. Local winds such as land/sea breezes and/or upslope/downslope winds dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds that move downslope and out to sea. During winter, occasional strong winds from the south or southwest occur in association with the passage of winter storm systems.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At Kainaliu, located abut 2 miles north of the project site at an elevation of about 1500 feet, average daily minimum and maximum temperatures are 61°F and 79°F, respectively [1]. The extreme minimum temperature on record at this location is 48°F, and the extreme maximum is 89°F. Temperatures at the project site are probably somewhat warmer due to the lower elevation.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is often measured

and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 is the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In the Kona area, stability classes 5 or 6 typically occur during the nighttime or early morning hours when temperature inversions form due to radiational cooling or to drainage flow from the mountainous interior of the island. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas also may experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Mixing heights in Hawaii typically are above 3000 feet (1000 meters).

Rainfall can have a beneficial affect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it also may "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The climate of the project area is wetter than might be expected for a leeward location. This is due to the persistent onshore and upslope movement of marine air caused by both eddie and seabreeze or mountain slope effects. Some of the rainfall occurs during summer afternoons and evenings as a result of this onshore and upslope movement of moisture-laden marine air, and some occurs in conjunction with winter storms. At nearby Napoopoo above Kealakekua Bay, average annual rainfall amounts to about 38 inches with each month registering about 2 to 4 inches [1]. Rainfall at the project site is probably somewhere near this amount.

5.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and/or agricultural sources. Table 2 presents an air pollutant emission summary for the island of Hawaii for calendar year 1993. The emission rates shown in the table pertain to manmade emissions only, i.e., emissions from natural sources are not included. As suggested in the table, much of the manmade particulate emissions on Hawaii originate from area sources, such as the mineral products industry and agriculture. Manmade sulfur oxides are emitted almost exclusively by point sources, such as power plants and other fuel-burning industries. Nitrogen oxides emissions emanate predominantly from area sources (mostly motor vehicle traffic), although industrial point sources contribute a significant share. The majority of carbon monoxide emissions occur from area sources (motor vehicle traffic), while hydrocarbons are emitted mainly from point sources.

It should be noted that Hawaii Island is unique from the other islands in the state in terms of the natural volcanic air pollution emissions that occur. Volcanic emissions periodically plague the project area. This is especially so since the latest

eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates or acid aerosols. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles east of the project site, the prevailing wind patterns eventually carry some of the emissions into the Kona area. These emissions can be seen in the form of the volcanic haze (vog) which persistently hangs over the area.

The major industrial source of air pollution in the project vicinity is Hawaii Electric Light Company's Keahole Power Plant, which is located 22 miles to the north. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen.

Mamalahoa Highway, which borders the project site on the mauka side, is the region's only major arterial roadway. Prevailing onshore winds during the daytime when traffic is heaviest tend to carry emissions from motor vehicles traversing this roadway away from the project area.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very little data are available for Hawaii Island, and even less data are available for the Kona area specifically. Recently, the Department of Health established an air quality monitoring site in the Kealakekua area, but no data from the station have been made available to the public to date. Currently, as indicated in Table 3, the only available monitoring data in the vicinity of the project site are rather dated and consist of sulfur dioxide and particulate measurements that were made at nearby Kealakekua during 1985 and 1986. During the two-year period, measurements of 24-hour average sulfur dioxide concentration at this location were consistently low with daily mean values ranging from less than 5 $\mu g/m^3$ up to 12 $\mu g/m^3$. No exceedances of the state/national 24-hour AAQS for sulfur dioxide were recorded. The twenty-four hour average particulate concentrations ranged from 4 to 28 $\mu g/m^3$; no violations of the state AAQS were measured during the 1985-86 monitoring period.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems; concentrations of these contaminants generally have not been found to exceed AAQS elsewhere in the state. Carbon monoxide air pollution, on the other hand, typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on computer modeling of motor vehicle emissions.

6.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions that could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation; and (2) exhaust emissions

from on-site construction equipment. Indirectly, there also could be short-term impacts related to slow-moving construction equipment traveling to and from the project site and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions may arise from the grading and dirt-moving activities associated with site clearing and preparation work. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately. This is because of its elusive nature of emission and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [2] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions in the project area would likely be somewhere near that level. In any case, State of Hawaii Air Pollution Control Regulations [3] prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-dirt surfaces in construction areas from becoming significant sources of dust. In dust-prone or dust-sensitive areas, other control measures such as limiting the area that can be disturbed at any given time, applying chemical soil stabilizers, mulching and/or using wind screens may be necessary. Control regulations further stipulate that open-bodied trucks be covered at all times when in motion if they are transporting materials that could be blown away. Haul trucks tracking dirt onto paved streets from unpaved areas is often a significant source of dust in construction areas. Some means to alleviate this problem, such as road cleaning or tire washing, may be appropriate. Paving of parking areas and/or establishment of landscaping as early in the construction schedule as possible can also lower the potential for fugitive dust emissions. Monitoring dust at the project property line could be considered to quantify and document the effectiveness of dust control measures.

On-site mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Slow-moving construction vehicles traveling on roadways leading to and from the project site could obstruct the normal flow of traffic to such an extent that overall vehicular emissions are increased, but this impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity. Thus, most potential short-term air quality impacts from project construction can be mitigated.

7.0 LONG-TERM IMPACTS OF PROJECT

7.1 Roadway Traffic

After construction is completed, use of the proposed facilities will result in increased motor vehicle traffic on nearby roadways, potentially causing long-term impacts on ambient air quality in the project vicinity. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides and other contaminates.

Federal air pollution control regulations require that new motor vehicles be equipped with emission control devices that reduce emissions significantly compared to a few years ago. In 1990, the President signed into law the Clean Air Act Amendments. This legislation requires further emission reductions which have been phased in since 1994. Just recently, President Clinton signed into law additional restrictions which will begin to take effect during the next decade. The added restrictions on emissions from new motor vehicles will lower average emissions each year as more and more older vehicles leave the state's roadways. Carbon monoxide emissions, for example, will go down by an average of about 10 percent per vehicle during the next 10 years due to the replacement of older vehicles with newer models.

To evaluate the potential long-term indirect ambient air quality impact of the roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles.

Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem that can be addressed locally to some extent, whereas nitrogen oxides air pollution most often is a regional issue that cannot be addressed by a single new development.

For this project, three scenarios were selected for the carbon monoxide modeling study: (1) year 2000 with present conditions, (2) year 2015 (the expected project buildout date) without the project, and (3) year 2015 with the project. To begin the modeling study, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic queuing. For this study, several of the same intersections identified by the project traffic engineers as being impacted by the project were selected for air quality analysis. These included the following four intersections:

- Mamalahoa Highway/Bypass Road at Napoopoo Road
- Mamalahoa Highway at Halekii Street
- Halekii Street at Bypass Road
- Kamehameha III Road at Alii Drive

Intersection configurations and traffic conditions at each of these locations are detailed in the traffic impact report for the project [4].

The main objective of the modeling study was to estimate maximum 1-hour average carbon monoxide concentrations for each of the three scenarios studied. To evaluate the significance of the estimated concentrations, a comparison of the predicted values for each scenario can be made. Comparison of the estimated values to

the national and state AAQS was also used to provide another measure of significance.

Maximum carbon monoxide concentrations typically coincide with peak traffic periods. The traffic impact assessment report evaluated morning and afternoon peak traffic periods. These same periods were evaluated in the air quality impact assessment.

The EPA computer model MOBILE5A [5] was used to calculate vehicular carbon monoxide emissions for each year studied. One of the key inputs to MOBILE5A is vehicle mix. Unless very detailed information is available, national average values are typically assumed, which is what was used for the present study. Based on national average vehicle mix figures, the present vehicle mix in the project area was estimated to be 61.6% light-duty gasoline-powered automobiles, 27.6% light-duty gasoline-powered trucks and vans, 3.1% heavy-duty gasoline-powered vehicles, 0.3% light-duty diesel-powered vehicles, 6.8% heavy-duty diesel-powered trucks and buses, and 0.6% motorcycles. For the future scenarios studied, the vehicle mix was estimated to change only slightly with fewer light-duty gasoline-powered automobiles and more light-duty gasoline-powered trucks and vans.

Other key inputs to the MOBILE5A emission model are the cold/hot start fractions. Motor vehicles operating in a cold- or hot-start mode emit excess air pollution. Typically, motor vehicles reach stabilized operating temperatures after about 4 miles of driving. For traffic operating on roadways within the project area, it was assumed that about 21 percent of all vehicles would be operating in the cold-start mode and that about 27 percent would be operating in the hot-start mode. These are typical default (national average) values.

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE5A are inversely proportional to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE5A, these data were then input to an atmospheric dispersion model. EPA air quality modeling guidelines [6] currently recommend that the computer model CAL3QHC [7] be used to assess carbon monoxide concentrations at roadway intersections, or in areas where its use has previously been established, CALINE4 [8] may be used. Until about two years ago, CALINE4 was used extensively in Hawaii to assess air quality impacts at roadway intersections. In December 1997, the California Department of Transportation recommended that the intersection mode of CALINE4 no longer be used because it was thought the model has become outdated. Studies have shown that CALINE4 may tend to over-predict maximum concentrations in some situations. Therefore, CAL3QHC was used for the subject analysis.

CAL3QHC was developed for the U.S. EPA to simulate vehicular movement, vehicle queuing and atmospheric dispersion of vehicular emissions near roadway intersections. It is designed to predict 1-hour average pollutant concentrations near roadway intersections based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Although CAL3QHC is intended primarily for assessing atmospheric dispersion near signalized roadway intersections, it can also be used to evaluate unsignalized intersections. This is accomplished by manually estimating queue lengths and then applying the same techniques used by the model for signalized intersections. Currently, one of the four study intersections is unsignalized; all four intersections were assumed to be signalized for the future scenarios.

Input peak-hour traffic data were obtained from the traffic study cited previously. This included vehicle approach volumes, saturation capacity estimates, intersection laneage and signal timings. All emission factors that were input to CAL3QHC for free-flow traffic were obtained from MOBILE5A based on an assumed free-flow vehicle speed of 30 mph.

Model roadways were set up to reflect roadway geometry, physical dimensions and operating characteristics. Concentrations predicted by air quality models generally are not considered valid within the roadway mixing zone. The roadway mixing zone is usually taken to include 3 meters on either side of the traveled portion of the roadway and the turbulent area within 10 meters of a cross street. Model receptor sites were thus located at the edges of the mixing zones near all intersections that were studied, whether or not sidewalks currently exist. All receptor heights were placed at 1.8 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for the morning case, and stability category 4 was assumed for the afternoon case. These are the most conservative stability categories that are generally used for estimating worst-case pollutant dispersion within suburban or rural areas for these periods. A surface roughness length of 100 cm and a mixing height of 1000 meters were used in all cases. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration. Concentration estimates were calculated at wind directions of every 5 degrees.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at low levels. Thus, background contributions of carbon monoxide from sources or roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.5 ppm to all predicted concentrations for 2000. Although increased traffic is expected to occur within the project area within the next several years with or without the project, background carbon monoxide concentrations may not change significantly since individual emissions from motor vehicles are forecast to decrease with time. Hence, a background value of 0.5 ppm was assumed to persist for the future scenarios studied.

Predicted Worst-Case 1-Hour Concentrations

Table 4 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 2000 with existing traffic, year 2015 without the project and year 2015 with the project. The

locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated intersections.

As indicated in the table, the highest estimated 1-hour concentration within the project vicinity for the present (2000) case was 7.9 mg/m^3. This was projected to occur during the morning peak-traffic hour near the intersection of Mamalahoa Highway and Napoopoo Road. The next highest value, 6.4 mg/m^3, was estimated to occur during the morning peak-traffic hour at the intersection of Mamalahoa Highway and Halekii Street. Concentrations at other locations and times studied ranged between about 4 and 6 mg/m^3. All predicted worst-case 1-hour concentrations for the 2000 scenario were well within the national AAQS of 40 mg/m^3 and the state AAQS of 10 mg/m^3.

In the year 2015 without the proposed project, a worst-case 1-hour concentration of 11.4 mg/m^3 was predicted to occur during the morning peak-traffic hour near the intersection of Kamehameha III Road and Alii Drive. The next highest value for the project area was 10.4 mg/m^3 and occurred during the morning near the intersection of Mamalahoa Highway/Bypass Road and Napoopoo Road. Peak-hour worst-case values at the other locations studied for the 2015 without project scenario ranged between about 5 and 8 mg/m^3. These concentrations were generally higher than those for the existing case, particularly at the intersection of Kamehameha III Road and Alii Drive (due to the assumed completion of the Bypass Road and the added traffic it will bring to the area). Predicted worst-case 1-hour concentrations for the 2015 without project scenario were within the national AAQS, but concentrations were estimated to slightly exceed the state AAQS at two of the four locations studied. It should be noted that because the state 1-hour carbon monoxide standard is set at such a stringent level, it is likely that it is currently exceeded at many locations in the state that have even moderate traffic volumes.

Predicted 1-hour worst-case concentrations for the 2015 with-project scenario ranged from 5.1 mg/m^3 during the afternoon at the Halekii Street/Bypass Road intersection to 11.4 mg/m^3 during the morning at the Kamehameha III Road/Alii Drive intersection. Compared to the 2015 without-project case, predicted worst-case concentrations for 2015 with the project were either unchanged or slightly higher at the four intersections studied. Similar to the 2015 without-project case, all of the locations studied were predicted to meet the national AAQS, but locations near two of the four intersections modeled were predicted to potentially exceed the more stringent state standard by a small margin.

<u>Predicted Worst-Case 8-Hour Concentrations</u>

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological conditions are more variable (and hence more favorable for dispersion) over an 8-hour period than they are for a single hour. Based on <u>monitoring</u> data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One recent study based on <u>modeling</u> [9] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [10] recommend using a value of 0.7 unless a locally derived persistence factor is available. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 will likely yield reasonable estimates of worst-case 8-hour concentrations.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 5. For the 2000 scenario, the estimated worst-case 8-hour carbon monoxide concentrations for the locations studied ranged from 3.0 to 4.0 mg/m^3. These estimated worst-case concentrations comply with both the state standard of 5 mg/m^3 and the national standard of 10 mg/m^3.

For the year 2015 without-project scenario, worst-case concentrations ranged between 3.3 and 5.7 mg/m^3. A substantial increase was indicated at the intersection of Kamehameha III Road and Alii Drive compared to the existing case due to the assumed completion of the Bypass Road and the added traffic it will bring to the area. The worst-case concentration estimates for all locations studied met the national 8-hour standard but slightly exceeded the state standard at two of the four locations that were evaluated.

For the 2015 with-project scenario, worst-case concentrations ranged from 3.4 to 5.7 mg/m^3, essentially unchanged from the without-project scenario. Similar to the without-project scenario, all predicted 8-hour concentrations for this scenario were within the national AAQS, but two of the four locations studied slightly exceeded the more stringent state AAQS.

Again, it should be noted that, because the state 8-hour carbon monoxide standard is set at such a stringent level, it is likely that it is currently exceeded at many locations in the state that have even moderate traffic volumes.

Conservativeness of Estimates

The results of this study reflect several assumptions that were made concerning both traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is extremely unlikely and may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above. The 8-hour estimates are also conservative in that it is unlikely that anyone would occupy the assumed receptor sites (within 3 m of the roadways) for a period of 8 hours.

7.2 Golf Course Pesticide Usage

The proposed golf course is expected to be developed during the early stages of the project. Once the golf course is completed and is in use, various chemical pesticides will be used to maintain grass quality. Impacts on air quality can potentially occur when chemicals drift away from areas targeted for treatment. Residences or persons in areas located immediately adjacent to the proposed golf course could potentially be exposed if drift should occur.

Table 6 shows a typical pesticide program for an 18-hole golf course in Hawaii. Herbicides are applied to greens, tees, fairways and perimeter areas, and insecticides and fungicides are used on greens and tees and for spot treatment of fairways. Herbicide products typically used include: MSMA, bensulide, 33 Plus, metribuzin and glyphosate. These chemicals typically are applied 2 to 6 times per year. Chlorpyrifos is used as an

insecticide on an as needed basis, and metalxyl and chlorothalonil are used to control fungi as required. An integrated pest management (IPM) plan designed specifically for this project will likely be prepared which may deviate from that given in Table 6.

Golf course pesticides are applied with ground spray equipment. Typically, this includes tractor-mounted spray bars for fairways and perimeter areas and portable sprayer units for greens and tees and spot treatment of fairways. In most applications, pesticide chemicals are diluted with water in a mixing compartment, and the solutions are then applied under 20 to 40 pounds per square inch (psi) pressure to the target area by flat-fan type nozzles at about 1 to 3 feet above ground.

Drift from spray equipment can occur by two different means. Vapor drift occurs when a chemical vaporizes after being applied to the target area. The vapors may then be carried downwind to adjacent locations. The amount of vaporization that occurs depends mostly on the ambient temperature and the volatility of the pesticide being used. Higher ambient temperatures promote more vaporization to take place. Ambient temperatures in the project area are relatively warm, which will tend to promote evaporation. In any case, the chemicals which will likely be used (see Table 6) have a low volatility within the temperature range that occurs in the area. Thus, vapor drift from the application of pesticides at the proposed golf courses should not be a problem.

Physical droplet drift occurs when the wind moves spray particles away from the target spray area. Pesticide solutions from spray equipment vary in size from large rain-drop size droplets down to small fog-sized mists. Table 7 shows the droplet size range distribution by volume for a flat-fan nozzle sprayer such as is typically used on a golf course. As indicated in the table, about 85 percent of the spray volume is typically larger than about 100 microns diameter when applied at 20 psi; this percentage reduces to about 70 percent when applied at 40 psi.

Large droplets are deposited on or very near the target area, while small droplets can drift significant distances downwind before being deposited. Figure 2 shows the approximate drift distances for various sizes of droplets from spray equipment falling 10 feet in a 3 mph wind. Droplets smaller than about 100 microns diameter can drift from several hundred to several thousand feet downwind when applied under these conditions. Normally, as mentioned above, the drop distance from a golf course sprayer will be about 3 feet or less, and thus the potential drift distances will be smaller than those shown in the figure.

Table 8 compares downwind distances for droplet drift from nozzle spray equipment to diminish to 1 percent when spraying is performed using various types of nozzles and under various spray height, pressure and wind speed conditions. These tests were performed using agricultural spray equipment at a location in North Dakota. As can be seen from the table, 99 percent of the spray was deposited within 17 feet even under wind speeds up to 10 mph. Lower spray heights, lower application pressures, use of thickeners and use of nozzles producing larger droplets all reduced the distance to the 1 percent value.

AAQS have not been established for any of the pesticides presently in use, although occupational safety and health standards have been established for some of the chemical ingredients. Most pesticide products carry warning or caution labels on their

containers. The primary purpose of these labels is to provide occupational safety and health guidance regarding proper handling and application. Pesticide applicators are trained and certified in proper application techniques, particularly with respect to minimizing pesticide drift. Measures available to control drift from pesticide application include:

1) using coarse nozzle and low pressure spray equipment;

2) using shielded or shrouded sprayers;

3) using flow-control computers;

4) using thickener additives;

5) using non-volatile or low-volatile chemicals;

6) applying at lowest possible height and during low wind speed conditions when the wind direction will carry any drift away from populated areas;

7) applying during periods when the temperature is cooler and the humidity is higher and when ground-based temperature inversion conditions are absent;

8) maintaining an adequate buffer distance (at least 100 feet) between sprayer and populated areas;

9) planting trees and shrubs around golf course perimeters to intercept drift at golf course boundaries.

If proper safety precautions are followed, the potential for serious air quality degradation from chemical spraying for turfgrass maintenance can be virtually eliminated.

7.3 Electrical Demand

The proposed project also will cause indirect air pollution emissions from power generating facilities as a consequence of electrical power usage. The peak electrical demand of the project when fully developed is expected to reach 2200 kW [11]. Assuming the average demand is approximately one-half the peak demand, the annual electrical demand of the project will reach approximately 10 million kilowatt-hours. Electrical power for the project will most probably be provided mainly by oil-fired generating facilities, but some of the project power may also be derived from geothermal energy, wind power or other sources. In order to meet the electrical power needs of the proposed project, power generating facilities will likely be required to burn more fuel and hence more air pollution will be emitted at these facilities. Given in Table 9 are estimates of the indirect air pollution emissions that would result from the project electrical demand assuming all power is provided by burning more fuel oil at local power plants. These values can be compared to the island-wide emission estimates for 1993 given in Table 2. The estimated indirect emissions from project electrical demand amount to less than 1 percent of the present air pollution emissions occurring on Hawaii Island even if all power is assumed to be derived from oil.

7.4 Solid Waste Disposal

Solid waste generated by the proposed development when fully completed and occupied is not expected to exceed about 140 tons per year [11]. Currently, all solid waste on the island is buried at solid waste landfills. Thus, assuming this continues to be the method for solid waste disposal, the only associated air pollution emissions that will occur will be from trucking the

waste to the landfill and burying it. These emissions should be relatively minor.

8.0 CONCLUSIONS AND RECOMMENDATIONS

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, depending on rainfall. To control dust, active work areas and any temporary unpaved work roads should be watered at least twice daily on days without rainfall. Use of windscreens and/or limiting the area that is disturbed at any given time will also help to contain fugitive dust emissions. Wind erosion of inactive areas of the site that have been disturbed could be controlled by mulching or by the use of chemical soil stabilizers. Dirt-hauling trucks should be covered when traveling on roadways to prevent windage. A routine road cleaning and/or tire washing program will also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Monitoring dust at the project boundary during the period of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary.

During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

After the proposed project is completed, emissions from project-related traffic will cause a very slight increase in carbon monoxide concentrations near intersections in the project area. With or without the project in the year 2015, worst-case carbon monoxide concentration levels within the project area will comply with the national ambient air quality standards but will potentially exceed the more stringent state standards at some locations. Due to the low levels at which the state carbon monoxide standards are set, it may not be possible to achieve continuous compliance with the standards, at least within some small hot-spot areas near high-volume intersections in the project area. Because the state standards are set at such stringent levels, it is likely that the standards are currently exceeded at many locations in the state that have even moderate traffic volumes. Due to the very small impact the project is expected to have on carbon monoxide levels in the project area and given that the predicted worst-case carbon monoxide concentrations are well within the national ambient air quality standards and that the more stringent state standards are probably currently exceeded near many roadway intersections in the state where traffic volumes are moderate to high, implementing air quality mitigation measures for long-term traffic-related impacts is probably unnecessary and unwarranted.

Pesticides will be used on the project site to maintain golf course grasses. Compliance with safety guidelines for the spraying of chemicals for golf course maintenance should mitigate potential air quality impacts from this activity. Pesticides should be applied using low-pressure, coarse-nozzle spray equipment less than 3 feet above the ground and only during light

wind conditions. Use of shrouded spray equipment will also reduce pesticide drift. Maintaining a 100-foot buffer distance from populated areas and the planting of trees and shrubs along the golf course perimeters would provide further practical mitigation measures.

Any long-term impacts on air quality due to indirect emissions from supplying the project with electricity and from the disposal of waste materials generated by the project will likely be relatively small based on the magnitudes of the estimated emissions compared to the current island-wide emissions. To further moderate any impacts, indirect emissions from project electrical demand could likely be reduced somewhat by incorporating energy-saving features into project design requirements. This might include the use of solar water heaters, water heater timers or possibly hot water on demand systems; designing building space so that window positions maximize indoor light without unduly increasing indoor heat; using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning; installation of insulation and double-glazed doors to reduce the effects of the sun and heat; movable, controlled openings for ventilation at opportune times; and possibly automated room occupancy sensors. Solid waste related air pollution could likely be reduced somewhat by the promotion of conservation and recycling programs within the proposed development.

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Figure 1

PROJECT LOCATION MAP

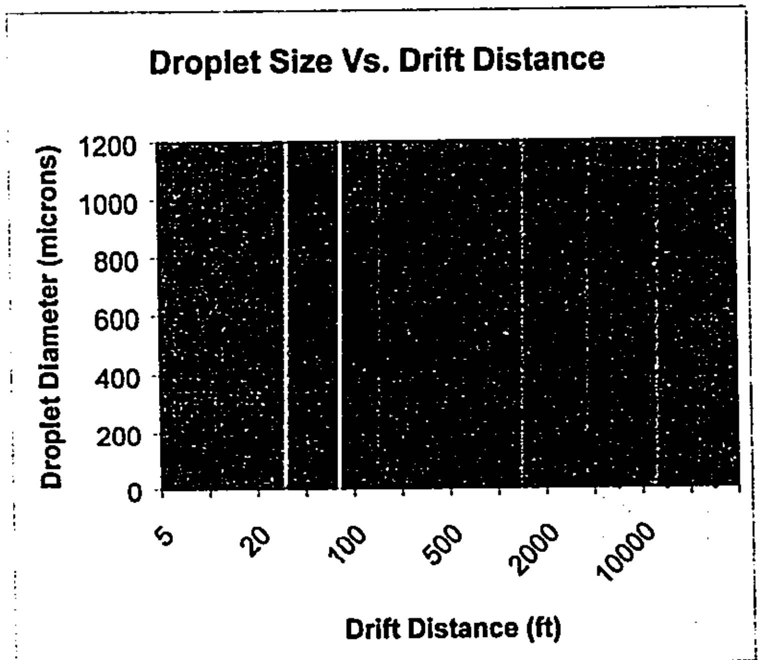


Figure 2

(Note: Based on droplets falling 10 ft in a 3 mph wind.)

Source: "Spray Equipment and Calibration", V. Hofman, et al., Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, Report No. AE73, Revised, January 1986.

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter (<10 microns)	$\mu g/m^3$	Annual 24 Hours	50[a] 150[b]	50[a] 150[b]	50 150[c]
Particulate Matter (<2.5 microns)	$\mu g/m^3$	Annual 24 Hours	15[a] 65[d]	15[a] 65[d]	- -
Sulfur Dioxide	$\mu g/m^3$	Annual 24 Hours 3 Hours	80 365[c] -	- - 1300[c]	80 365[c] 1300[c]
Nitrogen Dioxide	$\mu g/m^3$	Annual	100	100	70
Carbon Monoxide	mg/m^3	8 Hours 1 Hour	10[c] 40[c]	- -	5[c] 10[c]
Ozone	$\mu g/m^3$	8 Hours 1 Hour	157[e] 235[f]	157[e] 235[f]	- 100[c]
Lead	$\mu g/m^3$	Calendar Quarter	1.5	1.5	1.5
Hydrogen Sulfide	$\mu g/m^3$	1 Hour	-	-	35[c]

[a] Three-year average of annual arithmetic mean.
[b] 99th percentile value averaged over three years.
[c] Not to be exceeded more than once per year.
[d] 98th percentile value averaged over three years.
[e] Three-year average of fourth-highest daily 8-hour maximum.
[f] Standard is attained when the expected number of exceedances is less than or equal to 1.

Note: Standards for particulate matter (<2.5 microns) and for 8-hour ozone are subject to court appeal.

Table 2

AIR POLLUTION EMISSIONS INVENTORY FOR ISLAND OF HAWAII, 1993

Air Pollutant	Point Sources (tons/year)	Area Sources (tons/year)	Total (tons/year)
Particulate	30,311	9,157	39,468
Sulfur Oxides	9,345	nil	9,345
Nitrogen Oxides	4,054	8,858	12,912
Carbon Monoxide	3,357	23,934	27,291
Hydrocarbons	1,477	203	1,680

Source: Final Report, "Review, Revise and Update of the Hawaii Emissions Inventory Systems for the State of Hawaii", prepared for Hawaii Department of Health by J.L. Shoemaker & Associates, Inc., 1996

Table 3

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST KEOPUKA LANDS PROJECT

Parameter / Location	1985	1986
Sulfur Dioxide / Kealakekua, Kona		
Period of Sampling (months)	7	8
No. of 24-Hr Samples	31	40
Range of 24-Hr Values ($\mu g/m^3$)	<5-8	<5-12
Average Daily Value ($\mu g/m^3$)	<5	<5
No. of State AAQS Exceedances	0	0
Particulate / Kealakekua, Kona		
Period of Sampling (months)	7	8
No. of 24-Hr Samples	34	40
Range of 24-Hr Values ($\mu g/m^3$)	6-22	4-28
Average Daily Value ($\mu g/m^3$)	12	16
No. of State AAQS Exceedances	0	0

Source: State of Hawaii Department of Health, "Hawaii Air Quality Data for the Period of January 1985 to December 1987"

Table 4

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS AT SELECTED INTERSECTIONS NEAR KEOPUKA LANDS PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario					
	2000/Present		2015/Without Project		2015/With Project	
	AM	PM	AM	PM	AM	PM
Mamalahoa Highway / Bypass Road at Napoopoo Road	7.9	4.7	10.4	5.5	10.5	5.5
Mamalahoa Highway at Halekii Street	6.4	3.7	6.6	5.1	6.7	5.2
Halekii Street at Bypass Road	-	-	7.6	5.1	7.7	5.1
Kamehameha III Road at Alii Drive	6.1	4.6	11.4	6.3	11.4	6.6

Hawaii State AAQS: 10
National AAQS: 40

Table 5

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS AT SELECTED INTERSECTIONS NEAR KEOPUKA LANDS PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	2000/Present	2015/Without Project	2015/With Project
Mamalahoa Highway / Bypass Road at Napoopoo Road	4.0	5.2	5.2
Mamalahoa Highway at Halekii Street	3.2	3.3	3.4
Halokii Street at Bypass Road	-	3.8	3.8
Kamehameha III Road at Alii Drive	3.0	5.7	5.7

Hawaii State AAQS: 5
National AAQS: 10

Table 6

TYPICAL PESTICIDE PROGRAM FOR AN 18-HOLE
GOLF COURSE IN HAWAII

Chemical Group/Location	Area (acres)	Chemical	Frequency	Application Rate	Annual Total
<u>Herbicides</u>					
Greens	3	MSMA	6 times/yr	2 lbs/acre	36 lbs
		bensulide	2 times/yr	12 lbs/acre	72 lbs
Tees	3	MSMA	6 times/yr	2 lbs/acre	36 lbs
		33 Plus	3 times/yr	1 pint/acre	9 pints
		bensulide	2 times/yr	12 lbs/acre	72 lbs
Fairways	50	MSMA	6 times/yr	2 lbs/acre	600 lbs
		33 Plus	3 times/yr	1 pint/acre	19 gal
		metribuzin	2 times/yr	0.75 lb/acre	75 lbs
Perimeter areas	20	glyphosate	3 times/yr	1.5 lbs/acre	90 lbs
<u>Insecticides</u>					
Greens	3	chlorpyrifos	As needed	1 lb/acre	18 lbs
Tees	3	chlorpyrifos	As needed	1 lb/acre	18 lbs
Fairways	Local	chlorpyrifos	As needed	1 lb/acre	50 lbs
<u>Fungicides</u>					
Greens	3	metalaxyl	As needed	1.3 lbs/acre	25 lbs
		chlorothalonil	As needed	8 lbs/acre	72 lbs
Tees	3	metalaxyl	As needed	1.3 lbs/acre	25 lbs
		chlorothalonil	As needed	8 lbs/acre	72 lbs
Fairways	Local	chlorothalonil	As needed	8 lbs/acre	250 lbs

Source: "Environmental Impact of Fertilizer, Herbicide and Pesticide Use on the Proposed Bayview Golf Course Expansion", Charles L. Murdoch and Richard E. Green, April 6, 1989.

Table 7

DROPLET SIZE RANGE DISTRIBUTION BY VOLUME
FOR FLAT FAN NOZZLE SPRAY EQUIPMENT

Droplet Size Range (microns)	Percent of Total Volume	
	@20 PSI	@40 PSI
0-21	0.1	0.4
21-63	3.0	10.4
63-105	10.7	20.1
105-147	16.2	25.4
147-210	36.7	35.3
210-294	27.5	7.7
>294	5.8	0.7

Source: "Spray Equipment and Calibration", V. Hofman, et al., Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, Report No. AE73, Revised, January 1986.

Table 8

DOWNWIND DISTANCES FOR DRIFT FROM NOZZLE SPRAY EQUIPMENT TO DIMINISH TO 1 PERCENT

Run Number and Comparison	Pressure (PSI)	Wind Speed (mph)	Downwind Distance (ft)
1. Regular flat fan at 14" height	40	3.5	7
1. Regular flat fan at 27" height	40	3.5	13
2. Regular flat fan at low pressure	25	9.9	15.5
2. Regular flat fan at high pressure	40	9.9	17
3. Regular flat fan at 18" height	30	5.3	14
3. Low pressure flat fan at 18" height	15	5.3	11
4. Regular flat fan with thickener	30	8.2	7
4. Regular flat fan w/o thickener	30	8.2	16.5
5. Flooding flat fan at 13" height	10	4.2	5.5
5. Regular flat fan at 18" height	30	4.2	9
6. Raindrop nozzle at 18" height	40	10.3	7
6. Regular flat fan at 18" height	30	10.3	16

Source: "Spray Equipment and Calibration", V. Hofman, et al., Cooperative Extension Service, North Dakota State University, Fargo, North Dakota, Report No. AE73, Revised, January 1986.

Table 9

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM KEOPUKA LANDS PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	3
Sulfur Dioxide	25
Carbon Monoxide	2
Volatile Organics	<1
Nitrogen Oxides	11

[a]Based on U.S. EPA emission factors for utility boilers [2]. Assumes electrical demand of 10 million kilowatt-hrs per year and low-sulfur oil used to generate power.

APPENDIX M

Social Impact Analysis

Keopuka Development

Social Impact Assessment

Prepared for Pacific Star LLC
By Earthplan
May 2000

Contents

Tables and Figures

1. Background and Introduction

1.1. Report Description

Pacific Star Limited Liability Corporation (LLC) proposes to develop land in South Kona on Hawai'i Island. The project triggers the requirement for compliance with Chapter 343, Hawai'i Revised Statutes, regarding the disclosure of environmental impacts. These actions include the use of land within the Conservation District, the use of State land, and use within a Historic District. In accordance with Chapter 343, an Environmental Assessment and Environmental Impact Statement (EIS) Notice of Preparation was prepared in March 2000.

This report contains the social impact assessment conducted as part of the EIS process. It will be summarized in and appended to the EIS.

This social impact assessment was prepared by Earthplan, whose offices are located at 81 South Hotel Street, Suite 211, Honolulu, Hawai'i. Berna Cabacungan, principal of Earthplan, was project manager, and principal analyst, interviewer and writer. Traver Carroll, an independent contractor, provided assistance. Traver assisted with the interviews, gathered census statistics and identified impacts related to public services and facilities.

The remaining portions of this section describe the proposed actions at Keopuka, and discuss the role and purpose of social impact assessments.

Section 2 describes the existing social environment in terms of an historic overview, population trends and demographic information. Section 3 extends the baseline information by exploring what may occur in the region with or without the proposed changes.

Proposed social impacts are described in Section 4 in terms of population changes, impacts on the regional character, and potential impacts on public services and facilities. Community issues are presented and analyzed in Section 5.

1.2. Description of the Proposed Development

The subject property encompasses 660 acres and is identified as Tax May Key 8-1-07: 01, 54 and 55. Extending from east to west from Mamalahoa Highway to the ocean, it is bounded on the north by Onouli 1st and additional land in Onouli 2nd, and by Ka'awaloa to the south. Immediately surrounding lands are unused. Captain Cook is near the project site at the mauka or eastern portion of the project. Kealakakua is approximately one mile north along Mamalahoa Highway.

Currently, most of the project site is vacant, with vehicular access from Mamalahoa Highway. Pedestrian access is available across the project via the State's Old Government Road.

Approximately 30 acres of the most mauka portion of the property is used as a macadamia nut orchard.

The site is approximately 2.2 miles in length from the Mamalahoa Highway to the shoreline. The uppermost portion is narrow (600 feet wide) and begins at the 1,400-foot elevation above mean sea level. The project site widens as it slopes downward, and measures approximately 4,750 feet wide at the shoreline.

Landowner Pacific Star LLC proposes to transform the site into a master-planned agricultural and recreational community. Components of the conceptual master plan are as follows:

- ***Agricultural lots:*** Approximately 125 agricultural lots are proposed. The lots range in size from one to five acres, with the larger five-acre lots located mauka of the future Mamalahoa Highway Bypass Road. Below the bypass road are one to two-acre lots. Generally, the smaller lots are located in the makai-most portions of the site.
- ***Golf course:*** The proposed project includes an 18-hole golf course with uses typical for a golf course including a golf clubhouse, a practice range and a maintenance facility. These uses are located in the lower one-third of the project site, generally below the 375-foot elevation.
- ***Members' Hale:*** Ownership of a lot in the project constitutes membership in a golf course club, and accommodations for members will be provided on-site. Approximately 100 units will be provided in a hale located in the lower portion of the site. This hale will include a lobby, administration offices, dining facilities and related amenities.
- ***Open Space / Conservation District:*** The portion of the project site fronting the ocean is proposed to be maintained as open space to be used for recreational and public access uses, such as fishing.

Public access to and along the shoreline will be provided, including vehicular access, parking, restrooms, and shoreline trail improvements. Specific improvements will be developed in ongoing discussions with State and County officials.

1.3. The Role and Purpose of Social Impact Assessments

The social aspects of an area relate to people living and interacting with other people. Social impact analysis explores how the physical environment of a community or neighborhood may be changed by a proposed land development, and how these changes may affect the neighborhood as a social environment.[1]

Social Impact assessment, hereafter referred to as SIA, became a recognized subfield of research and policy application, with the passage of the U.S. National Environmental Policy Act (NEPA) legislation in 1969.[2] It is an interdisciplinary, inter-professional field of social science knowledge and application. SIA draws sometimes from social science, but other times from organizational development, political analysis, or journalism. Its primary function has to do with the development and disclosure of social information relevant to informing the decision-making process and/or designing management actions to deal with problematic social outcomes of a proposed project.

The goal of SIA is to predict the social effects of a policy, program or project while still in the planning stage, before those effects have occurred. The overall framework for SIA is anticipatory research, which seeks to place the expectation and attainment of desired outcomes on a rational and reliable basis.

Commonly identified uses of SIA include:

Understanding the ability of a community or group to adapt to changing conditions - In identifying social consequences of a proposed action, cause-and-effect relationships are complex. Different people and different communities react differently to similar events. An important function of SIAs is therefore to obtain and analyze the necessary information about community organization and likely responses to changing conditions. As such, the non-project social scenario is as important as the with-project scenario because it provides the analyst with a realistic social context for the proposed action.

Defining the problems or clarify the issues involved in a proposed change - Frequently, opposition to or support for a proposed project can only be understood and addressed when the proponent is aware of cultural tendencies, underling issues, vested interests, and misperceptions. The SIA is the basis for defining and clarifying project or program issues in a systematic approach within the EIS framework.

Illuminating the meaning and importance of anticipated change - An important objective of SIA is to determine what meaning a probable impact would have for a community and its residents. Whereas a certain impact may have relatively low social significance in some communities, it may be given more import or significance in other settings or communities.

[1] *Kathleen Christiansen, **Social Impacts of Land Development: An Initial Approach to Estimating Impacts on Neighborhood Usages and Perceptions** (1976)*

[2] *Rabel Burdge and Frank Vanclay, "Social Impact Assessment," **Environmental and Social Impact Assessment**, ed. Frank Vanclay and Daniel A. Bronstein (1996), 34.*

Identifying mitigation opportunities or requirements - Another function of SIA is to explore how a proposed action can cause the least adverse and most beneficial impacts, and to identify responses from the community and affected persons. SIA information can be crucial in determining what mitigation is necessary, what mitigation alternatives exist, and which mitigation strategies are most likely to work.

2. Profile of the Existing Community

This section establishes the social context for this project. Section 2.1 provides a brief overview of the history of the region. Section 2.2 describes the Study Area. In Section 2.3, population and demographic information is presented.

2.1. Brief Overview of the Region's History [3]

In prehistoric and early historic times, the Kealakekua Bay area was home of several ali'i, and was a traditional Hawaiian religious center. Ka'awaloa, located south and adjacent to the project site, is the resting place of the father of Kamehameha I, Keoua, as well as of other chiefs. The region was populous and the land productive. Within the various ahupua'a, fishing and gathering occurred along the coastline, and intensive agriculture occurred as allowed by the chief or the konohiki. Traditional agricultural productivity was enhanced by adapting the crops and practices to the land and climate conditions of each ahupua'a.

In 1779, Captain James Cook landed his ship off the coast of Ka'awaloa. His crew fought with the local inhabitants along this shore and, after he was killed, his body was hidden among the cliffs of Ka'awaloa. Monuments have been erected in the area.

In the early 1800s, with the new foreign visitors and residents came a shift in agricultural crops and practices and in the economy. Non-traditional crops, including cabbage, onions, oranges, melons and tobacco began dotting the landscape. By 1850, local subsistence farming had shifted to a market economy with the further introduction of beans, coffee, corn, cotton, pineapple and pumpkin. These new crops were often cultivated within the field system used by traditional agriculture.

Kiawe and koa haole were introduced to the region in the early 1800s, and these helped to alter the Kona landscape by contributing to coastal forest development. The development of new roads and trails, as well as the improvement of those already in existence, also affected land uses in the region.

As more foreigners moved to Hawai'i, there were conflicts between the native Hawaiian concept of relationship to the land and western land-holding concepts of fee simple, lease and transfers. Kamehameha III and the Council of Chiefs developed a series of agreements on land ownership beginning in 1948. The kin and chiefs separated their interests in certain lands and established their

[3] *Unless otherwise noted, History is excerpted from **Archaeological Inventory Survey and Limited Subsurface Testing of a 500-acre parcel in the Ahupua'a of Keopuka, District of South Kona, Island of Hawai'i** prepared by Cultural Surveys Hawaii (March 1995), 15 - 31.*

interests in others. In the process, divisions and allocations were validated by a series of Land Commission Awards and patents. The rights and interests of the commoners were recognized through Kuleana grants, and the Land Commission also validated land holdings of foreigners that had been previously awarded or sold. In South Kona, this meant new foreign residents and their heirs owned and controlled the majority of lands. [4]

While the new landowners built their homes near prime agricultural lands and along the mauka roads, many of the traditional coastal settlements were abandoned. The population declined. Census data from 1835 indicate a population of 462 persons in Keopuka and Ka'awaloa, which accounts for slightly less than ten percent of the South Kona population of 4,997 persons. By 1860, the South Kona total population decreased to 2,683 persons, which suggests that the Keopuka and Ka'awaloa population may also have been decreased by half.

The Greenwell family established itself in the region in the 1800s, and built a store in 1875 in Kalukalu to sell merchandise. Until this time, stores and warehouses were located along the seashore at the ports of Kailua, Keauhou, Napo'opo'o, and Ho'okena. In addition to a merchandise store, the Greenwell Store served as the community meeting place and post office. [5]

In the early 1900s, cattle ranching became a dominant activity in the marginal lands of the Kealakekua region. The Greenwell family operated four dairies that produced butter that was shipped to Honolulu to be sold.

In the agriculturally productive lands above Kealakekua Bay, pineapple, sugar, tobacco and coffee were cultivated. By 1920, coffee was the dominant commercial crop and the Captain Cook Coffee Company, or CCCC, was headquartered in Ka'awaloa. Eventually, the village took the name of the company.

"Kona coffee" eventually developed its own reputation, and the region became one of the few areas where public schools were scheduled around the coffee-picking season. [6] Generally planted 500 to 2,500 feet above sea level in mostly rocky soil, Kona coffee's unique flavor comes from its growing conditions.

The regional ethnic composition evolved as the Chinese, Portuguese, and Japanese laborers left the sugar plantations to sublease coffee lands. Eventually, these farmers settled in the South Kona region and continued to grow coffee.

By 1940, those of Japanese ancestry comprised the majority of the population, and Native and part Hawaiians accounted for only a quarter of the population.

[4] *Pulama la Kona Heritage Preservation Council, **Kona Heritage Corridor Feasibility Report** (July 1999), 13.*

[5] *Kona Historical Society, **A Guide to Old Kona** (1998), 48.*

[6] *Scott Stone, **The Island of Hawaii from Sail to Space** (1997), 84.*

The coast of Ka`awaloa was closed down by the military after the Japanese invasion of Pearl Harbor. Ka`awaloa was purchased by the State of Hawai`i for the Kealakekua Bay State Historical Park and Kealakekua Bay was designated a Marine Life Conservation District in 1969.

2.2. Study Area Definition

The project area is located in the South Kona District. The Study Area includes the South Kona District, as well as the southern most portion of North Kona. The following identifies communities within the Study Area:

- The area generally including Kahalu`u - Keauhou is included in Census Tract 215.98, and is part of the North Kona District.
- Kainaliu comprises Census Tract 215.97, and is also part of the North Kona District.
- Part of the South Kona District, Kealakekua and Captain Cook are included in Census Tract 214, which also includes the project site.
- Census Tract 213 includes Kealakekua Bay and the mauka area to the Rift Zone at Mauna Loa and extends south past Miloli`i.

Figure A illustrates the Study Area of this report.

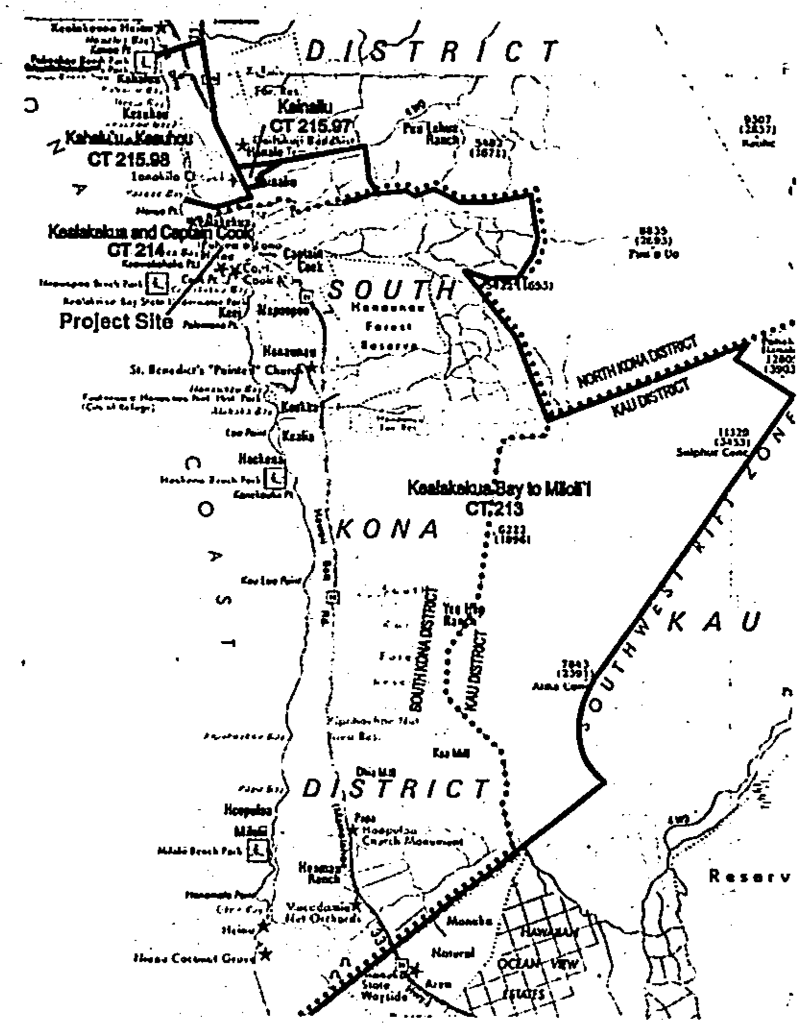


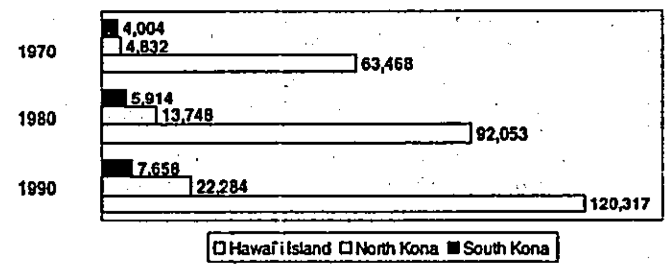
Figure A: Study Area

2.3. Population Trends and Demographics

2.3.1. Population Trend

Hawai'i Island population has steadily increased between 1970 and 1990. The island's population grew from approximately 63,000 in 1970 to 92,000 in 1980 to 120,000 in 1990, as illustrated in Figure B.

Figure B: Resident Population Trend for Hawai'i Island, North Kona and South Kona: 1970 to 1990



On the average, these population counts represent an annual 3.8 percent increase between 1970 and 1980, and a 2.7 percent increase between 1980 and 1990.

The population growth in North Kona was much more pronounced than that of the overall County. Its population almost tripled from 1970 to 1980, from approximately 4,800 to 13,748 persons, which implies an average annual growth rate of eleven percent during that decade. Growth slowed between 1980 and 1990 in North Kona, during which time the population increased to 22,300 persons. This represents an average annual growth rate of five percent.

The population of South Kona experienced steady, and relatively slow growth between 1970 and 1990. The increase from 4,000 to 5,900 persons between 1970 and 1980 implies an average annual growth rate of four percent. Between 1980 and 1990, the rate of growth decreased to 2.6 percent when the population increased to 7,700 persons.

2.3.2. Age and Ethnicity

In 1990, 10,851 people lived in the Study Area. Almost half of this population, or 5,000 persons, lived in the area extending from Kealakekua Bay - Miloli'i. The smallest population was in Kainaliu, with 104 persons in 1990.

As shown in Table 1, the median age of Hawai'i County was 34.3 years in 1990. Of the total population, 29 percent were under the age of 18 years. About 59 percent of the islandwide population were in the work force age category of 18 to 64 years, and 13 percent were 65 years or older.

As a whole, the Study Area mirrored the age breakdowns of the overall County. There were differences within the individual communities, however. Kainaliu tended to be the oldest community, with only 17 percent 18 years and younger. Further, 32 percent of the population were elderly. Kainaliu had the highest median age at 43.5 years.

The youngest region in the Study Area was the Kealakekua Bay - Miloli'i region. Almost a third of the population was 18 years and younger, and only nine percent was in the elderly category. The median age for this region was 33.1 years.

The largest ethnic category in Hawai'i County was Caucasian, which accounted for 40 percent of the total population. Japanese and Hawaiians made up, respectively, 21 and 19 percent of the population.

Table 1: Age and Ethnicity, 1990

Kahalu'u - Keauhou are in Census Tract 215.98.

	Hawai'i County	Total Study Area	Kahalu'u and Keauhou	Kainaliu	Kealakekua to Captain Cook, Inc. project site	Kealakekua Bay to Miloli'i Inc. mauka to Rift Zone
POPULATION	120,317	10,851	3,089	104	2,660	4,998
AGE						
Under 5	8%	8%	6%	4%	8%	9%
5 to 17	21%	20%	17%	13%	20%	23%
18 to 44	40%	40%	38%	36%	36%	43%
45 to 64	19%	19%	21%	15%	22%	16%
65 or more	13%	13%	17%	32%	15%	9%
Median age (in years)	34.3	NA	38.6	43.5	37.6	33.1
ETHNICITY						
Caucasian	40%	45%	61%	34%	27%	45%
Japanese	21%	20%	14%	44%	41%	12%
Hawaiian	19%	21%	15%	11%	15%	26%
Filipino	13%	9%	5%	7%	12%	9%
Other	7%	5%	5%	5%	5%	6%

Kainaliu is in Census Tract 215.97.
The area from Kealakekua - Captain Cook is in Census Tract 214 and includes the project site.
The area from Kealakekua Bay - Miloli'i is in Census Tract 213.
Source: U.S. Bureau of the Census, 1992, 1991.

The overall Study Area differed from this ethnic profile. Caucasians made up 45 percent of the total population, and the second largest category was Hawaiian at 21 percent. Those of Japanese ancestry accounted for 20 percent of the population.

Within the Study Area, Caucasians comprised the majority of the population in Kahalu'u - Keauhou (61 percent), and 45 percent of the Kealakekua Bay - Miloli'i region. Japanese was the largest category in Kainaliu (44 percent) and Kealakekua - Captain Cook (41 percent). The largest proportion of Hawaiians was found in the Kealakekua Bay - Miloli'i area (28 percent).

2.3.3. Education and Residential Stability

Of Hawai'i County residents 25 years and older, 31 percent completed high school, and another 19 percent attended higher education but did not receive a college degree or certificate. Another 28 percent received a college degree or certificate, as shown in Table 2.

Table 2: Education and Previous Residence

	Hawai'i County	Total Study Area	Kahalu'u and Keauhou	Kainaliu	Kealakekua to Captain Cook, Inc. project site	Kealakekua Bay to Miloli'i Inc. mauka to Rift Zone
EDUCATIONAL ATTAINMENT (25 years and older)						
High school graduate (1)	31%	32%	26%	22%	38%	33%
Some college (2)	19%	21%	25%	42%	18%	20%
College degree (3)	28%	29%	34%	14%	26%	29%
RESIDENCE IN 1985 (5 years and older)						
Same county, same house	53%	48%	45%	24%	61%	42%
Same county, different house	26%	29%	27%	49%	24%	34%
Different county	7%	5%	5%	27%	2%	7%
Different state	12%	16%	23%	0%	7%	16%
Different country	2%	2%	1%	0%	5%	1%

See Table 1 for Census Tract information and source.
(1) Includes persons with a high school diploma.
(2) Persons with some college but no college degree or certificate
(3) Includes persons with an Associates, Bachelors, graduate or professional degree

Generally, the overall Study Area population had similar educational achievements. Within the individual areas, the highest proportion of those completing high school and not pursuing higher education was found in Kealakekua - Captain Cook, with 38 percent in this category. Kahalu'u - Keauhou had the highest proportion of college graduates at 34 percent.

An indicator of residential mobility and stability is information about a person's residence five years prior to the 1990 census. Statistics indicate that about 53 percent of Hawai'i County's population resided in the same house in 1985. Seven percent had lived on another island, twelve percent had lived in another state, and two percent had lived in another country in 1985.

In the overall Study Area, less than half the population (48 percent) had lived in the same house in 1985, indicating a higher level of in-migration than Hawai'i Island. Sixteen percent had in-migrated to the Study Area from another state.

The highest level of in-migration was found in Kainaliu where only 24 percent had lived in the same house in 1985. Almost half of the area's residents had lived in another part of Hawai'i Island in 1985.

In-migration was also high in the Kealakekua Bay - Miloli'i region. Only 42 percent had lived in the same house in 1985, and another 34 percent had lived in another part of Hawai'i Island.

The highest level of in-migration from another state was found in Kahalu'u - Keauhou, where 23 percent of the population had lived in another state in 1985.

2.3.4. Household Information

The average size of Hawai'i County's 41,461 households was 2.86 persons in 1990, as shown in Table 3.

Table 3: Household Characteristics, 1990

	Hawai'i County	Total Study Area	Kahalu'u and Keauhou	Kainaliu	Kealakekua to Captain Cook, Inc. project site	Kealakekua Bay to Miloli'i Inc. mauka to Rift Zone
TOTAL HOUSEHOLDS (1)	41,461	3,766	1,142	33	937	1,654
Persons per household	2.86	2.88	2.63	2.67	2.83	3.01
Crowded households (2)	12%	15%	10%	6%	12%	21%
Median household income	$29,712	NA	$36,118	$40,469	$36,563	$29,617
FAMILY HOUSEHOLDS	30,235	2,739	821	24	712	1,182
As % of total households	73%	73%	72%	73%	76%	71%
Married-couple families	78%	79%	81%	75%	82%	77%
Median family income	$33,186	NA	$40,990	$41,250	$42,075	$32,333
Families below poverty level	11%	8%	6%	0%	2%	13%

See Table 1 for Census Tract information and source.
(1) Equivalent to the total number of occupied units.
(2) Defined as more than one person per room.

In the overall Study Area, the average household size was slightly larger, with 2.88 persons per household. The variations among the individual areas ranged from 2.63 persons per household in Kahalu'u - Keauhou to 3.01 persons in the region from Kealakekua Bay - Miloli'i.

Twelve percent of the islandwide households were considered crowded, as defined by the 1990 census.[7] In the Kealakekua Bay - Miloli'i region, there was a greater tendency towards crowded households; 21 percent of the total households were considered crowded. In contrast, only six percent of the households in Kainaliu met the crowded definition.

The 1990 islandwide median household income was $29,712. The median household income in the Study Area ranged from a low of $29,617 in the Kealakekua – Miloli'i region to a high of $40,469 in Kainaliu.

Seventy percent of the total households in Hawai'i County and the Study Area were family households. Within the Study Area, the Kealakekua - Captain Cook

[7] *Defined as more than one person per room.*

area had the highest family orientation, with family households comprising 76 percent of the total households. The lowest proportion of family households (71 percent) was in the Kealakekua Bay – Miloli'i region.

The 1990 islandwide median family income was $33,186. In the Study Area, the family median income ranged from a low of $32,333 in the Kealakekua – Miloli'i region to a high of $42,075 in Kealakekua – Captain Cook.

In 1990, eleven percent of Hawai'i Island's families had incomes below the poverty level. The Study Area's proportion of families below poverty level was lower at eight percent. The highest proportion was in the Kealakekua Bay – Miloli'i region, where 13 percent of its families were in this category.

2.3.5. Labor Force Characteristics

In 1990, approximately 90,000 persons were 16 years and older and therefore were part of Hawai'i County's potential labor force. Only 0.2 percent of the potential labor force were in the armed forces, and 64 percent participated in the civilian labor force. Table 4 contains labor force information.

Non-participants in the labor force are those who are not part of the labor force due to illness, injury, lifestyle choice or other reason. Such persons are not considered unemployed. Countywide, 36 percent of those 16 years and older did not participate in the labor force. Generally, the Study Area had an overall lower non-participation rate.

Within the Study Area, the potential labor force was very small in Kainaliu. Only 36 people, out of a total population of 104, comprised the potential labor force, and more than half of these did not participate in the labor force.

Non-participation in the labor force was also high in Kahalu'u – Keauhou, with 41 percent in this category.

In 1990, unemployment was higher in the Study Area than in Hawai'i County, which had an unemployment rate of 4.6 percent. In the Study Area, unemployment was 5.6 percent in 1990, with the highest rates in Kealakekua – Captain Cook and Kealakekua Bay – Miloli'i, both of which had a rate of 6.1 percent.

In terms of types of occupation, the largest category of occupation in the islandwide civilian labor force was the service category, which made up 30 percent of the total count. Managerial and professional occupations was the second largest category at 24 percent, followed by technical / sales and precision / craft, of which both were at 15 percent.

Table 4: Labor Force Characteristics

	Hawai'i County	Total Study Area	Kahalu'u and Keauhou	Kainaliu	Kealakekua to Captain Cook, inc. project site	Kealakekua Bay to Miloli'i inc. mauka to Rift Zone
POTENTIAL LABOR FORCE (1)	88,999	8,012	2,342	36	2,073	3,561
Civilian labor force (2)	64%	68%	58%	42%	67%	74%
Armed forces	0%	0%	0%	0%	0%	0%
Not in labor force	36%	32%	41%	58%	33%	26%
CIVILIAN LABOR FORCE (2)	56,986	5,414	1,370	15	1,398	2,631
Unemployed	4.6%	5.6%	4.4%	0.0%	6.1%	6.1%
EMPLOYED CIVILIAN LABOR BY OCCUPATION						
Number of people	54,348	5,109	1,310	15	1,313	2,471
Managerial & professional	24%	28%	32%	0%	28%	27%
Technical & sales	15%	14%	17%	0%	17%	12%
Service	30%	24%	26%	47%	32%	18%
Farming & fishing	6%	13%	7%	0%	2%	21%
Precision & craft	15%	14%	14%	53%	14%	13%
Transportation	4%	4%	3%	0%	4%	5%
Operators & laborers	5%	3%	1%	0%	4%	4%
MEAN COMMUTE TO WORK (in minutes)						
	20.8	22.1	15.5	30.3	17.2	28.2

See Table 1 for Census Tract information and source.
(1) All persons 16 years and older
(2) Persons 16 years and older who are part of the labor force but not in the armed force.

In the overall Study Area, the largest category of occupation was managerial and professional, which made up 28 percent of total occupations. Service was the second largest at 24 percent, followed by technical / sales and precision / craft, of which both were at 14 percent.

Managerial and professional occupations made up the largest category in Kahalu'u – Keauhou (32 percent), and Kealakekua Bay – Miloli'i (27 percent).

Whereas farming and fishing occupations made up a small proportion of occupations in Kahalu'u – Keauhou (seven percent) and Kealakekua – Captain Cook (two percent), they accounted for 21 percent of occupations in Kealakekua Bay – Miloli'i.

In Hawai'i County, the mean travel time to work was 20.8 minutes. Residents in Kahalu'u – Keauhou and Kealakekua – Captain Cook tended to live near their place of work, with mean travel times of 15.5 and 17.2 minutes, respectively. Kealakekua Bay – Miloli'i residents spent an average of 28.2 minutes in commuting time.

2.3.6. Housing Units

In 1990, there were 48,253 housing units in Hawai'i County, of which 14 percent were reported vacant. Of the 4,878 units in the Study Area, 23 percent were vacant in 1990, as shown in Table 5.

Table 5: Housing Unit Characteristics, 1990

	Hawai'i County	Total Study Area	Kahalu'u and Keauhou	Kainaliu	Kealakekua to Captain Cook, Inc. project site	Kealakekua Bay to Miloli'i Inc. mauka to Rift Zone
TOTAL HOUSING UNITS	48,253	4,878	1,912	38	1,003	1,925
Vacant units	14%	23%	40%	13%	7%	14%
TYPE OF UNIT						
Single-family (1)	79%	73%	49%	63%	84%	91%
Multi-family (2)	19%	25%	50%	34%	15%	6%
Other (3)	2%	2%	1%	3%	1%	3%
OCCUPIED UNITS						
Owner-occupied	61%	56%	57%	52%	58%	55%
Renter-occupied	39%	44%	43%	48%	42%	45%
Median Value of Owner-Occupied Unit	$113,000	NA	$267,000	$175,000	$178,300	$167,400
Median Rent of Renter-Occupied Unit	$428	NA	$674	$425	$350	$415

See Table 1 for Census Tract information and source.
(1) Includes both stand-alone detached and duplex units.
(2) Includes townhouses and apartments.
(3) A non-conventional dwelling, such as a trailer or mobile home.

Kahalu'u – Keauhou had a significantly high housing unit vacancy rate at 40 percent. Much of this is due to the presence of second homes that are not occupied throughout the year. A significantly low vacancy rate was found in the Kealakekua – Captain Cook region, where only seven percent of the units were vacant at the time of the 1990 census taking.

The islandwide housing stock was dominated by single-family homes, which accounted for 79 percent of the total units. Proportionally, slightly less (73 percent) were single-family units in the Study Area housing stock.

The largest proportion of single family units was in the rural area of Kealakekua Bay – Miloli'i, where 91 percent were in this category. Single family units also dominated the housing stock in Kealakekua – Captain Cook (84 percent).

Kahalu'u – Keauhou had proportionally more multi-family units, which made up half of the total units. Single family units accounted for 49 percent, and non-conventional units made up one percent.

The Study Area tended to have more renters than the islandwide community. In 1990, 39 percent of Hawai'i County's units were renter-occupied, as compared to 44 percent in the Study Area. Within the Study Area, the highest proportion of

renters was in Kainaliu (48 percent), and the lowest was in the Kealakekua – Captain Cook region (42 percent).

The owner-occupied units tended to have higher values than the islandwide housing stock, of which the median value of owner-occupied units was $113,000 in 1990. The Study Area owner-occupied units had median values ranging from $167,000 in Kealakekua Bay – Miloli'i to a high of $267,000 in Kahalu'u – Keauhou.

The 1990 islandwide median rent was $428. In the Study Area, the 1990 median rent ranged from a low of $350 in Kealakekua- Captain Cook to a high of $674 in Kahalu'u –Keauhou.

3. Major Forces for Change

This section identifies forces for change in the Study Area that are independent of the proposed project. The information extends the baseline information on the existing communities by exploring the type of change directed by public policy. The potential social impacts of the project can then be weighed against this "no-action" scenario. Section 3.1 discusses major County-wide projections, and Section 3.2 presents plans that guide the future of the Study Area. Section 3.3 discusses specific projects that potentially may change the Study Area.

3.1. Projections and Public Plans

3.1.1. Population Projections

The State Department of Business, Economic Development and Tourism, hereafter referred to as DEBDT, publishes long-range population and economic projections. The projections provide policymakers, the business sector and the public with a base scenario for growth and change of the State's economy and population over the next 25 years. They do not represent preferences for the future.

The most recent set of forecasts is part of the updated DEBDT 2020 services published in 1999. These replaced the M-K series that was first released in 1988.[8]

Selected DEBDT 2020 Series forecasts for Hawai'i County are contained in Table 6. The 2020 Series project that Hawai'i County's population could reach 149,600 persons in 2000, and would increase 16 percent within the next decade for a 2010 population of 173,900. This translates into an average annual growth rate of 1.5 percent. Between 2010 and 2020, the population is projected to increase about 18 percent and reach 205,400 persons, for an annual average growth rate of 1.7 percent. Between 2020 and 2025, the average annual growth rate is projected to decrease to 1.4 percent.

[8] *While this series is valuable in indicating possible trends, long-term projections and forecasts need to be considered in their proper perspectives. Long-term forecasts are not intended to predict economic measures for a specific time frame, such as population in a given year, or to forecast prevalent business cycles. Rather, long-term projections are valuable because they help us understand likely overall trends and patterns over many years.*

Table 6: Selected DEBDT 2020 Series Forecasts for Hawai'i County, 2000, 2010, 2020, 2025

	Year			
	2000	2010	2020	2025
Resident population	149,600	173,900	205,400	220,100
Percent change		16.2%	18.1%	7.2%
Average annual growth rate		1.5%	1.7%	1.4%
Average visitor census	22,500	33,700	46,400	51,300
Percent change		49.8%	37.7%	10.6%
Average annual growth rate		4.1%	3.2%	2.0%
Total civilian jobs	62,500	74,000	88,900	94,700
Percent change		18.4%	20.1%	6.5%
Average annual growth rate		1.7%	1.9%	1.3%

Source: State Department of Business, Economic Development and Tourism, 1999.

The average visitor census is projected to increase by almost 50 percent between 2000 and 2010, from 22,500 to 33,700. This represents an average annual increase of about four percent. Between 2010 and 2020, the average daily visitor census is projected to increase to 46,400, which is a 38 percent increase and approximately three percent a year. As with the resident population, the annual rate of growth of the average visitor census is expected to decrease between 2020 and 2025.

The 18 percent growth in civilian jobs from 62,500 in 2000 to 74,000 in 2010 is more modest than the visitor industry growth, but still reflects a fairly robust near-term economic future.

3.1.2. West Hawaii Regional Plan

In 1989, the Office of State Planning produced the West Hawaii Regional Plan to 1) coordinate State activities in responding to emerging needs and problems; 2) address State concerns; 3) coordinate the Capital Improvement Program in a regional planning framework; and 4) provide guidance in the State's decision-making process.

The plan focuses on North Kohala, South Kohala and North Kona. Four resort destination zones are delineated, with the closest being the Keahole – Keauhou Node.

In this context, South Kona was viewed as a secondary support community. The plan recognized the rural nature of this region, and that the region will continue to house many of West Hawai'i's work force. No specific action was proposed for South Kona.[9]

[9] *Office of State Planning, West Hawaii Regional Plan (1989), 20 – 23.*

3.1.3. State Land Use Boundary Review

In 1992, the Office of State Planning, or OSP, conducted a statewide policy-oriented examination of land use district classifications. The Five-Year Boundary Review allows the State Land Use Commission to review urbanization proposals in the context of a comprehensive planning horizon, rather than attempting to evaluate the merits of isolated cases.

As part of the review process, OSP comprehensively analyzed urban areas. It gauged the sufficiency of urban-zoned lands and the ability of those lands to deal with expected population and economic growth. Table 7 presents the Boundary Review's population projections derived from the earlier discussed M-K projections.[10]

Table 7: Five-Year Boundary Review Population Projections

	2000	2010
Hawai`i County	160,400	206,100
North Kona	35,700	52,600
South Kona	9,100	10,700

North and South Kona's combined population growth is estimated at 49 percent between 1990 and 2000, and 41 percent between 2000 and 2010. These figures tend to be somewhat high due to being based on the optimistic 1988 M-K Series. Nevertheless, it is clear that the state expects strong population growth pressures on the North Kona District over the next decade.

Growth in the South Kona region is expected to be modest, with a projected 17 percent increase between 2000 and 2010. This implies an average annual growth rate of 1.6 percent, which is lower than the 2.6 percent annual growth rate experienced from 1980 to 1990.

The only recommendations in the South Kona District are to add approximately 3,800 acres to the South Kona Forest Reserve, specifically at Honomalino, Oleomoana, and Kaohe – Kukuiopae.

3.1.4. Hawai`i County General Plan

First established in 1971, the Hawai`i County General Plan provides the legal framework for all subdivision, zoning and related ordinances on the island, and for the initiation and authorization of public improvements and projects. The General Plan was last updated in 1989, and a draft of the most recent update was in preparation at the time of this writing.

The current General Plan envisions increased agriculture while limiting urbanization in the distinctly rural South Kona. Only low-key, centralized

[10] *Office of State Planning, State Land Use District Boundary Review: Hawaii (1992), 235.*

industrial development is planned for the region, and the General Plan also calls for small family-operated resort facilities.

The public direction for North Kona is different. The Plan encourages new industries throughout the district, and advocates further development of diversified agriculture and aquaculture and the protection of the Kona coffee belt.

3.2. Development Projects

Given the rural nature of the South Kona portion of the Study Area, there is little development activity, particularly as compared to North Kona. The Hokuli`a planned community, previously known as The Villages at Hokukano, is currently under construction. The 1,540-acre project site is located north of the proposed Keopuka development. The project is a residential community comprising 730 units on large lots ranging in size from one to three acres. It includes a 27-hole golf course with a golf clubhouse, related facilities and infrastructure improvements.

A related change in the region is the proposed Mamalahoa Highway Bypass Road, which would bisect the mauka portion of the site for the proposed Keopuka development. The landowner / developer of Hokuli`a has proposed to construct an alternative route for interregional traffic between Kealakekua and the Keauhou – Kailua – Kona region. This bypass road is intended to relieve congestion along the existing roadway corridor between Honalo and Captian Cook, and to improve transportation efficiency and safety in the region. The project is also intended to help fulfill the County's long-range transportation plans for the region, as directed by the Hawai`i County General Plan. Because a small 2,500-foot portion of the corridor is in the Special Management Area, or SMA, the landowner submitted a petition for a SMA Use Permit in January 2000.[11] The petition was granted in May 2000.

[11] *PBR Hawaii, Mamalahoa Highway Bypass Road Special Management Area Use Permit (January 2000).*

The only other proposed development project in the vicinity of the project site is the Kealakekua Bay Club. The project site is located on the pali above Kealakekua Bay. The developer, Royal Coast Development Corporation, proposed 37 lots and an 18-hole golf course. An SMA Use Permit was issued in 1987 and rezoning from Agriculture – 5 to Residential / Agriculture – 3 and Residential / Agriculture – 4 occurred in 1988.[12] The project is deferred indefinitely.

[12] *Personal communication with Pam Harlow of the Hawai'i County Planning Department on 8 May 2000.*

4. Potential Social Impacts

This section presents social impacts that may occur in the Study Area due to the proposed development at Keopuka. Population impacts are presented in Section 4.1. Impacts on the regional character are discussed in Section 4.2. Potential impacts on public services and facilities are identified in Section 4.3.

4.1. Population Impacts

The proposed development at Keopuka will affect the population in the region by adding residents and generating short and long-term employment.

On a short-term basis, the project will generate 2,352 full-time equivalent worker years of employment over a 15-year period. It is expected that construction employees will be Hawai'i Island residents and that no in-migration will be required to fill these employment positions.

The long-term on-site de facto population includes permanent and part-time residents, members hale guests and on-site employees, as follows:[13]

- **On-site resident population**

  At full build-out, the total residential population of the proposed project could theoretically house 360 persons, based on 125 units and the Study Area average household size of 2.88 persons. This assumes full occupancy of the on-site residences.

  The project is designed as a second-home community, however, and only a very small proportion of the homes will house permanent residents. At full build-out, 26 permanent residents are projected.

  On the average, another 52 part-time residents may reside on-site temporarily.

  The total average resident population is therefore estimated at 78 persons.

- **Members hale guests**

  It is estimated that, on the average, 133 guests may be staying in the members hale at any given time.

[13] *Project-related population estimates were prepared by The Hallstrom Group and are presented in **Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment of the Proposed Keopuka Lands Development, Keopuka, South Kona, Hawaii (June 2000).***

- On-site operational employment

  Long-term operational jobs are estimated at 137 full time equivalent positions. These jobs would be related to the members hale, golf course operations, and home maintenance.

The estimated on-site de facto population is therefore estimated at 348 persons.

The additional resident population is less than the de facto population, however. The on-site employees are expected to be Hawai'i residents, and no in-migration will be necessary to fill the jobs. The additional population is estimated at 211 persons, which includes the residents and members hale guests.

This addition of 211 persons would comprise a very small proportion of the population of South Kona and the Study Area. The population projection for South Kona, based on the five-year Boundary Review projections prepared by State, is 10,700 persons. At full build-out, the project-related additional population would account for less than two percent of the total population.

Because this increase is not a significant addition to the population, no population-related mitigation is necessary.

4.2. Impacts on the Regional Character

The regional character of the Study Area shifts from a relatively urban and suburban environment in the Kahalu'u – Keauhou area in the northern portion of the Study Area to a rural agricultural atmosphere as one moves south.

This section discusses possible social impacts related to the implementing the proposed project in this environment. Section 4.2.1 looks at the project's relationship to public policies for the region, and Section 4.2.2 discusses impacts related to the nature of the proposed development.

4.2.1. Direction Set Forth By Public Policies

State and County public policies clearly advocate maintaining the rural and agricultural character of the South Kona District. While robust growth is anticipated for Hawai'i County, and further urban and resort development is anticipated for the South Kohala and North Kona regions, South Kona continues to be viewed as rural. Its present character of small towns and villages, single family homes, mauka and makai agricultural lands and expanses of undeveloped shoreline is to be retained.

The proposed project is consistent with this direction contained in public policies. Its density is very low, and agriculture can occur as appropriate. The predominant landscape will be open space related to the proposed golf course

and the undeveloped and agricultural portions of the individual lots. Further, the shoreline will remain in open space.

4.2.2. The Nature of the Proposed Development

While the proposed project at Keopuka is consistent with the overall direction set forth in public policies, it possesses two characteristics that will distinguish Keopuka from the character of most of South Kona, as follows:

- The project will introduce more out-of-state newcomers to the region. Demographically, the Study Area has a fairly stable population in that almost half of the residents had lived in the same house five years prior to the 1990 census. When there was in-migration, the new residents tended to originate from Hawai'i Island. Only the Kahalu'u – Keauhou region experienced significant in-migration from another state.
- The project will be an upscale gated community featuring a golf course. The only other similar community will be Hokuli'a, which is currently under construction. While the Study Area tended to have median housing values higher than the islandwide median housing value, most of the communities had medians within $70,000 of the islandwide median. The only community that significantly exceeded the islandwide median was Kahalu'u – Keauhou, whose median was more than twice the islandwide median.

To some extent, the introduction of more newcomers from out of state will be consistent with current real estate trends. Hawai'i Island has been experiencing an upswing in real estate sales. Vacant land sales have increased by more than 50 percent, and home sales by 65 percent. This trend has diminished the housing supply around the island. Many of the buyers are professionals in the West Coast high-tech industries looking for a second home.

While sales in South Kona have not been at the 40+ percent levels of North and South Kohala, the region experienced a seven-percent increase in home sales for the first four months of 2000. [14]

Further, the gated, upscale nature of Keopuka will be similar to existing and planned communities further north and will not be an entirely new element to the region.

Hence, while the in-migration of newcomers and the upscale community are not unique additions to the region, the project locates these elements further south. It introduces typically urban features, such as gates, on-site security, and restricted access. While the community will feature acres of open space, these spaces may differ from rural agricultural ambiance of much of the region in that on-site open space will be well-manicured landscaped lawns and a golf course.

[14] *Hugh Clark, "Big Island home, land sales surge," The Honolulu Advertiser (May 15, 2000), B-1.*

From a social perspective, these factors may contribute to the potential for social conflicts due to economic disparities between the existing and future communities.

Social conflict may be avoided, however, if there is successful social integration on a regional level. While the newcomers need to be able to adjust to the values and mores of the host community, the existing residents also need to help the more recent residents assimilate into the community. This scenario of mutual adjustment and acceptance is very likely, in that it has already been occurring. According to those interviewed, although there are some newcomers who have not been able to adjust to local ways, many have made meaningful contributions to community efforts.[15]

Another way to encourage social integration is to include measures in the project that will directly benefit the community. These measures may include contributions such as park and school improvements, and should be developed with the community. Like the scenario of mutual adjustment and acceptance, project-related community benefits have proven to help the community accept a new development. A recent example is Hokuli'a, whereby the developer has been working with the local residents for several years and has contributed to several community efforts.

4.3. Impacts on Public Services and Facilities

4.3.1. Police Protection Services

The Kona Police Station, which serves both the North and South Kona Districts, is located north of the project site on Queen Ka'ahumanu Highway in Kealakehe. There are 42 patrol officers working three shifts, with 13 officers assigned to each shift. Seven officers on patrol at any one time. The Kona and Hilo Police Stations are the only two 24-hour police stations in Hawai'i County.

The Study Area comprises two police beats, and one officer is assigned to each beat. One beat is geographically located between Keauhou mauka and Kealakekua, and the other beat extends from Kealakekua to Manuka State Park south of Miloli'i. These beat officers use the facilities at the Captain Cook substation. This station is not staffed; the beat officers have keys and use the station when necessary. The officers' primary area is in the northern, more populated area of the two beats, Keauhou mauka to Ho'okena. They only travel to the Miloli'i area when called. Response time to Miloli'i is one hour.[16]

[15] *See Section 5 for discussions on interview findings.*

[16] *Personal communication with Captain Dale Fergerstrom, Kona Patrol District, Hawai'i County Police Department, on 5 May 2000.*

The proposed project will impact the delivery of police services because it will increase the resident and de facto population on the project site. Relative to the total population of the region, the level of project-related population increase is not considered significant, however, and no mitigation is necessary. Further, the need for on-site police protection may be mitigated by the presence of on-site private security personnel.

4.3.2. Fire Protection

The project site is served by the Captain Cook Fire Station that is located less than a mile from the project site. This Fire Station covers the area from the Hokukano Ranch Cut-off Road in Kainaliu to the Manuka State Park, south of Miloli'i.

The Captain Cook Station has three shifts per day; with each shift staffed by five or six firefighters. Equipment includes a triple combination pumper with a capacity of 1,000 gallons, a mini pumper with a capacity of 250 gallons, and an ambulance.

The back-up station is the Keauhou Fire Station, located near the Pu'uloa Subdivision on Kuakini Highway. Equipment includes a triple combination pumper and an ambulance.[17]

The project will increase the residential population and number of structures in the service area, and therefore increase the need for fire protection services in the area. Relative to the total number of people and structures in the fire station service area, current facilities can adequately serve the project without significant impact. Hence, no mitigation is needed.

4.3.3. Medical Facilities

The project site is within the service area of the Kona Community Hospital located approximately 3.5 miles north of the project site in Kealakekua. The hospital is administered by the Hawai'i Health Services Corporation and is staffed by 60 doctors and 400 employees; an additional 40 consultant doctors also are available.

The facility's 75 hospital beds include 53 acute care beds and 22 long-term care beds. Nine of the acute care beds are in an Intensive Care Unit. An additional twelve psychiatric beds will be available by the end of summer 2000, and a Magnetic Resonance Imaging (MRI) unit will be operating by December.

Most surgery needs can be met at the hospital. The Kona Community Hospital occupancy is approximately 80 percent. During the high season, February

[17] *Personal communication with Assistant Fire Chief Garfield Arakaki, Hawai'i County Fire Department on 7 May 2000.*

through April, it is often 100 percent. Due to the present maximization of occupancy and need for expansion, the Hospital is already exploring options, including a search for 20 to 30 acres of flat land in the Kailua area for the development of a larger facility. [18]

The other health maintenance facility in the area is the Keauhou Rehabilitation and Health Center, a nursing home in Keauhou with 94 beds. Occupancy averages 90 percent. [19]

The proposed project will impact the hospital system by increasing the residential population in the hospital's service area. Given the proportion of increase relative to the total population, however, project-related population increases are not significant. Further, any impact would be mitigated when the hospital mitigates its plans for expansion.

4.3.4. Public Schools

The project site is served by the Konawaena School complex, located in Kealakekua. The complex serves the area from Keauhou Road south to Miloli'i.

Konawaena High School's present enrollment is 1,187 students and school has a capactiy for 1,533 students. The enrollment projection for next school year is 940 students, and the five-year projection for School Year 2005-2006 is 965 students. [20] Konawaena High School has 39 regular education faculty, seven special education faculty, and 21 supplementary faculty, some of whom are part-time.

Konawaena Middle School is fed by Honaunau Elementary, Ho'okena Elementary, and Konawaena Elementary Schools. The Department of Education plans to expand the middle school by adding sixth grade to the seventh and eighth grades it now serves. The school's current enrollment is 231 students, and the school has a capacity for 189 students. The projection for next year is 238, and the five-year projection is 638 students. Konawaena Middle School has nine regular, one special education, and four supplementary faculty.

Konawaena Elementary School's enrollment currently is 765 students, and the school has a capacity for 625 students. Projections are 765 next year, and 625

[18] *Personal communication with Joseph Wall, Chief Executive Officer, Kona Community Hospital on 5 May 2000.*

[19] *Personal communication with Aleta Springer, Finance Manager of the Keauhou Rehabilitation and Health Center on 5 May 2000.*

[20] *The drop in enrollment from this school year is due to the completion of the new Kealakehe High School that will serve students residing north of Keauhou. The new school will accommodate grades nine through eleven, and grade twelve will be accommodated next year.*

in 2005-06. Konawaena Elementary has 32 regular, six special education, and two supplementary faculty. [21]

A new Konawaena Elementary School campus is under construction and is expected to be in service next year. This will allow the middle school, now housed in a group of plantation houses and portable buildings, to move to the elementary school campus.

The potential social impact of the project on public schools ranges from five to 57 students. The market and economic impact study conducted for this project estimates that, because this is essentially a second-home community, the project will have a permanent population of only 26 persons, of whom five are projected between the ages of five and 17 years. [22]

The State Department of Education projected enrollment of the proposed project includes 31 students for Konawaena Elementary School, 13 for Konawaena Middle School, and 13 at Konawaena High School. [23]

While this range of student population increase will impact the areas' schools, two of which are operating over capacity, the planned improvements and new facilities will help to accommodate future population growth, including that attributable to the proposed project.

4.3.5. Public Recreational Facilities

The vicinity of the project site is served by following County parks and facilities:

- Greenwell Park and a community center (2.7 acres) in Captain Cook
- Kona Scenic Subdivision Park (five acres dedicated to the County) in Kealakekua
- Higashihara Park (five acres) north of Kainaliu
- Honaunau Boat Ramp
- Honaunau Rodeo Arena
- Ho'okena Beach Park

The first three parks feature a baseball field. The County also owns and maintains the swimming pool at Konawaena High School in Kealakekua. [24]

[21] *Personal communication with Alan Honma, CIP Planner, Hawai'i State Department of Education on 8 May 2000.*

[22] *The Halstrom Group, Market Study, Economic Impact Analysis and Public Cost/Benefits Assessment of Keopuka Lands Subdivision (June 2000), 36.*

[23] *Based on letter dated 5 April 2000 from the State Department of Education to PBR Hawaii.*

[24] *Personal communication with Glen Miyao, Planner, County of Hawai'i, Department of Parks and Recreation*

Additionally, the State of Hawai'i maintains the Kealakekua Bay State Historical Park and Kealakekua Bay State Underwater Park. The Kealakekua State Park adjoins the Napo'opo'o Village and is the site of the Hikiau Heiau. The heiau is the site where the resident population received Captain James Cook in January 1779. Less than a month later, Cook was killed at Ka'awaloa which is located on the north side of Kealakekua Bay. At Ka'awaloa, a 2-foot white obelisk monument is erected near the spot where Cook was slain.

The 315-acre Kealakekua Bay State Underwater Park was designated a Marine Life Conservation District in 1969 to preserve and protect the underwater features and life forms. The district is divided into two zones. Subzone A covers the area inshore of a straight line drawn from Ka'awaloa Point to the northern end of Napo'opo'o Beach Park. In this zone, all consumptive activities including the removal of coral, rocks and shells are prohibited. Subzone B is the area between the Subzone A line and a straight line drawn from Ka'awaloa Point to Manini Point. In Subzone B, fishing is permitted for any finfish by hook-and-line or thrownet and for akule, opelu and crustaceans.[25]

The proposed Keopuka development may impact public recreation resources in the area in three ways.

- First, the project will expand the region's recreational resources through the establishment of an open space buffer along the entire shore frontage of the project site. This coastal area will generally be kept in its natural state for recreation and public access. Also, public access to and along the shoreline will be provided including improved vehicular access, parking, restrooms and shoreline trail improvements. This area is envisioned to be located near the current camping area. Preliminary plans call for facilities to accommodate four vehicles and a total of twelve people. Access would be managed through a permit system administered by the owner or its representative; this is the current system.
- Second, the additional population may increase competition for recreational resources. Project-related increase in competition for recreational resources is not significant, however, when considered in the context of the total resident and visitor population, and no population-related mitigation is necessary.
- The third area of potential impact is the proximity of the proposed development to Kealakekua Bay and its recreational resources. The proposed project may affect the experience of those who visit these resources, especially if structures or landscaped areas may be visible from the bay.

[25] *John R. K. Clark, **Beaches of the Big Island** (1985), 96 – 98.*

Currently, the houses fronting the bay in Napo'opo'o are one- to two-story homes. Some houses, with their high fences and walls, block the view of the bay from the roads. Nevertheless, once a person is in the park, on the shoreline and in the bay, the natural environment dominates the experience.

Further, this natural experience has been long-standing. This area, including the Marine Life Conservation District, has been a public resource for about 30 years, and residents have become accustomed to the natural setting of the bay and the remaining undeveloped portions surrounding the bay.

Visibility of new homes and well-manicured golf courses and yards would alter the experience for bay and park users because it would increase the sense of an urban environment.

Possible mitigation is two-fold. First, the visibility of project components from the bay and park should be minimized. A visual impact study is part of the EIS process and will determine if further measures are needed.

Second, the coastal buffer zone should complement the adjacent Ka'awaloa and nearby Kealakekua Bay in any way possible. Further discussion with park users, public officials and the general public is needed to identify specific proactive measures to complement these adjacent resources.

5. Preliminary Community Issues

Impacts are changes that may occur as a result of a proposed action, plan or policy. Issues are reactions and opinions. Issues can change over time, as people's priorities and values change.

Issues analysis helps decision-makers identify and analyze community concerns about a proposed action. To ensure that a proposed action is reviewed in the full social context in which the project is proposed, feelings and concerns about the existing community need to be considered as well. For example, it is helpful to understand if a project is unique in terms of its issues, or if reactions are consistent with other proposed changes.

Issues analysis differs from statistical surveys, the latter of which is designed to focus on frequency of reactions. Polls are valuable because they tell us about the opinions of the majority or the minority. The survey instrument is not conducive to dialogue, however, and the personalized reasons for these opinions are not evident, or need to be inferred from the responses.

In contrast, the only time we make reference to the quantity of opinion in issues analysis is where there is significant difference of number or a distinct trend.

Section 5.1 discusses the study approach and methodology used in the issues analysis. Section 5.2 presents findings related to feelings about the existing community, and Section 5.3 presents reactions to the proposed development to Keopuka. Section 5.4 presents our analysis of community issues.

5.1. Approach

The source of information for this study is the collective information provided in community interviews, and the interview process is discussed in Section 5.1.1. A profile of those interviewed is presented in Section 5.1.2.

5.1.1. Interview Process

Two interviewers conducted interviews over a one-week period; a few telephone interviews were conducted after this period. Most of the interviews were held in person.

Our primary objective was to learn about the existing community and how the project would relate to the community. Hence, though the interview questions were standard, we also allowed for flexibility so that those interviewed could converse, or "talk story," in a manner that was comfortable for them.

Interviewees were informed that their names and affiliations would be listed in this report. They chose the affiliations for listing. We noted that the affiliations and organizational information was solicited to provide the readers an indication of the interest base of those interviewed. People spoke as individuals, and did not represent or speak for their organizations.

They were further informed that their individual conversations were confidential, and that their comments would be collectively analyzed. The four parts of the interviews are as follows:

- ***Feelings about the existing community***

  Interviewers asked people to first discuss their existing community. Interviewees were asked to identify the community's most important strengths, as well as the most important problems. Comments about major changes to these strengths and problems over the last five years were also solicited. Interviewees were then asked to discuss their hopes for the future of the community.

- ***The project site***

  Interviewers asked about the person's personal use, including frequency, of the project site and the nearby shoreline and Kealakekua Bay. They also asked the interviewee to share knowledge of use of the area.

- ***Feelings about the proposed development at Keopuka***

  Interviewers described the proposed project based on information available in the Environmental Assessment prepared by PBR Hawaii (March 2000), namely the summary and Section 2, Project Description. Interviewees were then asked to identify positive characteristics of the proposal and potential problems associated with this effort. It was noted if they felt that the project had either no positive characteristics, or no potential problems. Interviewees were also asked to relate the project to the community strengths and problems they earlier identified.

- ***Suggestions***

  Those interviewed were asked if they had any suggestions related to any aspect of the proposed project.

5.1.2. Profile of Those Interviewed

As previously discussed, an understanding of the full range of feelings and concerns about a proposed project needs a broad cross-section of people. Every effort was made to contact people who are active in their community through their participation in social, educational, cultural, and economic development activities and organizations. We also contacted people who are familiar with the site because they live nearby or use the shoreline. Finally, we contacted people who were recommended by those interviewed because they were recognized as important individuals in the community.

In all, 40 people were interviewed. Those interviewed were asked to identify their organizational and other affiliations so that the reader would have an idea as to the cross section of interests reflected in this analysis. Interviewees shared their opinions as individuals, however, and were not asked to take a position for their organization. The list of names is provided in Table 8.

Table 8: List of People Interviewed

Name	Affiliation and Background
Howard Ackerman	Resident along Kealakekua Bay Community volunteer
Sotero Agoot	General Manager of Kona Pacific Farmers Cooperative Board member, Hawai'i Coffee Association Board member, Hawai'i Macadamia Nut Association Member and Vice Chair, South Kona District, Kona Kohala Chamber of Commerce Member of the Kona Coffee Council
Gus Brocksen	Member of the Kona Farmers Alliance and Chair of the Communications and Steering Committees Member of the Kona Coffee Council Member of the Farm Bureau Owner of Pele Plantation (coffee farm)
William "Skip" Cowell	Chair of Kona Soil & Water Conservation District Director of Resource Conservation and Development, U.S. Department of Agriculture President and Chair of Tropical Reforestation & Ecosystems Education Center Past President of Kona Coffee Council Past Founding President of Hawai'i Coffee Growers Association Past Founding President of Hawaii Coffee Association
Mark Crawford	President of Hawaii Macadamia Nut Association Past Board member and Treasurer, Bay Clinic Member of the Royal Order of Kamehameha

Name	Affiliation and Background
Jack Davis	Daily swimmer in Kealakekua Bay
Kila DeMello	Napo'opo'o resident
Dale Fergerstrom	Assistant Leader, Boy Scouts of America Captain of Kona Patrol District, Hawai'i County Police Department
Jean Greenwell	Historian for the Kona Historical Society Member of the Kona Outdoor Circle Owner of Greenwell Farms, Inc.
Kelly Greenwell	President of Resource Conservation and Development, and Director of National Resource Conservation Service, U. S. Department of Agriculture Immediate Past President and current Public Relations Committee Chair of the Kona Outdoor Circle Founding member and Past President of the Kona Canoe Club Member of the Advisory Committee for the National Park Service, Na Kokua Koloko-Honokohau National Park Member of the Kona Farm Bureau President of Hawai'i of the Landscape Industry Council Owner of Orchard-Marine (dba Hawaiian Gardens)
Sherwood Greenwell	President of the Kona Historical Society Past President of the Hawaii Leeward Planning Conference Spent 18 years on the Board of Supervisors for the County Council President of Kealakekua Ranch Center.
George Harai	Board member of the Kona Daikujukuji Soto Mission Advisor to Hiroshima Ken Jin Kai Member of Kona Iki Trollers Macadamia nut farmer on project site
Luna aanawai Hauanio	Member of Advisory Panel and the Native and Indigenous Rights Panel of the Pacific Regional Fishery Management Council Member of the West Hawai'i Fishery Council Member of the Royal Order of Kamehameha.
Marni Herkes	President of the Kona-Kohala Chamber of Commerce Board member of the Rotary Club of Kona Advisor to Family Support Services, West Hawai'i Member of Kona Crime Prevention Committee Member of the League of Women Voters Member of the Kona Outdoor Circle Member of the Kona Hawaiian Civic Club Member of the Waimea Community Association Member of the Kona Historical Society
Nelson Ho	Conservationist Statewide Conservation Chair of the Sierra Club Recreational user of the island

Preliminary Community Issues

Name	Affiliation and Background
David "Bones" Inkster	President and owner of Kings' Trail Rides O' Kona Inc. Resides and operates business near project site
Sally Inkster	Recording Secretary on the Executive Board of the Daughters of Hawai'i Historian for Hulihe'e Palace Vice President of Hawai'i High School Rodeo Association Member of the Committee for the Living History of Ranching of the Kona Historical Society Secretary of the Kona Roping Club Secretary and Office Manager of Kings' Trail Rides O' Kona Resides and operates business near project site
Herb Kane	Past President and Co-founder of the Polynesian Voyaging Society Co-founder of the Keauhou Canoe Club Advisor for Hoala Na Pua (high school ocean studies program) Member of the ad hoc committee to host the HMS Endeavour replica at Kona Member of the Advisory Committee for the National Park Service, Na Kokua Koloko-Honokohau National Park Founding Trustee of the Native Hawaiian Culture and the Arts Program Past Advisory Board member of the Hale o Ho'oponopono Program Past Advisory Board member of the Kealakekua Bay State Historical Park Past Advisory Board member of the Kamoa Point State Historical Park
Sidney Kanno	Deputy Director of the County of Hawai'i Elderly Activities Division of the Department of Parks and Recreation
Lily Kong	Member of the Cultural Advisory Committee of the Office of Hawaiian Affairs Member of the Hanapono Development of Kamehameha Investment Corporation Member of the Queen Liliuokalani Kupuna Coucil Chair and Board member of the Hawaii County Economic Opportunity Council Vice President of Na Opio o Kahaluu
Gretchen Lawson	Executive Director of Kona Association for Retarded Citizens/Kona Krafts
Gordon Leslie	Owner of Pacific Consulting Consultant for Hokulia
James Lightner	General Manager of the Lanihau Center Chair of the Kona – Kohala Chamber of Commerce Past President of the Rotary Club of Kona Past President of West Hawaii Traffic Safety Committee
Dwight Manago	Major stockholder of Manago Hotel Hawai'i County Police Commission

Preliminary Community Issues

Name	Affiliation and Background
Barbara Nobriga	Regent for the Island of Hawai'i of the Daughters of Hawai'i President of Kahua Na'au a'o Ma Pu'uhonua o Honaunau NHP, Inc. (community partnership with the Park Service) Leader of Na Pua O Holo Leo (4-H Club) Rancher
Jill Olson	Executive Director of the Kona Historical Society Associate Director of Pulama la Kona Heritage Preservation Council
Fumi Teshima Ow	Assistant manager of Teshima Restaurant
Nancy Pisicchio	Hawai'i County Council Member representing District 7
Teunisse Rabin	Parent of public school children Honaunau farmer Executive Director of Society for Kona's Education and Art Artist in State Department of Education Artist-in-School program
Jerry Rothstein	Board Chair of Public Access Shoreline Hawai'i
Norman Sakata	President and Chair of the Kona Coffee Cultural Festival President and Chair of the Public Relations Committee of Hawai'i Lions Foundation Chair of the Hawai'i Eye Bank and Makana Foundation Associated with the Boy Scouts for 47 years Past President and Past District Governor for Hawaii of the Lions Club
George Schattauer	Member of Kona Historical Society Member of Lyman House Museum Member of the Resource Conservation and Development, U. S. Department of Agriculture Resident of Ka'a waloa lands in Captain Cook
Margaret Schattauer	Member of Kona Historical Society Member of Lyman House Museum Resident of Ka'a waloa lands in Captain Cook
Aloha Schneider	Coffee farmer mauka of the proposed project
Victor Schneider	Coffee farmer mauka of the proposed project
Kaz Shigezawa	Past President of Hawai'i Island Landscape Association Board Member of the Kona Outdoor Circle Past Commissioner, Kailua Village Design Commission Charter Member of the Our Kona Conference Member of the Kaulunani Hawai'i-Urban Forestry Council Member of Peoples Advocacy for Trails Hawai'i Member of the Public Industry Council President of Landscape Images Inc.
Alexander Davis Smith	Committee member of the Boy Scouts of America Past member of the Kona Farm Bureau Past member of the Hawai'i Coffee Growers Association Past member of the Hawai'i Coffee Association Past member of the Kona Coffee Council Nearby resident of Captain Cook

Name	Affiliation and Background
Nancy Soderberg	Principal of Konawaena Middle School
Frank Mailani Thompson	Retired fire captain
Daniel Yoshida	Principal of Konawaena High School Member of Hawaiian Golf Men's Club

The following highlights characteristics of those interviewed:

- *Place of residence*

  At the time of the interviews, 23 people, or 57 percent, lived in South Kona. Most of the South Kona residents (18 people) lived near the project site in Captain Cook, Napo'opo'o, Kealakekua and Kanaueue. The 16 North Kona residents lived as far north as Keahole and Honokohau and south in Honalo and Kainaliu. One person lived in the Hilo region.

- *Length of residence*

  The majority of those interviewed were either "born and raised" in the Kona region, or had lived there for more than 30 years. Twenty-two people, or 55 percent, were in this category. Three people lived in the region between 21 to 30 years, and seven were Kona residents between eleven to 20 years. Eight of those interviewed lived in the area for ten or less years.

- *Familiarity with the project site and the nearby shoreline*

  Of the 40 people interviewed, most were familiar with the project site. Sixteen people knew the site because their fished, dove and boated along the shoreline, or swam, snorkeled and kayaked in Kealakekua Bay. Eight people were familiar with the site because of on-site or adjacent agricultural activities. Several have hiked on the on-site trails. Ten people were not personally familiar with the site.

- *Affiliations*[26]

  Based on the affiliations provided, those interviewed tended to be very active in community efforts. Cultural activity was high among those interviewed, and 14 people belonged to organizations such as the Royal Order of Kamehameha, the Kona Historical Society, the National Park Service advisory group for the Kaloko – Honokohau National Park and the Kona Heritage Preservation Council.

  Agricultural involvement was also high, and 14 people participated in organizations such as the Kona Pacific Farmers Cooperative, the Hawaii

[26] *The total number of affiliations is not 40 because several people belonged to more than one organization.*

Coffee Growers Association, the Farm Bureau, the Hawaii Macadamia Nut Association, and the Kona Coffee Cultural Festival.

Thirteen people were either involved in providing a public service. They were administrators in the area's high and middle schools, involved in police police and fire protection, or provided a social service such as elderly programs.

Eleven people belonged to community organizations, such as the Kona Outdoor Circle, the Rotary, the Lions Club, Na Oplo o Kahalu'l, and the Boys Scouts.

Seven belonged to organizations that promoted environmental conservation and trail use. Their organizations included the Tropical Reforestation and Ecosystems Education Center, the Sierra Club, the Resource Conservation and Development for the U.S. Department of Agriculture, and Public Access Shoreline Hawaii.

Seven people were also involved in the community as business operators, including trail guide services, a restaurant and a hotel, or through organizations such as the Kona- Kohala Chamber of Commerce

5.2. Feelings About the Existing Community

Interviewees were asked to describe the strengths and problems of the existing community; their comments are presented in Section 5.2.1 and 5.2.2, respectively. Their hopes for the future of the community are discussed in Section 5.2.3.

5.2.1. Community Strengths

The most basic community strength identified by those interviewed was the rural character of the area. They liked the slow pace, the lack of high-density development, the friendliness of the people, and the predominance of open space and farmlands. Interviewees felt that these characteristics promoted community pride at several levels.

In this context, there were four elements that contributed to this rural character: 1) the people, 2) the Hawaiian culture and presence, 3) the region's agricultural foundation, and 4) the natural environment.

The People

Long-time residents strongly valued their ties with each other. They felt that this sharing of background makes it easier to get things done. Also, it was noted that families who have long-time roots in South Kona continue to contribute to community efforts. Their legacy is one of hard work and strong family values, and it was felt that these factors have continued through modern times.

It was also acknowledged that, as time passes, there is greater people diversity in the community, and this was considered a strength. The ethnic mix was seen as a plus because it allows people to learn about each other's culture, while maintaining their own values. It was pointed out that the newcomers bring diversity, and, while their presence is not entirely positive, they do contribute new ideas and resources to community projects.

Aloha and trust were also considered important community strengths. Interviewees felt that, even though there are differences among various groups in the community, people come together to help each other and for common causes. The schools, for example, benefit from volunteerism from many people in the community.

Hawaiian culture and presence

Those interviewed felt that a major strength in the area is the strong presence of Hawaiian people and culture. Ka'awaloa was considered a sacred site, and interviewees believed that the strong Hawaiian presence in South Kona brings a sense of spirituality.

Agricultural foundation

Large and small farms featuring coffee, macadamia nuts, fruits and other crops were considered a major part of the identity of South Kona. Tied closely to the rural character of the area is the predominance of agriculture. As one person said, "There's a lot of farmland. Not everyone is a farmer, but we all value farming in South Kona."

Natural environment

It was felt that the natural environment, with its lush mauka areas and clean shoreline and beaches, is a big strength in South Kona. The shoreline and beaches were highly valued and interviewees visited these resources often.

Interviewees felt that the natural environment allows the community to camp, fish and "enjoy the simple pleasures." They said that the region is a good place to raise children because it lacks the commercialism and distractions of city living.

Those interviewed liked the climate, although some felt that the vog is bothersome and uncomfortable for those with respiratory problems. Nevertheless, the climate was seen as a plus because it is good for growing coffee and macadamia nuts, and attracts visitors.

5.2.2. Community Problems

Community problems cited by those interviewed generally fell into five areas: 1) social divisions, 2) inadequate infrastructure, 3) lack of planning, 4) crime and 5) economic problems.

Social divisions

While they valued the people, those interviewed also felt that there are social divisions that threaten community cohesion. It was reported that there is a division between the educated and non-educated. Although the schools were appreciated, it was also noted that some students are not being educated up to accepted standards, and this promotes division between young people who can move ahead, and others who must settle for low-paying jobs. In a related note, a "brain drain" was also considered a problem because the brighter young people leave to find better opportunities.

Another type of social division was that between the "haves and have-nots," the rich and the poor. This situation leads to social tension and crime, and those interviewed felt the economic disparity problems were becoming more evident as affluent newcomers migrate into the region.

Yet another type of social division noted by interviewees was between newcomers and long-time residents. Long-time residents were especially concerned that newer residents try to stop development once they arrive and that they are more vocal than their local neighbors. While it was acknowledged that long-time and local residents need to better articulate their opinions and views, those interviewed expressed frustration about the sometimes lack of sensitivity of newcomers.

Also reported was an ethnic division. Interviewees were concerned that, while the region has many Hawaiian residents and is rich in Hawaiian culture, native Hawaiians are often the poorest and least educated. Those interviewed felt that this situation is not unique to South Kona, and felt that the statewide community needs to "make pono" with the host culture.

Inadequate infrastructure

Almost all of those interviewed felt that traffic is a big community problem. They were very concerned that the region has only one north-south road, and some said that a recent major car accident in Honalo paralyzed traffic for several hours. Many people could not get to school or work. They feared that there might be future instances in which emergency vehicles would not be able to reach their destinations.

Water supply and transmission were also noted as problems. The southern part of the region is reportedly not served by the County water system, and it was believed that, during low-water seasons, water salinity has been increasing due to low supply.

Lack of planning

A related community problem is the lack of community-based planning. Those interviewed felt that the County's planning system does not include broad and systematic community input. An example of this lack of organized community input reported by those interviewed is the process for updating the Hawaii County General Plan. Those interviewed said that people could provide input, but the solicitations for input have been disorganized. Hence, there is no systematic or coordinated effort to help the various communities develop and express their visions for their future.

Interviewees were concerned that, because there is little community-based planning, land use decisions are reactive and conducive to spot zoning. Further, the infrastructure systems are not improved on a timely basis because the plans for the future are not coordinated within the County system.

Another aspect related to lack of planning is the reported decrease in public access to the shoreline. It was felt that, as long as "development occurs for development's sake," and there is no comprehensive plan to protect community access, the people's right to the shoreline and public trails will be superceded.

Crime

While the interviewees consider South Kona a safe place, they are also concerned that crime is on the rise. Marijuana and other drug use are reportedly on the increase, and financial hardship has led some to theft. According to those interviewed, part of the problem is that parents are spending less time with their children because of their jobs.

Also, it was felt that the region needs more police officers. It was pointed out that, if there is a domestic violence call from Miloli'i, two beat officers are required to answer the call, thereby leaving the rest of South Kona with no beat officers.

Economic problems

A recent economic problem is the drop in coffee prices. Interviewees in agriculture said that, when coffee prices were high, many people purchased land and raised coffee. The increase in coffee acreage was significant, from 2,000 to 3,000 acres within two years. With the decrease in prices, marketing the excess pounds is a challenge.

5.2.3. Hopes for the future

Interviewees shared their hopes for the community's future and these were related to maintaining community strengths or solving its problems. There was a general hope that the community is able to keep what is good and valued, and solve what is currently problematic, while surviving in a rapidly changing world. One person wanted to see the community "thrive in a global community, while still retaining its rural quality of life."

In their desire to maintain the rural quality of the area, those interviewed hoped that the future would not bring gated communities and golf course communities. They did not want to see increased stratification between the rich and the poor.

Interviewees hoped that better planning would help the community articulate its vision for the future, and to come up with a long-term consolidated plan for how the South Kona region is to evolve in the future. It was also hoped that this process of planning would help residents reinforce their values and understand the community's resources and assets.

Interviewees especially wanted to see better stewardship of the region's natural and cultural resources. They wanted to make sure that areas like Kealakekua Bay and Ka'awaloa are protected, and that uses are regulated. They also called for more effective enforcement of rules and regulations.

5.3. Reactions to the Proposed Project

5.3.1. Positive Characteristics of the Proposed Project

When asked to identify positive characteristics of the proposed development at Keopuka, interviewees named characteristics in three categories: 1) economic benefits, 2) the developer's reputation, and 3) a preferred alternative.

Nine people felt that the project had no positive characteristics, and two people named the proposed Mamalahoa Highway Bypass Road, which is not part of this project, as a positive characteristic. One person felt that the project has positive characteristics only if the preliminary ideas to improve Ka'awaloa are part of the project.[27]

Economic benefits

Those interviewed felt that the project would bring jobs to the community. They appreciated both the short-term construction jobs, as well as the operational employment that would be needed to support the new community. It was also felt that the increase in economic activity would benefit the entire region.

[27] *At the time of this writing, project plans did not include measures to improve or "adopt" Ka'awaloa.*

Developer's reputation

Those interviewed were aware that the developer for Keopuka is the same as that of Hokuli'a. This was considered a big plus because interviewees felt that the developer has patiently worked with the community for many years, and has contributed to important community efforts. They had confidence that he would implement what was promised. Further, it was felt that the developer has demonstrated environmental and cultural sensitivity at Hokuli'a, as well in other parts of the world, and that this same sensitivity would guide his decisions at Keopuka. Interviewees were aware of the developer's practice of developing "reduced turf" golf courses to minimize environmental impacts.

Preferred alternative

While there was a preference to leave the project site undeveloped, those interviewed felt that, "if there had to be development at Keopuka," then the proposed plan is the preferred alternative.

Interviewees felt that full-scale agriculture on the entire site may have more impacts on the ocean due to runoff. Also, if the site were subdivided into smaller lots, there would not be a unified development scheme by the individual landowners. In addition, those interviewed did not want to see any possibility for a development density higher than allowed by agricultural zoning.

5.3.2. Potential Project Problems

Those interviewed discussed potential project problems related to 1) proximity to Ka'awaloa and Kealakekua Bay, 2) social tension, 3) cumulative development impacts, 4) trails, and 5) visual impacts.

Proximity to Ka'awaloa and Kealakekua Bay

The most prevalent concern of those interviewed was the project site proximity to Ka'awaloa and Kealakekua Bay. They noted that this is a sacred place, a national treasure, and a valued community resource.

Those interviewed were very concerned that the ecosystem of Kealakekua Bay, which is protected as a Marine Life Conservation District, would be altered due to runoff from the project. Construction runoff presented a concern, as did runoff related to maintaining the proposed golf course. It was feared that the impacts of chemical and soil runoff would negatively impact the water quality and change the underwater habitats.

Another concern was the introduction of residential and golf course uses to an area that currently is minimally accessible. By bringing more people to the area, the general ambience and experience would be transformed into a popular tourist attraction. One person envisioned "golf carts being able to ride right up to the bay."

Related to this concern is the "privatization" of Ka'awaloa and Kealakekua Bay. Those interviewed did not want to see future Keopuka residents and guests feel any sense of ownership over this community resource. Further, interviewees were concerned that, if there are affluent residents living nearby, then there would be a psychological barrier to using the public areas.

Social tension

Those interviewed responded negatively to gated communities, and this project was no exception. It was felt that the presence of two gated communities, including Hokuli'a and Keopuka, would increase social stratification, and have a negative effect on the sense of community. Interviewees were concerned that the exclusive nature of Keopuka would lead current residents to resent Keopuka residents, and that this would be a detriment to social harmony and acceptance.

Trails

Interviewees were not confident that the existing trail system through the project site would be maintained in its current state with the new development. They said that a gate was recently erected on the project site at one of the trails, and that these types of physical barriers would become more common as new residents move into Keopuka.

There was also concern that, to accommodate the golf course design and lot layout, the trails might be altered or moved.

Cumulative development impacts

Those interviewed were aware that Hokuli'a was approved and is under construction. They felt that the cumulative impacts of over 900 new residential units and two golf courses are more than the community can absorb. While they realized that implementation would occur over many years, the thought that these two projects are "on the books" concerned those interviewed.

Timing was an important factor for some. Interviewees, including some who supported the Hokuli'a project, felt that this project is being proposed too soon after the previous project received its approvals. They felt that Hokuli'a has yet to demonstrate success, and that the project's impacts have not been realized. They wanted to see the beginnings of a successful project before they agree to another similar project.

Further, those interviewed questioned the timing and reality of the new bypass road. They had believed that the new bypass road would be built before lots were sold, but had recently heard that lot sales are already occurring.

Visual impacts

Interviewees felt that the view of the project from the ocean and from Ka'awaloa and Kealakekua Bay might be a problem. Boaters and fishers were concerned that the project would alter their ocean experience because they would see large residences and a golf course instead of the natural environment.

There was also concern that the golf clubhouse and on-site residences would be visible from Ka'awaloa and Kealakekua Bay. As one person said, she did not want to see "rich people in their fancy houses and golfers looking down on us."

5.3.3. Relationship to Community Strengths and Problems

Generally, those interviewed saw little relationship between the proposed project and community strengths cited earlier. Rather, they focussed on the relationship between the project and community problems. Interviewees were concerned that the project will contribute to the gap between the rich and poor by bringing in more people who are obviously affluent. The gated feature was also seen as contributing to community problems related to economic stratification.

Another type of community problem discussed by those interviewed was the continuation of unplanned and piecemeal development. Those interviewed felt that the project was part of this type of "spot zoning."

5.3.4. Suggestions from Those Interviewed

Given their input on community strengths and problems, and on the proposed project, those interviewed offered the following suggestions:

Project location and timing

- Don't build this project. Development should not occur this far south.
- Find a location further north, near areas that are already well developed and away from Ka'awaloa.
- Wait to see how Hokuli'a develops so that we have a better understanding of impacts on the community.
- Wait until the bypass road is completed.
- Wait until there is a systematic and comprehensive community-based planning effort.

Type of project and employee relations

- Keep the lots large (all 5+ acres), and make sure there is "real" agriculture.
- Diversify the market mix so that there is greater diversity in affordability.

- Include on-site employee residential opportunities.
- Include off-site employee housing.
- Provide educational opportunities for employees.

Impacts on Ka'awaloa and Kealakekua

- To control runoff, keep the residential development above the Old Government Road. Makai of the road should be open space and the golf course.
- Allow mauka – makai public access through the project site so that the public can access the monument.
- Provide an on-site parking lot on the makai-south corner of the project to allow the community to access the monument.

Community Interaction

- Use the Hokuli'a model for community input, including extensive grass roots involvement
- Sponsor large community meetings so that people can learn about this new project
- Be patient and listen to the community. Don't fast track the process.

5.4. Analysis

1. **Project is seen in context with Hokuli'a.**

   It was difficult for interviewees to separate the proposed development at Keopuka from the Hokuli'a project. Given the common developer and similar project components, this project was viewed as an extension of Hokuli'a, rather than a separate development effort. As an example, the proposed bypass road was frequently considered part of this project, and interviewers needed to clarify the distinction.

   Those interviewed therefore tended to consider the cumulative impacts of the two developments, rather than weigh the impacts of this particular project. As such, the project was viewed as "larger" than its own attributes.

2. **Project location is significant to those interviewed.**

   The most common denominator of concern among those interviewed is the location of the project site relative to Ka'awaloa and Kealakekua Bay. This concern was expressed whether the person lived near or far from the project site or was a long-time resident or a newcomer. They considered these areas very crucial to the culture and identity of South Kona.

Given the importance of these areas, it is very likely that any proposed change on this project site would elicit community concern. The challenge to any proponent of developing this site is to work with residents to understand what the community can adjust to and tolerate on this site. Further, project-based stewardship of these areas may be possible as long as the community does not view this stewardship as intrinsic ownership.

3. **For those interviewed, economic benefits are not as important as social and environmental implications.**

Typically, economic benefits, namely jobs and increased spending, play an important role is a community's acceptance of development projects. This is particularly so in rural communities, where residents seek employment opportunities closer to home.

In interviews for this study, however, jobs and the economy were somewhat important but not as important as the gated feature or the proximity to Ka'awaloa. This attitude may be attributable to the economic recovery that has been occurring on Hawai'i Island. Hotel occupancy is improving in the north, and land and housing sales are increasing. The sense of economic urgency may not be as strong as in previous years, when Hokuli'a was being proposed and discussed in the community. Further, the need for more jobs in the area may seem lessened with the construction activity and sales occurring at Hokuli'a.

4. **This study is early; further community interaction is needed.**

This social impact assessment was conducted very early in the planning process. The project concept is in its early development stages, and operational and design aspects are being formulated.

The community apprehension and concern about the proposed development are a reflection of the people's need for more definitive information regarding characteristics such as visual impacts, runoff into the ocean and public access.

This study and the EIS are intended to provide information that should begin the dialogue about the proposed development at Keopuka. It is strongly recommended that a community information and participation program be designed to provide project information, understand community concerns and discuss how the project can mitigate its impacts. This program should be implemented as soon as possible, prior to formal public deliberations, such as public hearings. Hearings and large community meetings are not conducive to dialogue and a full exchange of ideas.

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APPENDIX N

Market Study, Economic Impact Analysis and Public Cost/Benefits Assessment

Market Study, Economic Impact Analysis, and Public Costs/Benefits Assessment of the

PROPOSED KEOPUKA LANDS SUBDIVISION

Keopuka, South Kona, Hawaii

THE HALLSTROM GROUP INC.
REAL ESTATE CONSULTANTS & APPRAISERS

**Market Study,
Economic Impact Analysis, and
Public Costs/Benefits Assessment
of the Proposed**

KEOPUKA LANDS SUBDIVISION

Located at

Keopuka, South Kona, Hawaii

Prepared for

**Mr. James M. Leonard, AICP
Managing Director – Hilo
PBR Hawaii**

ARBITRATION
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MARKET STUDIES

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June 2000

THE HALLSTROM GROUP INC.
REAL ESTATE CONSULTANTS & APPRAISERS

June 2, 2000

Mr. James M. Leonard, AICP
Managing Director – Hilo
PBR Hawaii
Hilo Lagoon Center, Suite 310
101 Aupuni Street
Hilo, Hawaii 96720-4276

Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment of the Proposed Keopuka Lands Subdivision Keopuka, South Kona, Hawaii

Dear Mr. Leonard:

At your request, we have completed a series of analyses assessing the market demand for, economic impacts of, and public costs/benefits associated with the proposed Keopuka Lands subdivision and golf course to be located on 660 oceanfront acres just north of Kealakekua Bay, 16 miles south of Kailua-Kona Village. The single phase project will provide a mix of competitive inventory intended to service the expanding demand for quality membership community homesite and membership recreational development in West Hawaii.

The property, identified on State of Hawaii Tax maps as Third Division Tax Map Key 8-1-07, Parcels 1, 54 and 55, varies from gently to steeply sloping, has a desirable windless climate, and offers superior ocean and mountain views. The site varies in width from 4,750 feet along the rocky shoreline to a mauka boundary having 600 feet of Mamalahoa Highway frontage at the 1,400-foot elevation level.

The holding is master planned for subdivision into a freestanding, private membership community comprised of some 125 agricultural lots, ranging in size from one to five acres, which will front a private golf course having an extensive clubhouse facility and a 100-room member lodge. The project will be primarily targeted to Pacific Rim second/vacation home purchasers, specifically from Western North America, a currently vibrant sector that has rapidly absorbed comparable product at the several projects made available over the past three years.

The focus of our assignment is fundamentally three-fold:

1. **Market Study.** To ascertain whether there will exist sufficient demand in the West Hawaii industrial real estate market to successfully absorb the finished subject inventory in a timely manner given its characteristics and those of competing in-place and proposed regional development.

2. **Socio-Economic Impact Analysis.** To estimate the general and specific effects on the local economy which will result from the development of the Keopuka Lands subdivision, including construction and operating employment, wages and income, contractor/supplier profits, end-user expenditures, and other regional monetary and employment effects. And, to identify and determine specific social effects associated with real property issues including population, traffic, affordable housing and property values.

3. **Public Cost/Benefit Assessment.** To quantify the impact on the public purse arising from the subject project in regards to tax/fee revenues which will be received by the State of Hawaii and Hawaii County due to the project's actualization, versus the actual and implied costs of providing needed governmental services to the development.

The pertinent results from our studies are presented within the *Executive Summary* which opens the report. The document also contains addenda presenting supporting data and background materials.

As part of our investigation program, we have inspected the subject property and its environs, researched the West Hawaii residential and resort/residential real property market sectors, interviewed knowledgeable parties active in the Kona/Kohala economy, reviewed government statistics, policies and publications, accessed on-line data bases, and compiled materials from published and private sources.

All conclusions presented herein are subject to the identified limiting conditions, assumptions and certifications of The Hallstrom Group, Inc., in addition to any others specifically set forth in the text. All work has been completed in conformance with the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice (USPAP).

We have reached the following conclusions as of May 15, 2000 regarding the probable market standing and economic impacts of the proposed Keopuka Lands development:

- The subject property is a superior location for the proposed development in regards to views, slope, ocean frontage, climate and ability to achieve the thematic objectives of the project.

- The demand for lots and units within membership communities has strongly emerged in West Hawaii over the past three years, and activity in the neighbor island resort/residential sector has meaningfully accelerated following an extended slump in the early to mid-1990s.

- Based on prevailing and forecast market trends, we estimate the 125 subject lots will achieve good to strong market acceptance and will be fully absorbed (sold-out) within a 20 to 36 month marketing period. The lodge is an economically feasible component and will provide needed amenities and accommodations for non-resident members and guests, and reach stabilized occupancy and operations within three years of opening.

- The construction of the subdivision, golf facility, lodge and individual homes will provide an estimated 3,528 "worker years" of employment and $105.4 million in total wages over a 15-year build-out period. After completion the community will support some 147 permanent jobs with an annual payroll of about $5.5 million.
- The project will have nominal impacts on the socio-economic aspects of the community that relate to real property issues. Property values, currently rising without the Keopuka Lands development, will not be specifically stimulated; traffic loads from the subdivision should be light, there are no direct in-migration or housing sector effects, and the number of school-age permanent residents will be minimal. Conversely, residents and guests of the development will spend some $12.83 million in the region each year.
- The State of Hawaii will receive a net revenue gain after operating costs of $24.8 million in taxes during the 15-year build-out, and an estimated $2.8 annually thereafter as a result of the subject project. The county will receive a net benefit of $26.6 million during construction and $2.8 million per year on a stabilized basis. In no year will the public purse be negatively effected by the undertaking.

We appreciate the opportunity to be of service in regards to this prominent holding and quality project. Please contact us if further discussion or detail on the matter covered herein is required.

Respectfully submitted,

THE HALLSTROM GROUP, INC.

James E. Hallstrom, Jr., MAI, CRE

/as

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EXECUTIVE SUMMARY

The proposed Keopuka Lands subdivision will comprise approximately 660 acres located on the westerly flank of Mauna Loa, fronting the ocean between Keawekaheka and Kaawaloa Points, and extending inland more than two miles to the 1400-foot elevation level along Mamalahoa Highway. Capitalizing on an undulating, scenic site having a favorable climate and superior view potentials, the proposed development will incorporate 125 agricultural homesites, an 18 hole championship golf course and clubhouse facility, 100 room lodge, and expansive open space and water features into a private "membership community."

The objective of the undertaking is to transform a near-vacant bulk acreage, lava-strewn holding having limited agricultural or alternative use potentials and providing no regional economic benefit, into an asset attracting new investment and spending by members and guests, which in turn creates employment and business opportunities for West Hawaii residents and increased net revenues and an expanded tax base for the state and county. The developers believe demand for competitive finished inventory is presently strong and anticipated to escalate during the coming decade, and the actual and implied impact of the project on neighborhood infrastructure and ownership will be limited.

The master plan is intended to represent the current highest and best use for the property from a market, economic and public purse perspective. It would provide a superior opportunity to maximize the in-flow of off-island dollars into the South Kona community by tapping evident high demand trends uniquely available through low intensity real property development.

The Hallstrom Appraisal Group, Inc., assignment was to analyze the proposed Keopuka Lands subdivision and the probable impact associated with the master plan in light of competitive, regional, prevailing and forecast economic/market conditions in order to answer four primary study questions:

1. Is there sufficient market demand to absorb the various components of the Keopuka Lands project during a reasonable exposure period given competing developments and statewide/regional economic trends?

2. From a market perspective, will the subject be an appropriate use of the underlying site relative to governmental land planning objectives, accepted master plan design characteristics, and the area environs?

3. What will be the general/specific and direct/indirect socio-economic impacts in West Hawaii resulting from the undertaking of the subject development through employment, wages, business operations, population, property values and other economic activity related to the real property asset?

4. What will be the impact on the state and county "public purse" from the project in regards to costs of services required versus increased tax/fee receipts?

These issues were addressed through a comprehensive research and inquiry process utilizing data from market investigation, governmental agencies, various Hawaii-based media, industry spokespersons/sources, on-line databases, and published public and private documents.

The pertinent results of our study are highlighted in this *Executive Summary*. Supporting narrative, tabular data and other materials contributing to these conclusions are contained within a series of addenda comprising the body of the report. The synopsis presentation is divided into nine sections:

1. **Primary Study Conclusions**
2. **The Subject Property and Proposed Project**
3. **Overview of the West Hawaii Region**
4. **The West Hawaii Resort/Residential Homesite**
5. **Analysis of Membership Lodge Market Factors**

6. **Appropriateness of the Subject for the Planned Use and Absorption Estimates**

7. **Analysis of Employment, Wage and Business Activity Impacts of the Proposed Development**

8. **Analysis of Population, Property Values and Socio-Economic Impacts of the Proposed Development**

9. **Assessment of the Public Costs/Benefits Associated With the Project**

The primary source information regarding the subject used in our study were: maps, phasing schedules and cost estimates provided by PBR Hawaii; the March 2000 Environmental Assessment and Notice of EIS Preparation, submitted by Pacific Star LLC which contained project descriptions, details and planning objectives and timing guidelines; and site specifics, marketing goals and development insight provided through Hokulia/1250 Oceanside Partners.

The Keopuka Lands site and environs were inspected for this assignment during April 2000.

Primary Study Conclusions

Based on our analysis of the subject property, its environs, and envisioned development, we have reached the following primary study conclusions regarding the proposed Keopuka Lands project.

Among our market conclusions:

- After an extended period of slumping activity, the West Hawaii residential estate/resort sector is undergoing a resurgence of demand, with numerous projects (notably the "membership communities" at Hualalai and Hokulia) experiencing strong market acceptance and appreciating prices. This level of demand is being seen throughout the neighbor islands and is anticipated to continue during the emerging economic upcycle.

- Several factors have contributed to the resurgent economy, primarily a growth in tourism brought about by the maturation of the Kohala resort communities, increases in the number of

direct flights into West Hawaii from the mainland U.S. and Japan, and the interest in purchase opportunities from upper-income west coast second home buyers (many from the San Francisco and Pacific Northwest regions). Visitor arrivals and expenditures have climbed rapidly over the past four years, and the leeward side of the Big Island is now establishing itself as a destination competitive with Maui, traditionally the leader in neighbor island tourism.

- While there have been numerous golf course-oriented subdivisions proposed in Kona over the past 15 years, most have not come to fruition due to entitlement, capital or economic problems, resulting in a currently limited competitive supply. The membership community subsector is the fastest growing constituent of the larger resort/residential market and is expected to comprise in excess of 70 percent of total demand over the next 20 years. Although additional competitive member homesites are anticipated to come on-line during the next several years at Kaupulehu, Kukio, Maniniowali and elsewhere, they are not anticipated to fully address the level of potential demand forecast for the sector. Under mid-point demand assumptions, the level of supply will fall at least 100 lots short of demand during the projection period.

- The subject property is a superior location for the proposed development in regards to views, slope, climate and achieving an ambiance of exclusivity and isolation attractive in a members-only community. Ocean panoramas will be available from every lot, the area is consistently warm, dry and wind-less (the latter plaguing many West Hawaii residential/resort areas), and the surrounding area has a rural/agricultural character that sets it apart from the coastal developments which comprise the majority of supply.

- We conclude the 125 lots will achieve good to strong market acceptance upon offering, particularly the oceanfront (a scarce commodity) sites and those fronting the golf course and ponds. There is only one other project in the state, Hokulia, which has provided significant numbers of acreage on-course lots, and it has been well-accepted during its on-going sales program. We estimate the cumulative absorption of the finished lots will be at a rate of 3.5 to 6.0 per month during sales, resulting in an overall sell-out period of from circa 20 to 36 months.

- The "Members Hale" lodge will provide needed support to the proposed community in regards to dining, concierge, sundries and entertainment services, and will be the central meeting place of the development. It will also allow non lot-owning members to visit the site and play the course, and will allow lot buyers access to the project prior to completion of their homes. It will be an assistance to the sales program. We anticipate the facility will reach a stabilized operation at nearly 70 percent occupancy within three years of opening and that it will have the necessary characteristics to be economically viable.

Among our economic impact conclusions:

- The project will be a significant source of employment for the region, which currently lacks many such opportunities, during both construction and on-going operation. We have projected it will require approximately 15 years from ground-breaking to total community build-out. During this time, there will be an estimated 3,528 full-time equivalent worker years of employment created on-site, with an additional 1,176 worker years in off-site positions. After completion, there will be some 147 permanent on-site jobs in the members hale, at the golf course and in home maintenance, and an additional 74 off-site support positions.

- Total wages paid into the region as a result of the subject development during the construction period will be in excess of $105.4 million in constant year 2000 dollars, including the on-going hale and course operations, with a stabilized operating payroll (on and off-site positions) of about $5.5 million. The total direct costs capital investment required for the community will be about $156.9 million, or the equivalent of a large resort hotel. Area contractors and suppliers should reap profits approaching $22 million from the project.

- At build-out the average daily de facto population of Keopuka will be about 211 persons, comprised of some 133 hale guests and 78 home-users. Of this total, the full-time resident population is expected to be some 26 persons, with fewer than

five school-age children. Discretionary expenditures by project residents/guests into the West Hawaii region on a stabilized basis are forecast to be $12.83 million per year, and total more than $95 million during the 15 year construction period. Full-time resident income is forecast at $2.58 million annually.

- We do not foresee any significant off-site socio-economic impacts resulting from the project. The members only character of the community will substantially limit the associated effects. Sales activity and property values in the subject "neighborhood" have been moving upwards for more than a year, and will continue to do so for a variety of factors not related to the development. There is a heavy and increasing demand for view lots in the greater Napoopoo region. While some immediately abutting parcels may see appreciation as a result of enhanced view planes across the golf course to the ocean, the overall impact will be nominal. Building the Keopuka Lands subdivision will not increase the upward pressures in values, nor will abandoning it bring about a drop in prices or demand.

- Traffic is being addressed by others. However, the de facto population and associated number of trips will be comparatively low. Further, the eventual completion of the proposed Highway By-pass Road will provide the primary access and meaningfully increase the carrying capacity of the region's road system, more than off-setting any minimal increases due to Keopuka. Use of other public systems, such as schools, parks and government facilities will not measurably increase.

Among our public costs/benefits assessment conclusions:

- At build-out the assessed value of the project will be en estimated $208.15 million, generating some $3.05 million annually in property taxes for Hawaii County.

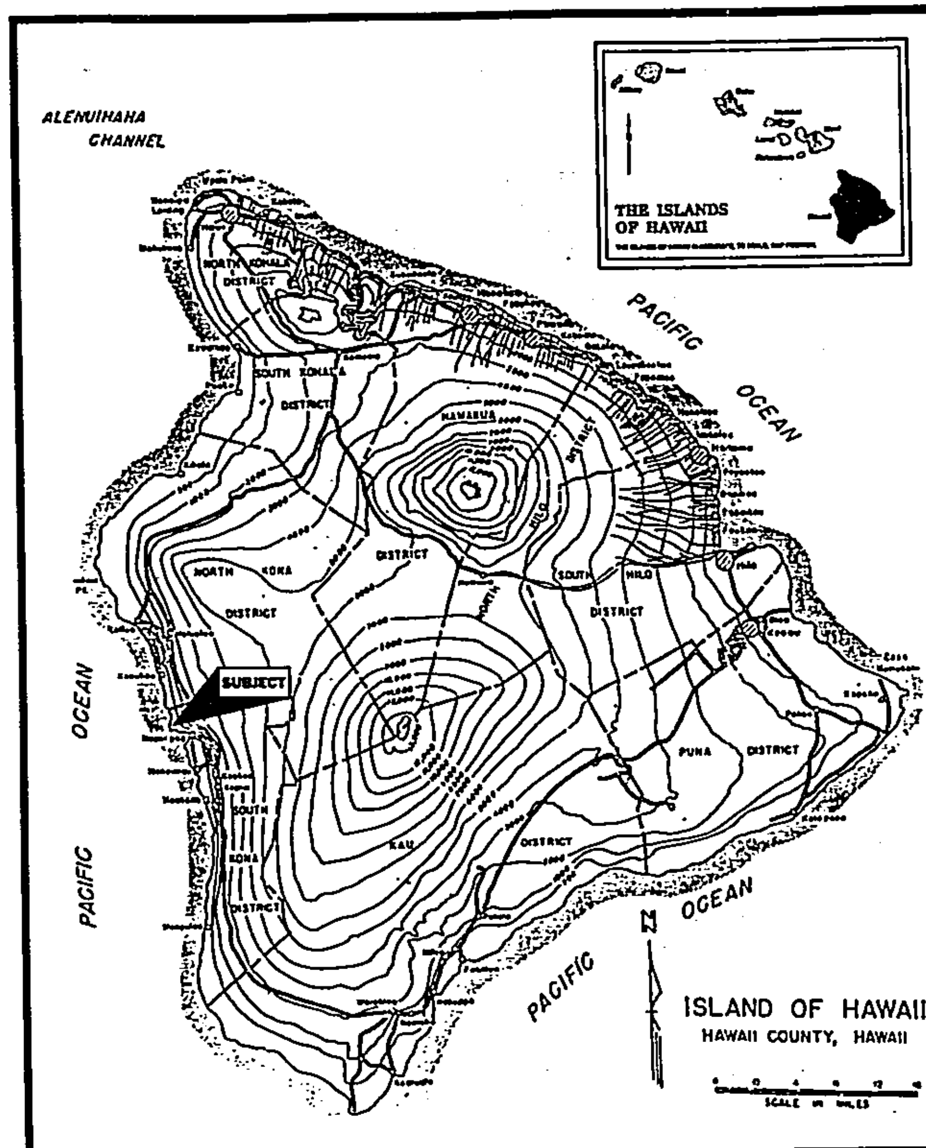
- During the 15 year construction period, we forecast total personal state income taxes paid by the workers and residents will total $24.9 million, with an additional $2.8 million paid annually on a stabilized basis. Corporate/business taxes during the build-out will total nearly $800,000 exclusive of those paid by the developer.

- The state will reap an estimated $7.5 million in gross excise taxes during the construction time-frame, and some $750,000 million annually after build-out.
- The per capita allocated costs of the community to the public purse will be approximately $9.4 million dollars during the construction period, split between the state ($7.6 million) and the county ($1.8 million). On a stabilized basis the annual cost total will be some $1.02 million for the state and $242,970 for the county. The actual costs incurred by government agencies will be less.
- Overall, the state will see a net benefit of $24.8 million in benefits versus costs during the construction period, and about $2.75 million annually thereafter. The county will have an aggregate benefit of more than $26.6 million during build-out and $2.8 million yearly thereafter. In no year will either the state of county pay out more in costs as a result of the project than received in primary taxes.

THE SUBJECT PROPERTY AND PROPOSED PROJECT

The subject property has a general, narrow "wedge" shape, having an average depth of about 11,750 feet and ranging in width from 4,700 feet along the shoreline to 600 feet of frontage on Mamalahoa Highway on the mauka boundary. The holding comprises 660 acres of undulating lands which stretch from the arid, rocky shoreline upslope to a cooler, forested 1400-foot elevation. The site is located one-half mile north of Kealakekua Bay, approximately 16 and 24 miles south, respectively, of Kailua-Kona Village and the Kona International Airport.

The property, identified on State of Hawaii Tax maps as Third Division, Tax Map Key 8-1-07, Parcel 1, 54 and 55, ranges in topography from gentle to steeply sloping, with most locations having panoramic ocean views (westerly), along the central Kona coastline (northerly) and the lower flanks of Mauna Loa (easterly). The climate



ISLAND LOCATION MAP
Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

is warm, generally dry, and protected from the tradewinds, with superior conditions for the type of use proposed.

Access to the site, which is currently undeveloped with the exception of about 30 acres of Macadamia orchards in the mauka portion, is available from Mamalahoa Highway, a two-lane macadam surfaced arterial that is the region's sole thoroughfare and the foundation for the ribbon effect of the community and its land use patterns. The planned Highway Bypass road will bisect the upper elevations of the subject and provide primary access to the subdivision.

The majority of the holding is presently within the Agricultural District on State Land Use Maps; however, it has moderate to poor soil conditions, and no history of meaningful economic farm or ranching use apart from the small nut orchard. A band along the shoreline is within the Conservation District. The county of Hawaii General Plan classifies the subject as Extensive Agriculture (the majority of the site), Orchards (in the mauka areas) and Open (along the waterfront). County zoning is "A-5a" which calls for agricultural lots no less than five acres in size. The near-shore portions of the holding are within a county-administered Special Management Area.

The Keopuka Lands master plan has been designed to permit the proposed development without requiring changes in the foundational state and county land use designations; yet, numerous special permits, use permits, and density allocation approvals will be necessary.

The surrounding neighborhood is generally undeveloped, with no in-place uses of the majority of the lands to the north and south. There is some limited residential and agricultural-related uses near the highway, with the inland (or easterly) tip of the property near Captain Cook village and about one mile north of Kealakekua village. The Kealakekua Bay State Historical Park abuts the subject to the south, with the Captain Cook Monument located just south of the Keopuka shoreline.

Though the area remains rural in character, sub-urban development pressures are emerging, a product of the favorable climate, excellent views, choice lifestyle, vast lands available, and proximity to the urban transformation of greater Kailua-Kona. Demand for real property in the region is increasing, and a variety of use alternatives are being

explored; yet, the study area is likely to continue as agrarian-oriented in use and ambience into the foreseeable future.

The proposed Keopuka Lands subdivision will include:

- 125 agricultural/estate homesite lots spread throughout the property, all having superior views and approximately half with golf course frontage, classified as shown in the chart below.

Lot Type (Minimum Size)	No. of Lots	Location in Project
Five-Acre Lots	13	Mauka
One-Acre Lakefront Lots	8	Central/Mauka
Two-Acre Lots	77	Central
One-Acre Oceanfront Lots	27	Makai

- An 18 hole championship, private golf course, spreading over the lower elevations of the project (below the 700-foot elevation). The clubhouse will provide administration, retail/dining, and storage support for the course operation and community.
- A private 100-room Members Hale lodge, containing lobby, dining room(s), administration offices, and amenities for non-resident member and their guests. To be located on 15 acres adjacent to the clubhouse.
- An open space, landscaping, roadways, and several acres of pond/lake features.

The infrastructure, golf course and site features will be constructed in a single phase estimated to take from 18 months to two years. The Members Hale will be built in about three years after the opening of the development, with the clubhouse serving as the community gathering place until the lodge is completed. Construction of the finished homes will take a decade after the lots are fully absorbed.

OVERVIEW OF THE WEST HAWAII REGION

The subject development will service the resort/residential needs created by the continuing economic and population expansion of West Hawaii, a 1,000 square mile region covering the leeward side of the Big Island. The area stretches some 100 miles along the coastline and is comprised of the districts of North and South Kohala and North and South Kona, which contain a variety of land and use types, including lava deserts, rain forests, ranch and agricultural lands, and urban development.

The area is in the midst of a major transition in regards to land use and the economic base. Forty years ago West Hawaii was a stable agrarian culture, with scattered villages, a resident population of about 14,000, little tourism, and limited commercial and industrial development. All products were shipped from Oahu, there were few major retailers, it had a relatively primitive financial structure, and most of the island's businesses were located on the Hilo side.

Over the past four decades, the trend towards an urban economy has been exceptional, though cyclical, echoing the transitions seen on Oahu in the 1940s through 1960s, and on Maui in recent years. Today, the state's major businesses are represented in West Hawaii, with independent major facilities and not mere transshipment points. The type of businesses are evolving to that of a freestanding modern community, as opposed to the traditional "outer island" character. Where few base businesses once existed and consumer options were limited, there is now competition and an expanding spirit of local entrepreneurship.

At present there are approximately 64,165 people residing in West Hawaii, with an average daily count of about 21,690 tourists. By the year 2020, it is projected the resident population of the region will be 104,343 (an increase of 63 percent) and the daily visitor count will be 42,688 persons (up 97 percent).

These persons generate a significant demand for urban land uses, which is expected to more than double over the next two decades, as more competition enters into the market and the transitional economy further solidifies into typical modern form.

A summary of West Hawaii population and economic indicators is displayed on Table 1.

Currently there is an estimated 1.8 square feet of commercial development in the study area, some 1.96 square feet of finished industrial space, about 7,600 visitor units, and over 24,000 residential units. Each of these use types is expected to grow by a minimum of 70 to 120 percent by the year 2020, an increase which will be further stimulated by the emergence of West Hawaii as a more energized political unit. Where it was often overlooked in regards to civic resources in past years, the region is now the recipient of significantly more public projects.

The Kailua-Kona to Keahole corridor has been identified as the focal point for future urbanization and the location of the supporting industrial, commercial and civic uses vital to the long-term success of the region. Both the state and county have developed land use plans for this area during the past 11 years in order to establish a reasonable framework for uses in the West Hawaii coastal corridor.

The region boomed in the mid to late-1980s, with major development of all types, particularly those associated with resort and commercial uses. More than one million square feet of commercial space was added, including the first stores for major mainland retailers (Costco, K-Mart Safeway, Borders, among others), and the visitor unit inventory expanded by nearly 3,000 units. Significant growth was also experienced in the industrial and residential sectors.

By the end of the decade, the regional job count had doubled (from 17,300 to 34,200 positions), unemployment had dropped to about six percent, and real estate appreciation was well into double-digits annually. Major projects were being pursued in West Hawaii that would have added another 25,000 resort units, 15,000 residential units and more than 600 acres of commercial/industrial/business lands.

The deep recession of the early to mid-1990s resulted in a severe stagnation of virtually all economic activity. By 1996, the population of West Hawaii had stabilized, unemployment was above 10 percent, construction activity was at a standstill, and most of the proposed projects had been placed on hold or abandoned. There were some positive aspects, such as the successful acceptance of the "big box" retailers, the high-quality reputation being established by the coastal

TABLE 1

SUMMARY OF HISTORIC AND PROJECTED POPULATION AND ECONOMIC INDICATORS
FOR THE WEST HAWAII REGION 1960 TO 2020 (1)
Market Study, Economic Impact Analysis, and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

	Historic				Projected		
	1960	1970	1980	1990	2000	2010	2020
Resident Population							
Hawaii County	61,332	63,468	92,053	120,317	149,600	173,900	205,400
% Annual Compounded Change		0.34%	3.79%	2.71%	2.20%	1.52%	1.68%
West Hawaii Region	14,167	14,472	27,518	43,373	65,031	82,776	104,343
% Annual Compounded Change		0.21%	6.64%	4.66%	4.13%	2.44%	2.34%
% of County Total	23.10%	22.80%	29.89%	36.05%	43.47%	47.60%	50.80%
Economic Indicators							
1. Tourism							
Hawaii County Room Count	581	3,166	5,889	8,952	9,900	11,400	13,000
% Annual Compounded Change		18.48%	6.40%	4.28%	1.01%	1.42%	1.32%
West Hawaii Region	152	1,584	3,844	6,825	7,600	8,900	10,200
% Annual Compounded Change		26.41%	9.27%	5.91%	1.08%	1.59%	1.37%
% of County Total	26.16%	50.03%	65.27%	76.24%	76.77%	78.07%	78.46%
Hawaii County Visitor Arrivals	119,000	477,720	761,103	1,030,900	1,300,000	1,800,000	2,350,000
% Annual Compounded Change		14.91%	4.77%	3.08%	2.35%	3.31%	2.70%
West Hawaii Region (2)	27,000	254,720	442,483	730,900	975,000	1,450,000	1,975,000
% Annual Compounded Change		25.16%	5.68%	5.15%	2.92%	4.05%	3.14%
% of County Total	22.69%	53.32%	58.14%	70.90%	75.00%	80.56%	84.04%
2. Job Count							
Hawaii County Job Count	22,293	28,410	38,200	57,200	63,500	78,400	95,000
% Annual Compounded Change		2.45%	3.01%	4.12%	1.05%	2.13%	1.94%
West Hawaii Region (est.)	3,300	8,600	17,300	34,200	40,200	53,900	68,000
% Annual Compounded Change		10.05%	7.24%	7.05%	1.63%	2.98%	2.35%
% of County Total	14.80%	30.27%	45.29%	59.79%	63.31%	68.75%	71.58%

(1) Includes the districts of North Kohala, South Kohala, North Kona and South Kona.
(2) Estimated according to port of entry.

Sources: US Census (population figures), Hawaii Visitors Bureau (tourism)
County of Hawaii and State DBED (employment), and
The Hallstrom Group, Inc.

resorts, and that the number of business declaring bankruptcy were less than seen in other island locales.

Several factors have contributed to the change from stagnation to growth in recent years, notably a resurgence of tourism (due to direct daily flights to Kona from the mainland and Japan, and upscale resort development drawing the newfound West Coast wealthy), an increase in construction activity, and a general (though limited) strengthening of the statewide economy. The orientation of the visitor industry towards the mainland U.S. traveler also helped the region weather the problems associated with the Asian currency crises of late 1997.

Virtually every indicator points to the returning health of the West Hawaii market. Unemployment has dropped several points to about eight percent, construction activity is up by more than half from four years ago, appreciation is being evidenced in the real estate market once again, and agents report significantly increased interest in available commercial and industrial space, with building owners offering fewer concessions to prospective tenants. Many landowners are reviving development plans that had been on hold for the past decade, and the absorption of new inventory additions in the resort, residential and industrial sectors is typically exceeding all expectations.

It is evident the economy is in an "up" or growth cycle, one that is expected to continue for several years. Even if there is an economic slowdown on the mainland, the increasing number of direct flights to West Hawaii should help off-set any downturn, as should the more diversified and established business community that is emerging in the region which will be less subject to off-island whims.

The fundamental regional economic support for the proposed Kaloko-Honokohau Business Park development is highly favorable at this time.

THE RESORT/RESIDENTIAL HOMESITE MARKET SECTOR

Until the mid-1980s, the resort/residential homesite market was considered as an incidental component within neighbor island destination communities, overshadowed by hotel, condominium, commercial, and amenity development.

By late in the decade activity in this sector surged to the forefront of the resort-oriented market. Several factors contributed to the rapid emergence and success of this product type; most notably, the 1986 U.S. Tax Reform Act, the escalating financial status of individuals in the prime Hawaii purchaser markets of Japan and the West Coast, diversification of project orientation, and the higher profit/lower risk profit potentials for lot subdivision relative to that offered through condominium or hotel development.

The result was a meteoric expansion of developer, investor, and purchaser interest in moderate to up-scale resort/residential homesites within neighbor island destination communities, with more than 1,000 subdivided between 1986 and 1990. The resort finished home market also dramatically widened.

Resort/residential homesites encompass a broad range in size (from 10,000 square feet at Wailea to over an acre at several Big Island resorts and Kapalua), amenities, exclusivity and locational attributes. Many of the projects (such as the subdivisions at Princeville, Keauhou, and in the northerly areas of Wailea) have a distinct residential feel with large numbers of full-time residents, being merely up-scale subdivisions within a greater resort community. Others possess a definite resort ambience as at Kapalua, Hualalai, Mauna Kea, and Mauna Lani.

Privacy and exclusivity are focal points of the higher quality developments, with security gates, rock walls and extensive covenants regarding design, color, upkeep and use. Most projects have an extremely low occupancy factor with significant numbers of homes sitting vacant much of the time. Buyers are typically offered membership in a resort club providing use, changing and service privileges. In most resorts, home building occurs relatively rapidly after initial lot sales.

Historic Development and Sales

The attraction of the homesites beyond their inclusion in a resort are the strict building and maintenance covenants that are often lacking outside master planned communities, access to up-scale dining and

shopping establishments, proximity to recreational opportunities (golf, tennis, beach), the enhanced security associated with a resort, and a typically greater price and demand stability than found in non-resort projects. For purchasers, name recognition is very important (as owning a Hawaii resort home has a definite status quotient), a factor lacking outside the resort communities except for those properties having direct beach frontage.

In the late 1980s, buyers were a mix of West Coast United States and Japanese purchasers. However, demand among Asians has dropped substantially during the past ten years, being replaced somewhat by a broader international clientele; although West Coast purchasers continue to dominate the sector.

Over the past several years the percentage of local resident buyers has increased in many resorts, interior/non-golf course fronting subdivisions at Wailea, and throughout the homesite projects at Keauhou and Princeville.

As with other resort property types, demand for lots and homes began to fall by 1991, after surging the previous four years with activity leveling off sharply (by nearly 80 percent) over the ensuing half decade. The dependency of the sector on Japanese, investor, and corporate purchasers groups, all heavily hit by the recession, exacerbated the trend.

In 1981, there were only 640 competitive neighbor island resort homesites, with total sales of only 54 lots during the year at prices ranging from $40,000 to $135,000–most towards the lower end of the spectrum.

Nearly two decades later, the total number of prime homesites has increased to 2,151, the majority developed during the 1987-91 period, with 418 original lot transactions recorded at the peak of the market in 1990. Selling prices now are typically in the range of $400,000 to $800,000.

A long-term summary of the development and sales activity in the identified neighbor island destination resort developments is shown on Table 2; included are both interior and on-water sites.

The resort/residential homesite subdivisions competitive in West Hawaii, and their sales from 1986 through 1999 are shown on Table 3. The number of sales and velocity overall has climbed steadily since 1994, and escalated rapidly after 1998. Data for the first four months of 2000 show a continuation of the upcycle trend, with the result being more sales, stiffening prices and the emergence of the re-sale market.

Resort Home Site Sales Prices

The data uncovered by our research of resort home site sales in major resorts through year-end 1999 in the State of Hawaii is summarized in the Addenda. The data is comprised of transactions obtained from various sources including on-line and in-house databases, project price lists, and other sources.

Table 4 displays vacant land transactions occurring within the competitive West Hawaii resorts of Mauna Kea, Mauna Lani, and Hualalai. Overall, prices range from $200,000 and $4,200,000 per single-family lot. Residential sites in the one-half-acre range having no extraordinary features (such as proximity to the ocean or expansive views), that are part of earlier developments and have been around for several years, comprise the lower end of the price range. The upper end consists of newer larger lots (approximately one acre) and those having ocean and/or superior golf course frontage or panoramic views.

General Demand Trends

Our analysis indicates the demand for new resort-quality homesites on the neighbor islands from 1999 through 2019 will be as follows:

NEIGHBOR ISLAND NEW RESORT/RESIDENTIAL HOMESITE DEMAND			
	Average Annual Demand	Total Periodic Demand	Cumulative Demand
2000 to 2004	180	900	900
2005 to 2009	200	1,000	1,900
2010 to 2014	190	950	2,850
2015 to 2019	200	1,000	3,850

TABLE 2

SUMMARY OF NEIGHBOR ISLAND RESORT/RESIDENTIAL HOME SITE ACTIVITY
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

Development	Total Subdivided Lots	Range in Size (Sq. Ft.)	Current Price Range Low	Current Price Range High	Percent of Lots Offered Absorbed	Average Annual Sales Original Sales (1)	Average Annual Sales 1/1986 through 12/1999 (2)
Wailea	506	10,000 to 23,500	$170,000	$900,000	92%	24.8	67.3
Kaanapali Beach	276	10,500 to 69,696	$150,000	$500,000	94%	22.8	25.3
Kapalua	143	9,500 to 350,000	$210,000	$1,050,000	100%	80.5	22.9
Mauna Lani	105	15,000 to 83,000	$200,000	$3,475,000	100%	26.5	11.5
Mauna Kea Beach	100	20,000 to 57,000	$1,250,000	$3,500,000	100%	8.3	4.8
Hualalai @ Kaupulehu	53	11,250 to 42,500	$650,000	$5,400,000	100%	17.7	15.5
Keauhou	183	15,000 to 23,000	$175,000	$325,000	88%	25.7	36.1
Princeville	785	10,000 to 31,000	$115,000	$275,000	96%	51.8	46.5

(1) Average lots sold yearly during original sales program.
(2) Average lots sold yearly from January 1986 through year-end 1999, original and resales; or since lot sales began.

Source: Various, and The Hallstrom Group, Inc.

TABLE 4

REPRESENTATIVE HOME SITE SALES PRICES IN COMPETITIVE WEST HAWAII RESORTS
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

Development	Land Area (Sq. Ft.)	Price Range Low	Price Range High
Mauna Kea Resort			
The Bluffs at Mauna Kea	24,319-55,342	$1,250,000	$3,500,000
The High Bluffs at Mauna Kea	31,327-37,206	$1,250,000	$1,750,000
Moani Heights	17,497-44,985	$690,000	$990,000
Mauna Lani Resort			
Champion Ridge at Mauna Lani	20,454-24,949	$200,000	$276,000
The Point Estates at Mauna Lani	16,384-20,297	$532,500	$550,000
The Cape at Mauna Lani	36,446-39,897	$900,000	$1,200,000
49 Black Sand Beach	26,877-64,382	$850,000	$4,200,000
Hualalai Resort			
Hualalai K-1 Subdivision	22,958-70,480	$1,600,000	$3,503,000
Hualalai K-2 Subdivision	19,985-49,136	$2,400,000	$3,703,000
Kai Malino at Hualalai Resort	11,277-22,290	$650,000	$850,000
Ka'ulu at Hualalai Resort	22,954-43,821	$950,000	$2,003,000

Source: MLS Hawaii, Inc., and The Hallstrom Group, Inc.

TABLE 3

SUMMARY OF ANNUAL HOME SITE (LOT) SALES OF PRIMARY COMPETITIVE DESTINATION RESORT/RESIDENTIAL SINGLE FAMILY LOT INVENTORY 1986 THROUGH 1999
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

Resort/Project	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Total	Annual Average
Wailea																
Fairway Homes	1	0	2	2	1	1	0	0	0	0	0	0	1	1	9	0.64
Wailea Kai	26	13	15	6	6	0	1	0	2	1	3	2	0	5	80	5.71
Wailea Golf Estates	16	17	12	9	3	2	2	1	0	0	0	1	2	3	68	4.86
Wailea Kaiola		45	66	28	23	2	4	4	6	3	3	5	5	6	200	15.38
Wailea Golf Vistas								1	1	8	0	6	9	12	37	5.29
Wailea Highlands												12	14	6	32	10.67
Pualani Estates									3	12	13	2	1	14	45	7.50
Total Resort Lot Sales	43	75	95	45	33	5	7	6	12	24	19	28	32	47	471	33.64
Kapalua																
Kapalua Place				7	1	0	0	1	1	0	1	1	2	2	16	1.45
Pineapple Hill		57	61	21	22	5	5	8	4	11	5	11	12	14	236	18.15
Plantation Estates					28	2	2	12	1	3	3	3	9	6	69	6.90
Total Resort Lot Sales	0	57	61	28	51	7	7	21	6	14	9	15	23	22	321	22.93
Mauna Kea Beach																
The Fairways	2	13	9	11	6	2	1	0	1	1	0	1	2	4	53	3.79
The Bluffs												1	7	6	14	4.67
Total Resort Lot Sales	2	13	9	11	6	2	1	0	1	1	0	2	9	10	67	4.79
Mauna Lani																
The Cape					14	1	1	1	0	0	3	1	2	2	25	2.50
The Point Estates				19	5	1	0	0	1	0	1	2	3	5	37	3.36
Champion Ridge					25	2	1	2	0	1	14	4	6	10	65	6.50
49 Black Sand Beach														34	34	34.00
Total Resort Lot Sales	0	0	0	19	44	4	2	3	1	1	18	7	11	51	161	11.50
Hualalai @ Kaupulehu																
K-1											4	7	2	4	17	4.25
K-2												15	11	4	30	10.00
A-1														15	15	15.00
Total Resort Lot Sales											4	22	13	23	62	15.50
Total Competitive Units Sales	45	145	165	103	134	18	17	30	20	40	50	74	88	153	1,082	88.36

Source: Prudential Locations, Inc., Coopers & Lybrand L.L.P., Maui and Big Island Board of Realtors, and The Hallstrom Group, Inc.

TABLE 5

SUMMARY OF PROPOSED NEIGHBOR ISLAND
SINGLE FAMILY RESORT/RESIDENTIAL DEVELOPMENT
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
Approved Projects Only (1)

Project	Residential Development Proposed To Begin	Single Family Homesites Existing	Proposed/ Approved	Total
MAUI COUNTY				
Wailea	Underway	506	182	688
Kaanapali Beach (2)	Underway	276	585	861
Kapalua	Underway	143	450	593
Makena	Pending	0	750	750
Maui Wailea 670	Pending	0	548	548
BIG ISLAND				
Mauna Kea Beach (5)	Underway	100	131	231
Mauna Lani	Underway	161	1,345	1,506
Waikoloa Beach	Pending	0	800	800
Keauhou	Underway	183	841	1,024
Hualalai @ Kaupulehu	Underway	60	137	415
Kukio Beach	Underway	0	100	100
Kohanaiki	On-Hold	0	380	380
Maniniowali	Pending	0	150	150
LANAI/MOLOKAI				
Kaluakoi (Molokai) (3)	Underway	15	800	815
Koele (Lanai) (4)	Underway	12	588	600
Manele Bay (Lanai) (4)	Pending	0	400	400
KAUAI				
Princeville	Underway	785	2,015	2,800
TOTALS		2,241	10,202	12,661

(1) Only those projects having SLU and/or County General Plan approvals considered. Vacation areas (such as Poipu) are excluded. Where proposed units range in number, mid-point is shown. "Existing" totals include units under construction.
(2) Assumes up to 325 additional lots within South Beach Mauka increment, and circa 250 in North Beach Mauka project, actual number may be from 0 to 500.
(3) Proposed units based on most recently forwarded plans. 4,500 acre holding could support significantly more development over long-term.
(4) Proposed units based on estimate of density of development parcels. Three units/acre.
(5) Includes proposed inventory in the adjoining South Kohala Resort.

Source: Various, and The Hallstrom Group, Inc.

The substantial portion of total demand (up to 98 percent) would be anticipated to flow to leeward Maui and West Hawaii, with about 45 to 55 percent of this amount, or 1,887 to 2,264 total homesites, directed to Maui, divided into five-year periods as follows:

ESTIMATED WEST HAWAII MID-POINT RESORT SINGLE-FAMILY DEMAND (2000 through 2019)

	Average Annual Demand	Total Periodic Demand	Cumulative Demand
2000 to 2004	100	450	450
2005 to 2009	90	500	950
2010 to 2014	95	475	1,425
2015 to 2019	100	500	1,925

General Supply Trends

Significant numbers of competitive, moderately-high to upscale single-family subdivisions are proposed for the neighbor islands over the coming two-plus decades, the majority in West Hawaii. A summary of the approved projects are shown on Table 5.

If all of the developments were built according to publicly-announced development plans (including long-term expansion areas), the total number of new homesites offered over the next 20-plus years would be 10,202, or equivalent to 265 percent of the indicated demand. Additionally, significant numbers of golf course fronting lot homesites have been considered at several other off-water, quasi-resort developments.

Beyond this large quantity of proposed development, both quality and likelihood of occurrence must be considered. We consider it highly unlikely that all of the projects will be built to maximum densities, particularly at Makena, Mauna Lani, Mauna Kea Beach, and Keauhou, or that all of the proposed communities will be constructed in a timely fashion. Additionally, 1,788 of the homesites are proposed for unproven locations on Lanai and Molokai.

On an overall basis, the sector has generally sufficient supply to meet indicated non-specific demand levels, but it is unlikely that enough competitive inventory will be developed to create as substantial an oversupply condition as the gross proposed unit numbers indicate. We anticipate supply and demand levels to be relatively in-sync in the critical Maui and West Hawaii regions during the projection period.

The "Membership Community" Homesite Subsector

At the peak of the resort/residential and golf course markets in the late 1980s, there was significant interest expressed by developers and purchasers in limited-size, private membership communities. The projects would be centered around championship golf courses and provide a full-range of resort quality amenities and services within large, exclusive, low-intensity developments. Access and use would be limited to members and guests.

Numerous freestanding communities were proposed on the neighbor islands (in West Hawaii at Puako, Maniniowali, Waikoloa and elsewhere), and many standard resorts began marketing homesites stressing a strong "membership" aspect within the greater resort.

Yet, the proposed developments were not actualized due to recessionary effects, capital difficulties master plan changes and sundry other causes with two exceptions. But the concept remained strong from a market perspective, as demonstrated by the two projects that have been in sales and leading the resort/residential sector.

Hualalai at Historic Kaupulehu is a combination upscale resort and members community that has achieved excellent resort/residential product absorption and has forged a superior reputation in the marketplace since 1996. Hokulia, an under-construction South Kona project very comparable with the subject, has sold 45 percent of its Phase I inventory in less than two years and is demonstrating the potential demand for rural communities fully removed from visitor industry influence and an alternative to resort lots.

The success of these two projects has created widespread interest, and there are many emerging proposals for new such development at stand-alone sites and within existing resorts. The fundamental attractions of these projects are:

- An exceptional quality of the constituent facilities (particularly the golf course design and lodge/hotel facility).

- Highly restricted, low intensity, low rise, and low density development, creating scarcity of product and an environment of exclusivity.
- Community control of operational, club, architectural and land use issues.
- Sufficient space to insure isolation, open space/buffers and amenities, and limit negative future off-site influences.
- Restricted use of the course and amenities, to ensure easy access for members and guests without outside crowding influences.
- A pride of integrated ownership unavailable in a typical mixed-use resort environment.
- A marketing/promotional plan and on-site ambience which creates a feeling and reputation of special or privileged membership

Existing Supply

The two developments which have offered product meeting these criteria have done very well over the past several years.

Hualalai at Historic Kaupulehu is a 600-acre project centered around an 18-hole Jack Nicklaus-designed, members-only course that is considered one of the finest in the state. A typical resort hotel was demolished in mid-construction and replaced with a bungalow-style facility operated by Four Seasons. The ultra-luxury 243-room lodge has among the highest average daily room rates in Hawaii and has high occupancy levels. The community will contain up to 400 total single-family lots and multifamily units. The residential sales program has been a notable success, achieving rapid absorption of all product offered at high average prices. The community is about half finished, and the second phase will contain another course and the remaining 250 resort/residential units.

More than three-quarters of the first 60 single-family lots, ranging in size from 11,277 to 43,821 square feet, and in price from $600,000 (interior) to $4,200,000 (oceanfront) have been sold or are reserved. With marketing programs for some of the various products requiring just a few months to achieve sell-out. Purchasers are primarily from the West Coast (dominated by northwest and northern California residents) seeking an ownership "feel," prestige and exclusivity, and typically specifically avoiding Maui and the large resorts.

The overall average original selling price for the lots has exceeded $1.5 million and is the highest average price achieved by any resort in the islands. The few re-sale prices show escalation equal to nearly 10 percent annually from initial sales. Resort brokers report sales continue to be strong and all available inventory will be quickly sold. Developer studies project the remaining inventory in the project will require a maximum of six to seven years, equating to a minimum absorption rate of 3.5 to 4.0 per month. In a move to maximize scarcity premiums and generate the highest prices, the project has pursued a course of limiting development; otherwise, the average sales velocity would be higher.

The project has also experienced strong acceptance of its multifamily units, with 55 of the first 66 units sold or reserved to date (83.3 percent of the product offered). Prices have ranged from $812,000 to $1,700,000, a high average price for non-oceanfront condominium inventory. Current starting prices for the large duplex to four-plex townhouses are above $1.25 million, and there have been resales showing appreciation of up to 8 percent annually from the first sales which began in December 1996.

Club members (which include homeowners) have full use of course, spa and recreational facilities and access to the Four Seasons. Most have several homes and spend only a small portion of the year in Hawaii.

While there has been marked recovery in residential sales at other Kohala resorts in recent months, none of the other communities has approached the level of absorption and pricing seen at Hualalai. All parties, the developer, brokers/agents, and purchasers all point to the quality, exclusivity, reputation and scarcity associated with the

membership concept, and expect the market share for this development type to increase in coming years.

Hokulia is an under-construction 1,550-acre membership community located three miles north of Keopuka. The first phase of the development will include 261 homesites (ranging upwards in size from one acre), an 18-hole Nicklaus designed golf course and clubhouse, tennis center, beach pavilion, spa, restaurant, parks/open space and other amenities. Additional phases will include a members lodge, a second golf course and up to 400-plus more homesites.

The club is designed for some 390 members, with the first 250 lot purchasers receiving special membership packages that retain privileges for the initial buyer even if the property is later sold. While many of the purchasers are from the Western U.S., a more diverse international demographic is emerging at this project than seen at the coast resorts.

The absorption of lots at the project has been exceptional to date, despite the initial concerns by some regarding its relatively outlying location; a factor brokers now contend contributes to a reputation for isolation, exclusivity and as providing a unique experience/opportunity alternative to typical coastal resorts. Buyers are attracted by the terrain, views, gentle winds, vegetation and a sense of retreat not found in the arid, lava-strewn and often windy coastal developments.

Through the study date, a total of 119 lots sales have been recorded, are in escrow, or reserved during the initial seven months of an official sales program. This equates to an average sales rate of about 17 lots per month. However, given the extended pre-sale promotional efforts the true absorption rate over time would be less than this level, but nonetheless, very strong.

The average price for the sold lots has been $992,500, and slightly less for those in escrow and reserved. The average price for the remaining available parcels (excluding 15 being retained by the developer) is $1,086,000. Brokers expect sales to continue at rates of up to seven per month, which would result in total sell-out of the initial phase of the community within about 30 months.

We consider the strong market acceptance of Hokulia, which dramatically proves the outlook for such uses in South Kona, to be a primary indicator of the probable levels achievable at a Keopuka Lands project that shares many similarities and will have (by virtue of fewer total homesites) greater potential scarcity and exclusivity quotients.

Virtually every major "standard" resort community on the neighbor islands has promoted exclusive "golf/member" homesite developments featuring larger lots one-half to two acres, special resort and course privileges, security gates. Absorption of the product in the most notable subdivisions has been strong, at Wailea Highlands and Black Sand Beach. However, the speed of sales and average prices are lower than that at three membership communities.

Prior to 1996, all 367 of the developed resort/residential homesites in West Hawaii were in standard resort communities. While most stressed a membership affiliation with the resort, there was no membership control or exclusivity.

Currently, of the 765-lot total available inventory, 321 lots (or 42 percent) of the product is within membership communities. Further, during 1999 and the first quarter of 2000, these homesites constituted 72 percent of all resort/residential lot purchases. The expansion of the membership community submarket is a natural evolution in the upper-end resort industry.

We anticipated this trend to continue until it constitutes 70 to 80 percent of the entire sector. This would make the total demand for such single-family lots in West Hawaii at some 1,037 to 1,320 over the next 20 years. Because of the availability of land and a greater feeling of isolation/exclusivity, the Big Island will have a higher market share than Maui.

Proposed Supply

Several projects are being forwarded in the greater study area which are intended to service the membership community subsector, as

identified below. In total they could comprise up to 1,413 total competitive lots.

PROPOSED WEST HAWAII MEMBERSHIP COMMUNITIES

Name	Proposed Remaining Homesites(1)	Projected Construction Offering Date
Hualalai @ Kaupulehu	137	In latter phases
Hokulia, Phase I	126	Under-construction
Kukio Bay Beach Club	100	Just underway (2)
Loko Ia @ Kaupulehu	300	Mid decade (2)
Maniniowali	150	Early Decade
Mauna Lani Parcel	200	Mid to Late Decade
Hokulia, Phase II	400	Mid to Late Decade
Total	1,413	

(1) Taken from developer and/or public materials. Excludes Makalei Estates which will have no course fronting lots and limited membership privileges.
(2) Current plan for membership community development represents revision from "standard resort" master plans originally approved.

If all 1,413 of these lots were constructed in a timely manner they would be barely sufficient to meet minimum demand estimates (1,321 lots), but would fall short of average probable demand levels by about 412 total lots. And, as had been evidenced during the past 15 years, rarely do all proposed projects proceed at the speed or densities envisioned in the planning process. We consider it highly likely that one or more of these developments will be delayed, abandoned, not approved or meaningfully revised prior to construction. The result would be to exacerbate the indicated shortfall in the market and fail to meet minimum demand levels.

Many of these projects and their constituent units are several to many years away from actualization. Only Hualalai and Hokulia will be able to market additional inventory over the next two years, followed by Kukio Bay Beach Club and Maniniowali, after which the other projects would come on in an extended staggered basis. The envisioned timing of the developments does not appear to create an obvious period of large scale oversupply, leaving room for additional competition.

Of the proposed inventory, 63 percent is located in coastal resort communities, the remainder at Hokulia. It would appear there is room for additional more remote developments outside the resort corridor.

Given the increasing interest in membership communities, the success achieved at nearby Hokulia, the escalating demand for membership homesites, and the qualities and timing of the subject, we believe it will be competitive in this sub-sector, and able to capture a commensurate market share.

Market Summary

The continuing expansion of the West Coast economy and an increasing number of local resident purchasers should further energize the sector which recovered strongly in 1999 and continues to do well into 2000. A variety of quality product is being proposed throughout the neighbor islands, with the "membership community" concept quickly becoming a major alternative to the "standard resort" inventory expected to dominate the long-term market.

The total demand for Big Island resort/residential homesites over the next 20 years is about 1,925 lots. The demand for "membership"-style lots is expected to be more than 1,500 of this total, or about 75 sales per year, on average over the next two decades.

Even if all of the currently proposed West Hawaii membership community projects were built, it would still be insufficient to meet average demand requirements by upwards of 100 lots during the projection period. If any developments are delayed or canceled, the shortfall would become meaningful.

ANALYSIS OF MEMBERSHIP LODGE MARKET FACTORS

The Members Hale, a 100-room full-service lodging facility, is a critical component of the Keopuka Lands concept. It will provide:

- vital access to the community for the two-thirds of total membership who will not own homes in the subdivision;

- needed services (including food and beverage, recreational/concierge, and retail) to members and guests visiting the rural development;
- a community gathering place and village center;
- a thematic foundation and focal point for the project;
- club and community administration and support areas; and
- a business that generates an on-going income stream in support of community operations.

The demographic target for the subject lodge is highly specific comprised of, and limited to, club members, their families and guests. As such, the demand for room nights and services can be readily quantified, enabling a determination of whether there is market justification and sufficient need for the Members Hale.

Despite its membership orientation, the subject lodge will still be operating within, and somewhat competitive with, other lodging/hotel businesses in the West Hawaii market sector. The Members Hale and the entire Keopuka Land project, is dependent upon the general health of, and specific penetration into, the Big Island and statewide tourism market.

On a foundational basis, a prosperous and expanding Hawaii visitor industry, populated by repeat guests looking for fresh island experiences, bodes well for both the subject lodging operation and demand for memberships and subdivided lots.

Big Island/West Hawaii Tourism Overview

After several years in the early to mid-90s of slumping tourism indicators, the Big Island visitor market has shown steady growth over the past three years, despite the effects of the Asian economic crises which have dampened most Pacific destinations since late 1997. Hawaii County welcomed a record 1.26 million arrivals in 1999, up markedly from the previous year, and the fourth consecutive annual increase.

Several factors have contributed to this positive trend:

- The upscale resort and membership communities along the West Hawaii coast have successfully attracted the young, affluent west coast travelers which are the emerging "power" demographic in the industry. The reputations of the resorts are exceptional, known for excellent golf courses and luxury quality hotels and service.
- There are now numerous direct flights daily into Kona from the mainland and Japan (typically sold-out), and several carriers are seeking to expand service.
- The visitor plant in West Hawaii is extremely diverse running from some of the lowest priced hotel rooms in the state (as at Keauhou) to some of the most expensive (Hualalai and the Kohala resorts) and has a growing number of dining, entertainment and recreational opportunities which had been limited.
- The cruise ship sector is rapidly expanding, with nearly 200 cruise ships annually expected to make port calls annually in Kailua-Kona within several years, exposing thousands of high-spending passengers to the island.
- The Big Island has an emerging reputation for Hawaiiana culture, natural beauty, and a breadth of experience unavailable on the other islands.
- The Kilauea volcano continues an extended eruption (since 1982) which specifically attracts many visitors to the windward and southern sides of the island.
- The popularity of coffee, macadamia nuts and other products has enhanced the name recognition of West Hawaii, as have several golf tournaments in recent years.
- The county has pursued an aggressive parks upgrade program, opening and/or expanding facilities throughout the island, with particular emphasis in West Hawaii.

Trends among primary Big Island tourism indicators from 1989 through 1999 are summarized on Table 6. Of particular note are the meaningful increases over the past four years in Total Visitors, Total

TABLE 6

ISLAND OF HAWAII TOURISM INDUSTRY TRENDS
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

								VISITOR EXPENDITURES					
YEAR	TOTAL VISITORS	Annual Pct. Change	PERCENT OF STATE TOTAL	AVERAGE LENGTH OF STAY (days)	Annual Pct. Change	TOTAL VISITOR DAYS	Annual Pct. Change	ESTIMATED TOTAL (000's)	Annual Pct. Change	DAILY PER CAPITA	Annual Pct. Change	TOTAL LODGING UNITS	Annual Pct. Change
1989 (1)	999,140	—	15.04%	6.49	—	6,482,400	—	$902,560	—	$139.23	—	8,161	—
1990	1,030,900	3.18%	14.79%	6.44	-0.68%	6,643,000	2.48%	$925,664	2.56%	$139.34	0.08%	8,952	9.69%
1991	1,020,390	-1.02%	14.84%	6.80	5.58%	6,942,300	4.51%	$1,090,603	17.82%	$157.10	12.74%	9,383	4.81%
1992	972,720	-4.67%	14.93%	7.25	6.56%	7,051,800	1.58%	$1,012,131	-7.20%	$143.53	-8.64%	9,170	-2.27%
1993	978,440	0.59%	15.98%	7.13	-1.67%	6,975,150	-1.09%	$1,012,636	0.05%	$145.18	1.15%	9,490	3.49%
1994	933,700	-4.57%	14.52%	7.55	5.89%	7,048,150	1.05%	$1,185,845	17.10%	$168.25	15.89%	9,595	1.11%
1995	917,610	-1.72%	13.85%	7.52	-0.41%	6,898,500	-2.12%	$1,228,906	3.63%	$178.14	5.88%	9,432	-1.70%
1996	1,031,550	12.42%	15.12%	7.38	-1.82%	7,613,900	10.37%	$1,325,800	7.88%	$174.13	-2.25%	9,141	-3.09%
1997	1,102,200	6.85%	16.04%	7.23	-2.05%	7,968,900	4.66%	$1,405,692	6.03%	$176.40	1.30%	9,913	8.45%
1998	1,150,000	4.34%	17.01%	7.38	2.10%	8,489,000	6.53%	$1,506,000	7.14%	$177.41	0.57%	9,865	-0.48%
1999	1,259,000	9.48%	18.25%	7.12	-3.59%	8,960,000	5.55%	$1,638,000	8.76%	$182.81	3.05%	9,982	1.19%

(1) Prior to 1989, quality, comprehensive data specific to the Big Island for the identified indicators were unavailable.

Source: The Hawaii Visitors & Convention Bureau, First Hawaiian Bank, and The Hallstrom Group, Inc.

Visitor Days and Visitor Expenditures, which are considered the three most critical statistics. For if more tourists are coming to the Big Island and they are collectively spending more time and money, the health of the industry is assured.

In many respects, the current upward cycle is occurring as projected during the mid to late 1980s, when many analysts forecast the island would move strongly forward into a position where it could challenge Maui for dominance among the neighbor islands by the year 2010. Due to the effects of the last decade recession, the trend was substantially slowed, but the long-term expansion movement remains evident.

First quarter data point to a continuation of the current upcycle for 2000-2001, with arrivals expected to increase by upwards of three to five percent over the next year. We believe there is significant upside potential in the present market, particularly if the U.S. economy remains strong and there is any marked recovery in Asia. Even if there is a weakening in the markets, the established reputation of the West Hawaii resorts and increased direct air service should provide for modest expansion in the near to mid-term.

Average operational levels for the Kohala resort lodging facilities are shown on Table 7. While the subject would not be directly comparable with these projects, they would be competing for a similar demographic. Further, the Kohala facilities are now considered the bellwether for the success of the island's tourism industry. The figures project the recent strength of the Big Island visitor market.

Average daily room rates (ADR) in the area (which is about 40 miles north of Keopuka) are the highest among any of the 10 identified statewide sectors, at nearly $239 nightly through 1999, with several hotels approaching an ADR of $400. They have more than doubled over the past five years, and are expected to show increases of above seven percent in 2000. This demonstrates there are large numbers of on-island visitors capable of paying the relatively high tariffs envisioned for the subject lodge.

Occupancy rates have also climbed steadily in the region, reaching 68 percent in 1999, up some 12.5 points from 1992. While the average is still five to ten points below long-term projections for the area, it demonstrates that the Big Island market has had the ability to absorb

TABLE 7

KOHALA COAST HOTEL INDUSTRY TRENDS (1)
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

									TOTAL FOOD AND BEVERAGE		
YEAR	ROOM RENTAL RATE	Annual Pct. Change	AVERAGE OCCUPANCY RATE	Annual Pct. Change	FOOD REVENUE/ ROOM (1)	Annual Pct. Change	BEVERAGE REVENUE/ ROOM (1)	Annual Pct. Change	REVENUE/ ROOM (1)	RATIO TO ROOM RATES	Annual Pct. Change
1985*	$71.76	—	58.67%	—	$32.75	—	$11.35	—	$44.10	61.45%	—
1986*	$82.02	14.30%	64.60%	10.11%	$33.58	2.53%	$11.73	3.35%	$45.31	55.24%	-10.11%
1987*	$94.24	14.90%	62.46%	-3.31%	$35.84	6.73%	$11.44	-2.47%	$47.28	50.17%	-9.18%
1988*	$99.00	5.05%	58.37%	-6.55%	$37.74	5.30%	$11.43	-0.09%	$49.17	49.67%	-1.00%
1989	$180.22	82.04%	60.67%	3.94%	$42.16	11.71%	$13.13	14.87%	$55.29	30.68%	-38.23%
1990	$192.19	6.64%	58.33%	-3.86%	$41.35	-1.92%	$12.26	-6.63%	$53.61	27.89%	-9.08%
1991	$186.28	-3.08%	56.08%	-3.86%	$42.57	2.95%	$11.80	-3.75%	$54.37	29.19%	4.64%
1992	$173.54	-6.84%	55.49%	-1.05%	$42.19	-0.89%	$12.03	1.95%	$54.22	31.24%	7.05%
1993	$173.31	-0.13%	57.02%	2.76%	$40.98	-2.87%	$12.01	-0.17%	$52.99	30.58%	-2.14%
1994	$164.66	-4.99%	62.44%	9.51%	$36.91	-9.93%	$10.36	-13.74%	$47.27	28.71%	-6.11%
1995	$169.77	3.10%	61.45%	-1.59%	$35.85	-2.87%	$9.76	-5.79%	$45.61	26.87%	-6.42%
1996	$175.24	3.22%	67.45%	9.76%	$36.96	3.10%	$10.16	4.10%	$47.12	26.89%	0.09%
1997	$199.41	13.79%	67.09%	-0.53%	$39.60	7.14%	$10.80	6.30%	$50.40	25.27%	-6.00%
1998	$214.71	7.67%	67.46%	0.55%	$42.86	8.23%	$12.22	13.15%	$55.08	25.65%	1.50%
1999	$238.68	11.16%	68.01%	0.82%	$46.04	7.42%	$12.68	3.76%	$58.72	24.60%	-4.10%

* Prior to 1989, the Kohala Coast was included in the "Kona" market sector.

Source: Pannel Kerr Forster, The Hawaii Visitors & Convention Bureau, and The Hallstrom Group, Inc.

hundreds of new upscale/luxury rooms and lodging units during an otherwise slow tourism period. Average occupancies above 70 percent are forecast for 2000, the first time the region has based this market (considered the baseline for a "strong" sector) since regional data has been kept.

In response to the expansion and positive outlook, many developers are now constructing major resort and resort/residential projects on the Big Island at Kukio, Kaupulehu, Hokulia. Almost all are ocean-oriented. Numerous West Hawaii bulk holdings are also being newly master planned, and are beginning to move through the approval process.

From a general statistical perspective, it is now a moderately to strongly favorable time to pursue tourism oriented development on the Big Island, particularly if it is upscale and provides either a premium or unique experience for westbound, moneyed travelers.

Given the limited number of subject lodge rooms (100 total) which must be filled relative to the overall size of the Hawaii County visitor market (at most about one-half of one percent of the total rooms on the island), the Members Hale must capture only a small fraction of the total arrivals in order to be successful.

The demographics of the Big Island are also favorable towards the subject project. Hawaii County is attracting younger, moderate to upper income travelers, many with families, and most repeat visitors to the state. This segment aggressively seeks unusual/atypical Hawaii vacation and ownership opportunities.

Analysis of Subject Lodge Demand and Feasibility

Use of the Members Hale at Keopuka will be limited to members of the community club, their families and guests. Application of standard demand formulae indicates this will provide a sufficient population to support the operation of the facility and effectively "absorb" the 100 rooms in the Hale from a market perspective.

The circa 375 memberships in the community will be purchased by a combination of individual, couples, family and corporate interests. Each would be anticipated to bring families and guests when visiting the project. Discussions with representatives of membership course

"destination" developments in Hawaii and the Western U.S. indicates each visiting member party is typically two to five persons, with an estimated average of over 3.5 persons. The more exotic and upscale destination tend towards the upper end of the range.

The average member visits the club from two to six times per year, and stays from five to 14 days per visit, with the more outlaying developments being visited less frequently and for longer stays. Often guests extend stays beyond the length of the member host.

Additional demand is created by guests of club members who visit the community apart from the member. The size of this demand segment varies in accordance with the membership/use rules of each development.

Demand by members will be highest in the first years of the lodge operation, before all the homes in the subdivision are built. The capture rate of the Members Hale will be virtually 100 percent of the visiting membership when opened (anticipated at the end of year 5 in the construction program, about three years into lot sales). Occupancy will decline over the subsequent decade as the houses are finished, until about one-third of the membership will not generally require the accommodation services of the lodge.

Homeowners will still represent a substantial patronage potential for the restaurant(s), boutique, concierge, spa and other services incorporated into the Hale facility. And, these members will still have a limited number of guests who will stay at the lodge instead of their home.

On a stabilized basis after build-out, we estimate the average non-homeowner member will visit the course two to three times each year (or an average of 2.5 times each), staying an average of 11 days each visit, and traveling with a party of four-plus persons requiring three total guest rooms. An additional 10 percent demand will be created by guests of homeowner members. The calculation is as follows:

Non-Home Owner Members		Avg. Visits Per Year		Avg. Length of Stay (days)		Avg. No. Rooms Per Party		Total Room Night Demand
275	x	(2.5	x	11)	x	3	=	22,688
				Plus 10% Allowance for Homeowner Guests				+ 2,269
				Total				24,957
				Total Available Rooms (365 days x 100 rooms)				÷ 36,500
				Indicated Stabilized Occupancy Rate				68.38%

The indicated stabilized occupancy rate of 68.4 percent is comparable with the average rates currently being achieved by the upscale South Kohala resorts, and is sufficient to support the proposed Keopuka Members Hale, particularly given the anticipated comparatively high average daily room rates charged. During the initial years of operation, before large numbers of homes are built, the total guest demand may be as much as twenty to thirty percent higher, equating to an occupancy rate of 80 to 87 percent.

The lodge operations food and beverage departments should achieve well-above average sales and profit levels for a facility of this size. The isolated character which enhances its attraction means there are few alternative dining opportunities for visiting members and guests, with the result being the lodge will capture a very large share of meal and libation requirements created by the membership population. Additionally, homeowner members and their guests would be expected to partake a meaningful share of meals in the lodge and clubhouse restaurants. There are significant market data demonstrating the correlation between the location of accommodations and in-house food and beverage sales, and the subject lodge will have the characteristics placing it at the upper end of the capture range.

Should the restaurants allow off-site patrons (non-members or guests), even on an occasional basis, the stability of the food and beverage operations would be enhanced.

Most secondary departments should also fare well in the subject lodge setting. Above average telecommunication and business charges would be expected, as would concierge, spa service and other

incidental billings. Space lease rents from retail stores would be limited.

Overall, there will be strong foundational tourism support, sufficient patronage by members and guests, and a reasonably high probability of operational success for the Members Hale at Keopuka. We conclude there is a market demand for this component of the proposed project, that it will be well-received by its target market, and has the capability to be economically feasible.

Although its occupancy rates will fluctuate for several years as more member homes are constructed, we anticipate the basic operational parameters of the Member Hale will become stabilized in about three years from opening.

APPROPRIATENESS OF THE SUBJECT PROPERTY FOR THE PLANNED USE AND ABSORPTION ESTIMATES

The subject site is a highly appropriate location for a competitive, low intensity "membership" community as proposed for a variety of reasons, most notably:

- *It has favorable climatic and scenic attributes necessary to attract the most probable purchaser groups.* The lee of Mauna Loa provides the South Kona coast with some of the finest resort-quality climate in the state, relatively dry, consistently warm, comparatively low humidity, and limited winds. By extending so far inland and upslope, numerous climatic bands are accessible on the holding ranging from hot, and oceanfront to the lower elevations of the forest lands. The slope of the mountain flank allows sweeping unobstructed panoramas from most points on the site, and the extensive shoreline is a significant community amenity. These are the requisite factors that form the basis of the attraction for competitive resort/residential development in Hawaii, and the Keopuka Lands has these qualities in abundance. Additionally, the developer proposes to incorporate any important archeological sites as thematic enhancements to the project.

- *The holding is of sufficient size to allow effective development of the concept, and the shape enhances the ocean-orientation.* With 660 acres, more than one square mile, the subject property will provide enough area to undertake a complex membership-oriented, mixed-use design plan that has both enough units to amortize the development costs but avoids "squeezing" any of the use-types or open space allotments which could damage sense of completeness, low intensity and long-term exclusivity of the project. The wedge-shape of the holding, with an extended oceanfront creates the feel of an even larger project area, and will enhance the entry experience.

- *It will be a new development on the leading edge of the emerging trends in the market.* Purchasers of membership community homesites expect to pay premiums over standard resort lots for both the exclusivity of a limited access development and the pride of ownership associated with something new and trendsetting. Comprising an ever increasing share of the resort/residential market, these buyers are not attracted to existing resorts which are high activity, have large transient populations, and often disparate use-types. A new development offers a fresh alternative with buyers having a comprehensive integration into all the components of a project and the assurance of limited construction of controlled quality.

- *The neighborhood has a low intensity rural character which contributes to the ambience of exclusivity and confirms it as an alternative to intensive resort development.* The underdeveloped, agrarian nature of South Kona is a desirable setting for the subject development type. In many respects, the emerging membership community market sub-sector is in opposition to the standard purchaser trends of the prior 15 years, during which most buyers actively sought inclusion in the upper-end, broad-amenity resorts. This new group seeks the remote club concept and is unlikely to consider the majority of in-place neighbor island resorts as viable purchase opportunities due to the intensity of their construction, impact of nearby urban land uses, and lack of uniqueness in the experience.

- *It has no other meaningful economic uses during the near to mid-term.* Although strides are being made to enhance the success of Big Island agricultural production, there is no shortage of suitable lands. Instead, it is a shortfall in investment capital and identification of end-markets that is limiting the market. If the subject development is not pursued, there is no near to mid-term use for the property except for the minor area in macadamia orchards, and/or as an exclusive estate. Neither of these uses would provide economic stimulus to the community over the coming decade, benefit the public in regards to the site, or enhance agricultural production. The proposed Keopuka Lands master plan does generate significant economic activity while keeping a low profile consistent with an agricultural subdivision use. Over the long-term, as the demand for housing in South Kona increases suburban residential construction may be a potential use of the property, but this would provide a lesser economic impact, would result in higher governmental costs versus benefits, and could have more of an effect on the surrounding community and infrastructure.

- *The land will be effectively used to meet expressed market demand and provide quality employment opportunities in a high-unemployment region without setting the precedent of requiring a major revision to area land use classifications.* Employment opportunities in a community are intimately related to land use. Jobs in South Kona are very limited as there are few job-intensive commercial/industrial developments in the area. The existing work is in relatively low-paying retail sales in tourist and neighborhood-oriented shops along the highway, and some minor agricultural and ranching endeavors. Most of the employment is in small businesses, often staffed by family members. There are few sites capable of providing meaningful employment without major land classification changes that could disrupt the character of the entire region. As a result, workers must commute to central Kailua-Kona or the northerly resorts, increasing traffic and diminishing lifestyles. The subject master plan would tap into strengthening capital investment markets (non-resident lot purchasers) to provide local jobs without requiring significant land use guidelines changes.

Based on these attributes of the subject property, the resort/residential sector demand/supply indicators, and the historic experience of competitive projects in the regional marketplace, we have estimated the probable absorption velocity for the subdivided subject lots using three methodologies:

<u>Basic Demand/Supply Comparison</u> -- This straight-forward technique assumes that if there is insufficient existing and planned supply to meet projected market gross demand levels during the projection period, the proposed subject lots will be absorbed in a reasonable manner, regardless of competitive qualities, as there are no other alternatives available. Although the "membership community" concept is relatively new to the neighbor island market, initial projects are experiencing an exceptional response and strong absorption.

Over the next two decades there will be a shortfall in excess of 100 membership community homesites in West Hawaii, at average demand forecasts, even if all the presently proposed developments are built to maximum densities in a timely manner. The undersupply condition will be sufficient to absorb the project within the projection timeframe.

<u>The Residual Method</u> -- In this technique, all of the major proposed competitive resort/residential projects are placed on a time-line depicting the sales absorption either anticipated by the developers (as stated in EIS, reported in the media or through interviews) or assuming a reasonable market share. To the extent these projects and the remaining existing market land/space supply fall short of the forecast demand for space in the study region or exceed the total, a respective undersupply or oversupply situation is present.

Having accounted for all of the proposed space in the market, and acknowledging the unlikelihood of otherwise competitive sites in the region, it can be asserted the subject development will capture a significant portion of any residual demand. This approach is generally conservative, as it assumes the subject will capture only what is left over after all other projects garner their share. Given the nature of the subject holding we believe it could be a regional market leader, not a follower.

Based on the number of projects which will be providing competitive lots during the subject sell-out period, we project the total absorption using this method will require about two to five years for the 125 lots in the development.

<u>The Market Shares Method</u> -- This approach accounts for the probable competitiveness of the subject inventory regardless of the total level of product being otherwise offered on the market. In essence, it is an estimate of how much of the total forecast demand in the West Hawaii resort/residential markets the subject could expect to achieve on an annual basis in light of its locational, pricing and amenity characteristics.

Generally moderate in application, this technique tests "pure" competitiveness and is considered the classic methodology, but does require subjective selection of factors. We conclude the subject will have good to superior competitive features, and forecast the absorption of the homesites will require from 18 to 48 months using this method.

Correlation

Given the favorable attributes of the subject property (its climate, scenic and rural characteristics), and the market acceptance of a nearby competitive project, the subject is likely to gain a favorable share of the regional market demand. **We therefore project the subject lots will be absorbed by the market within an approximately 20- to 36-month period from the beginning of initial sales.**

The membership and guests in the community will create a demand for on-site lodging units sufficient to adequately support a 100-room lodge. The Members Hale will provide accommodations for virtually all visiting members for the first several years, until homes are built on the finished lots and then to a lessening degree over time. The basic economic foundation is solid (established clientele and a strong tourism industry) and the specific location is competitive. We forecast the Keopuka Lodge will achieve stabilized operation approaching 70 percent occupancy by its third year in business.

Socio-Economic Impact Analysis of the Proposed Development

Economic Impact

The development of the Keopuka Lands subdivision will result in significant expenditures that will favorably impact the West Hawaii economy on both a direct and indirect basis, increasing the level of capital investment and capital flow in the region, which will in turn create employment and widen the tax base.

From a direct perspective, the proposed 125 estate homesites, 100-unit lodge, and 18-hole golf course will create numerous construction, equipment operator and specialty trade jobs on- and off-site during the planning and emplacement of the infrastructure and building of the improvements. After completion of the member homes, clubhouse and Members Hale over an estimated 15-year total development period, there will be additional employment positions created in the on-going operations of the facilities and upkeep of the structures (landscape service, maintenance, and renovation needs in the course of their use).

Numerous local businesses will enjoy significant profit opportunities arising for contracting companies constructing the improvements, and for local businesses which would supply a substantial portion of the materials needed in the building efforts.

Indirectly, as these wages, profits, and expenditures move through the regional economy, they will have a ripple, or "multiplier," effect--increasing the amount of capital flowing to the entire community as a result of the subject.

Construction, operational and other workers earning wages from the subject and associated off-site efforts will spend the majority of their income on living and entertainment expenses while supporting and patronizing other island businesses. Much of this spending would be re-directed by these businesses to other island industries, and significant portions of these secondary profits would in turn be put back through the region's economic and tax structure.

These substantial direct and indirect economic impacts associated with the proposed subject project are all the result of the capital investment and entrepreneurship necessary to convert undeveloped and limited-use agricultural lands into a competitive, modern membership community. The Big Island economy will be meaningfully stimulated by the capital investments and business operations within the Keopuka Lands development.

Among the primary conclusions from our economic impact study, as summarized on Tables 8, 9, 10 and 11, are:

TABLE 8

EMPLOYEE JOBCOUNT AND WAGE ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
Worker Requirements (1)										
Infrastructure	70	63								
SFR Construction			21	43	43	43	43	43	43	43
Members Hale Construction				32	21		32	21		
Members Hale Operation					40	40	40	80	80	80
Golf/Clubhouse Construction	55	51								
Golf/Clubhouse Operation			42	42	42	43	42	42	42	42
Home Maint. & Services			1	3	5	7	9	11	13	15
Off-Site Employees (2)	43	57	32	60	75	66	83	98	89	90
TOTAL EMPLOYMENT CREATED	168	171	96	179	226	197	248	295	266	269
Worker Wages										
Infrastructure	$3,150,000	$2,835,000	$0	$0	$0	$0	$0	$0	$0	$0
SFR Construction	$0	$0	$954,250	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500
Members Hale Construction	$0	$0	$0	$1,440,000	$960,000	$0	$1,440,000	$960,000	$0	$0
Members Hale Operation	$0	$0	$0	$0	$1,000,000	$1,000,000	$1,000,000	$2,000,000	$2,000,000	$2,000,000
Golf/Clubhouse Construction	$2,475,000	$2,295,000	$0	$0	$0	$0	$0	$0	$0	$0
Golf/Clubhouse Operation	$0	$0	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000
Home Maint. & Services	$0	$0	$30,000	$90,000	$150,000	$210,000	$270,000	$330,000	$390,000	$450,000
Off-Site Employees	$1,542,500	$1,425,000	$803,125	$1,491,750	$1,883,417	$1,643,750	$2,068,750	$2,460,413	$2,218,750	$2,243,750
TOTAL ANNUAL WAGES PAID	$7,167,500	$6,555,000	$2,753,375	$5,900,250	$6,871,917	$5,732,250	$7,657,250	$8,628,913	$7,487,250	$7,572,250

Development Year	11	12	13	14	15	Total Years 1-15	Stabilized
Worker Requirements (1)							
Infrastructure						133	
SFR Construction	43	43	43	43	43	531	
Members Hale Construction						107	
Members Hale Operation	80	80	80	80	80	780	80
Golf/Clubhouse Construction						106	
Golf/Clubhouse Operation	42	42	42	42	42	546	42
Home Maint. & Services	17	19	21	23	25	169	25
Off-Site Employees (2)	91	92	93	94	95	1,176	74
TOTAL EMPLOYMENT CREATED	272	275	278	281	284	3,538	221
Worker Wages							
Infrastructure	$0	$0	$0	$0	$0	$5,985,000	
SFR Construction	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$23,906,250	
Members Hale Construction	$0	$0	$0	$0	$0	$4,800,000	
Members Hale Operation	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$19,000,000	$2,000,000
Golf/Clubhouse Construction	$0	$0	$0	$0	$0	$4,770,000	
Golf/Clubhouse Operation	$966,000	$966,000	$966,000	$966,000	$966,000	$12,558,000	$966,000
Home Maint. & Services	$510,000	$570,000	$630,000	$690,000	$750,000	$5,070,000	$750,000
Off-Site Employees	$2,268,750	$2,293,750	$2,318,750	$2,343,750	$2,368,750	$29,292,918	$1,837,500
TOTAL ANNUAL WAGES PAID	$7,657,250	$7,742,250	$7,827,250	$7,912,250	$7,997,250	$105,428,208	$5,553,500

(1) All jobcounts expressed as "full-time" equivalent positions.
(2) Includes all off-site jobs created by work efforts at the project, direct and indirect.

Source: Various, and The Hallstrom Group, Inc.

TABLE 10

POPULATION, DISCRETIONARY EXPENDITURES AND RESIDENT INCOME ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	3	4	5	6	7	8	9	10	11
Cumulative Residential Development									
Single Family Homes	5	15	25	35	45	55	65	75	85
Total Residential Units	5	15	25	35	45	55	65	75	85
Average Resident/Guest Population									
Single Family	3	9	16	22	28	34	40	47	53
Members Hale Guests	0	0	0	48	57	67	95	114	133
Total De Facto Population (1)	3	9	16	69	85	101	135	161	186
Total Resident Population (2)	3	3	5	7	9	11	13	15	18
Estimated School Age Children	1	1	1	1	2	2	2	3	3
RESIDENT/USER DISCRETIONARY EXPENDITURES	$134,000	$328,899	$546,822	$4,347,427	$5,201,172	$6,154,717	$8,321,887	$9,882,345	$11,442,403
FULL-TIME RESIDENT INCOME	$310,800	$309,690	$516,190	$722,610	$929,870	$1,135,530	$1,341,990	$1,548,490	$1,754,910

Development Year	12	13	14	15
Cumulative Residential Development				
Single Family Homes	95	105	115	125
Total Residential Units	95	105	115	125
Average Resident/Guest Population				
Single Family	59	65	71	78
Members Hale Guests	133	133	133	133
Total De Facto Population (1)	192	198	204	211
Total Resident Population (2)	20	22	24	26
Estimated School Age Children	4	4	4	5
RESIDENT/USER DISCRETIONARY EXPENDITURES	$11,789,335	$12,136,068	$12,482,801	$12,829,533
FULL-TIME RESIDENT INCOME	$1,961,370	$2,167,830	$2,374,290	$2,580,750

(1) Average daily resident and overnight guest population in project.
(2) Full-Time residents only.

Source: Various, and The Hallstrom Group, Inc.

TABLE 9

CONSTRUCTION COSTS AND CONTRACTOR AND SUPPLIER PROFIT ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
Construction Costs (1)										
Infrastructure (2)	$13,000,000	$12,000,000								
SFR Construction (3)			$3,875,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000
Members Hale Const. (4)				$5,000,000	$3,500,000		$3,500,000	$3,000,000		
Golf/Clubhouse Const. (5)	$11,000,000	$9,000,000								
TOTAL CONSTRUCTION COSTS	$24,000,000	$21,000,000	$3,875,000	$12,750,000	$11,250,000	$7,750,000	$11,250,000	$10,750,000	$7,750,000	$7,750,000
CONTRACTOR'S PROFIT	$2,400,000	$2,100,000	$387,500	$1,275,000	$1,125,000	$775,000	$1,125,000	$1,075,000	$775,000	$775,000
SUPPLIER'S PROFIT	$830,000	$720,000	$155,000	$510,000	$450,000	$310,000	$450,000	$430,000	$310,000	$310,000

Development Year	11	12	13	14	15	Totals
Construction Costs (1)						
Infrastructure (2)						$25,000,000
SFR Construction (3)	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$96,875,000
Members Hale Const. (4)						$15,000,000
Golf/Clubhouse Const. (5)						$20,000,000
TOTAL CONSTRUCTION COSTS	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$156,875,000
CONTRACTOR'S PROFIT	$775,000	$775,000	$775,000	$775,000	$775,000	$15,687,500
SUPPLIER'S PROFIT	$310,000	$310,000	$310,000	$310,000	$310,000	$6,025,000

(1) Direct costs only for infrastructure ($25,000,000) incurred in Years 1 & 2.
(2) Estimated average construction cost of $775,000 per home, 3,500 square feet at $200 per square foot, plus $75,000 for site work, landscaping and amenities.
(4) Estimated construction cost of $15,000,000 (or $150,000 per room), in two phases, with first phase of $8,500,000. Includes site work, landscaping and amenities.
(5) Direct costs only, estimated @ $20,000,000.

Source: Various, and The Hallstrom Group, Inc.

- The project will be a significant source of employment for the region, during both construction and on-going operation. We have projected it will require approximately 15 years from ground-breaking to total community build-out. During this time, there will be an estimated 3,528 full-time equivalent worker years of employment created on-site, with an additional 1,176 worker years in off-site positions. After completion, there will be some 147 permanent on-site jobs in the various lodge, golf course operations and home maintenance businesses, and an additional 74 off-site support positions.

- Total wages paid into the region as a result of the subject development during the 15-year construction and initial business operation period will be in excess of $105.4 million in constant year 2000 dollars, including the on-going business operations, with a stabilized operating payroll (on and off-site positions) of about $5.5 million. The total direct costs capital investment required for the project will be about $156.8 million, or the equivalent of one resort hotel. Area contractors and suppliers should reap profits approaching $22 million from the project.

- The total direct "overall" community impact from the project during its 15-year construction and initial operating period will be $223.2 million, exclusive of up to $36-plus million in operating revenues generated annually by the businesses in the project.

- At build-out the average daily de facto (resident and guest) population of the Keopuka Lands will be about 211 persons. The total discretionary expenditures by this group into the local economy will be about $12.8 million per year. There will be about 26 permanent residents in the project and a maximum of about five resident school age children. The taxable resident income would be at $2.58 million annually.

Socio-Economic Impacts

From a real property/land use perspective, the subject development has the potential to present socio-economic impacts in the surrounding community. However, we do not believe the effect of the project will meaningfully escalate or negatively impact these issues, or that foregoing the project would mitigate the concerns in any notable way. There are three potential negative impacts:

TABLE 11

SUMMARY OF ECONOMIC IMPACTS ASSOCIATED WITH DEVELOPMENT
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
ANNUAL WAGES GENERATED	$7,187,500	$6,555,000	$2,755,375	$5,902,250	$6,873,917	$5,732,250	$7,657,250	$8,628,917	$7,487,250	$7,572,250
CONTRACTOR'S PROFIT	$2,400,000	$2,100,000	$387,500	$1,275,000	$1,125,000	$775,000	$1,125,000	$1,075,000	$775,000	$775,000
SUPPLIER'S PROFIT	$830,000	$720,000	$155,000	$510,000	$450,000	$310,000	$450,000	$430,000	$310,000	$310,000
DISCRETIONARY EXPENDITURES			$124,000	$520,099	$866,832	$4,247,627	$5,201,172	$6,154,717	$8,321,887	$9,882,345
TOTAL BASE ECONOMIC IMPACT	$10,417,500	$9,375,000	$3,421,875	$8,207,349	$9,315,748	$11,064,877	$14,433,422	$16,288,634	$16,894,137	$18,539,495
Multiplier Effect Ratio	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL OVERALL IMPACT	$20,835,000	$18,750,000	$6,843,750	$16,414,698	$18,631,497	$22,129,754	$28,866,844	$32,577,268	$33,788,275	$37,078,990

Development Year	11	12	13	14	15	Total 1 Through 15	Stabilized
ANNUAL WAGES GENERATED	$7,657,250	$7,742,250	$7,827,250	$7,912,250	$7,997,250	$105,448,208	$5,553,500
CONTRACTOR'S PROFIT	$775,000	$775,000	$775,000	$775,000	$775,000	$15,687,500	
SUPPLIER'S PROFIT	$310,000	$310,000	$310,000	$310,000	$310,000	$6,025,000	
DISCRETIONARY EXPENDITURES	$11,442,603	$11,789,335	$12,136,068	$12,482,801	$12,829,533	$95,998,920	$12,829,533
TOTAL BASE ECONOMIC IMPACT	$20,184,853	$20,616,585	$21,048,318	$21,480,051	$21,911,783	$223,159,628	$18,383,033
Multiplier Effect Ratio	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL OVERALL IMPACT	$40,369,705	$41,233,171	$42,096,636	$42,960,102	$43,823,567	$446,319,256	$36,766,066

Source: Various, and The Hallstrom Group, Inc.

- Real Property Values – Demand for land and homes in the Captain Cook-Napoopoo-Kealakekua area has been strong for more than 18 months, with activity levels more than doubling since 1996-1997. Average prices have shown appreciation of eight to 12-plus percent since early 1999, following upward movement in 1998. Early year 2000 data indicate additional appreciation for this year reaching into double-digits for well-located view homesite properties. Many of the buyers are international, upper-class vacation home purchasers/builders who are attracted to the area for a variety of existing reasons. This trend exists regardless of the subject project and will not recede if there is no Keopuka project, and not be exacerbated by its development.

  The limited membership character of the community will necessarily minimize off-site property value impacts. While its success could stimulate the bulk acreage sector, the effective impact on individual parcels will be nominal.

- Traffic Congestion -- Comprehensive traffic studies are being completed by others who are specialists in the field. However, on a theoretical basis the actual traffic generated by Keopuka Lands will be nominal relative to the existing loads carried by a congested Mamalahoa Highway. The actual de facto population of the community will be just over 200 people (a minor percentage of the population within a five-mile radius). Further, the rural character ensures members/guests will have limited off-site excursions relative to most island visitors and create less of a traffic load per capita than a standard tourist. By locating a source of employment in the South Kona community, the amount of commuting required by working area residents will be less, particularly in the exceptionally strained "down stream" Villages of Kainaliu, Honalo and Kailua-Kona. The net effect of the project may prove balanced, with the reduction in worker commuter traffic off-setting any increase due to members and guests.

- Affordable Housing – The overbuilding of the 1980s coupled with the recession of the 1990s has brought the once chronic affordable housing shortfall problem in West Hawaii into balance in recent years. There are rental and purchase opportunities for moderate income households in the region

based on HUD median income estimates and MLS sales data, and there is no evident dire need for additional supply as there was emerging over a decade ago. The biggest affordability concern at present is when non-resident second home buyers purchase outside resorts and remove an existing home from the permanent residential inventory. The subject will create new lots which would attract some of this buyer segment, relieving housing pressures without negatively impacting the existing stock. The employment opportunities in the construction and operation of the project would go to local trade workers and craftsmen and not attract in-migrating workers in need of affordable housing. Further, the site and proposed community is not a particularly appropriate place for it to be located even if there was need. The hot, dry, lower elevations are typically not strongly desired by local residents, and the site is removed from government, health and support services. We do not believe affordable housing to be a primary issue of social or economic impact.

There are also several notable, potential, positive impacts to the regional community associated with the Keopuka Lands project:

- Local Jobs -- Having quality employment opportunities in the local community has substantial positive effects on the social fabric of an area beyond mere wages. Reduced commuting times make more available for families, school, work and community involvement, and lessens the regional traffic loads for other out-of-area commuters. They provide connection between community groups that are not built at job sites 30 to 50 miles away. Businesses serve as focal points of community pride and ensure the long-term (inter-generational) economic stability of an area.

- Relationship With Members – The intimate size of Keopuka Lands coupled with the character of the available local worker pool will help build relationships between members (who are after all becoming long-term participants in the South Kona community) and full-time residents to a degree not generally found in Hawaii. This relationship will help the performance of the subject project and increase the acceptance of the development in the region.

Assessment of the Public Costs/Benefits Associated With the Project

We have identified the primary areas in which the proposed subject mixed-use resort/residential development will potentially impact the sphere of public agency resources, and quantified (where possible) the costs of providing expanded governmental services to the project versus the economic benefits that accrue to the public purse through an increase in local and state tax payments.

As a low-key, privately built, membership project, public costs will not be markedly increased on the state or county levels in South Kona as a result of the proposed Keopuka Lands subdivision. There will be only nominally increased educational or recreational needs directly attributable to the subject development, the major public infrastructure items (highway and primary water/sewer mains) are already in-place or being built by the developer, and the development will require no specific public subsidies, welfare services, bonding or capital improvements. Most governmental costs actually incurred will be for emergency services, oversight and nearby road maintenance.

Direct tax benefits to the state and county coffers will primarily flow from the project and its operation over time in the form of real property taxes, gross excise taxes, and state income taxes.

Some cost/benefit issues are considered as off-setting, or "a wash," as the cost of the services to the government is theoretically directly reimbursed in the form of user fees. Building permits and utility hook-up fees are two prime examples. Other such items include workers compensation premiums versus benefits, utility operations versus billing rates, and business oversight/registration being covered by licensing fees. These items were excluded from this study.

Our analysis of Hawaii County and state budgets indicate the actual effect of governmental services relating to Keopuka Lands would not create the need to expand county and state services.

As an alternative to actual cost estimates, which are often disparate as it inherently cannot provide for unexpected and/or atypical items, it is most common to project public costs on a per capita allocation formula based on the de facto population relating to a proposed development.

We have estimated the public costs issue from both perspectives, on a actual and per capita bases; the latter of which we believe to be most appropriate for the subject project and is the focus of our conclusions.

Quantification of Costs

The county of Hawaii will directly incur several areas of cost increases as a result of the Keopuka Lands subdivision, primarily in regards to emergency services. Based on analysis of response frequencies, time/cost data and discussions with affected agencies we have made general allowances for these items.

The total annual cost to the county on a stabilized basis at build out of the subject development would be less than $100,000. This cost was reached on an escalating basis over time, in accordance with the growth in club membership number of operating businesses in the business park.

State of Hawaii costs would include highway frontage work, health inspections of food service establishments and other minor oversight duties. An allowance of $20,000 per year was made for these items, increasing to the stabilized level as the community is built out.

The alternative and preferred method for determining public costs is through per capita expenditures incurred by the State of Hawaii and Hawaii County in accordance with the de facto population area of the jurisdiction. This is founded on the principal that each individual on the island equitably benefits from all governmental costs, regardless of type or focus throughout the day, with each new member of the community (whether resident or visitor) creating a proportionate new cost burden in their daily home and working life.

The average daily population of the community (residents, other members and guests) at build-out will be 211 persons, a figure reached in year 15 of the development process. The per capita expenditure for the state in the year 2000 will be at $4,855. The total inferred costs to the public purse at stabilization by the project using the per capita allowance method would be $1.02 million.

The average annual amount spent by Hawaii County to support the de facto population of the island is $1,157 per capita.

Application of this figure to the average total on-site population at subject build-out would be $242,970 annually in costs to the county government on a stabilized basis (210 persons x $1,157).

Although the per capita costs incurred by the state and county are notably higher than the anticipated actual expense, we have used the higher figure in the comparative analysis as the preferred planning enumeration alternative.

Quantification of Benefits (Revenues)

Real Property Taxes -- Property taxes paid by landowners in the subject project were calculated using the 1999-2000 tax rates for both land and buildings, improved and unimproved.

Assessed values for the lots are based on an average sales prices of $900,000 for the homesite lots, $50,000 per unit for the hotel site, and $15 million for the golf course site. The improvement assessments are based on the projected development/construction costs of the finished buildings (at $750,000 per home on average, $15 million for the Members Hale, and $5 million for the clubhouse). This may result in a slight understatement of assessments on the home improvements, as market value often exceeds reproduction expense.

It was assumed the land would be taxed at an average rate of $10.00 annually per $1,000 of assessed value. The improvements would have average tax rates of $8.50 per $1,000 of assessment.

The total real property tax to be paid to Hawaii County in 2000 dollars ranges from $264,000 in year 1 of development, to a stabilized level of $3,048,375 at build-out in year 15 and beyond.

State Income Tax -- The state will receive income taxes from three sources:

- the wages of the workers associated with the construction, maintenance, and operation of the Keopuka Lands components;
- the income of full-time residents of the development; and
- the corporate profits from contractors and suppliers serving the construction and maintenance phases of the development, and generated by on-going lodging and recreational/commercial operations.

The total income tax revenues to be received by the state are projected at $481,475 in the first year of construction increasing to a maximum level at year 15 of $3.02 million annually in constant 2000 dollars.

On a stabilized basis, after build-out, the permanent worker incomes, building maintenance and off-site workers, and operating businesses, would pay an annual state income tax in excess of $2.5 million.

State Gross Excise Tax -- This 4.166 percent of expenditures tax was applied against:

- the total estimated construction contract costs;
- the total gross sales of the lodge and recreational/commercial businesses; and
- the discretionary expenditures of the de facto population of the subject.

The anticipated state excise tax receipts arising from the subject development grow from an estimated $414,934 in the first year of development to a peak of $751,944. Over the 15-year study period, the receipts total $7.5 million and stabilize at circa $750,000 per year.

Total Public Benefits (Revenues) -- In constant 2000 dollars, the aggregate annual tax revenues flowing from the subject development at full project build-out range from:

- $264,000 to $3,048,375 per year for the county of Hawaii, stabilizing over time at the higher figure, totaling $28.42 million over the 15-year development projection time-frame;
- $410,503 to $3,771,525 annually for the State of Hawaii, stabilizing at $3.7 million per year, and cumulatively at $32.41 million over the 15-year projection period; and
- $1,060,532 to $6,819,900 per year for total tax receipts (county and state), totaling $60.83 million for the one and a half decades of the Keopuka Lands community.

Correlation

Table 12 summarizes our public costs/benefits findings using the higher per capita allowance governmental cost basis for the entire project.

As can be seen, regardless of the higher cost methodology adopted, in no single year does public coffers suffer a net loss on a stabilized basis the net benefit to the state will exceed $2.75 million per year and reach nearly $2.8 million for the county.

TABLE 12

PUBLIC COST/BENEFIT SUMMARY TABLE
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2008 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
PUBLIC BENEFITS (Revenues)										
1. REAL PROPERTY TAXES										
Cumulative Assessed Values										
Improvements			$8,750,000	$16,250,000	$28,750,000	$39,750,000	$50,750,000	$61,250,000	$68,750,000	$76,250,000
Land	$26,400,000	$26,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000
Total Assessed Value	$26,400,000	$26,400,000	$103,150,000	$110,650,000	$123,150,000	$134,150,000	$145,150,000	$155,650,000	$163,150,000	$170,650,000
TOTAL REAL PROPERTY TAXES	$264,000	$264,000	$1,105,875	$1,244,625	$1,475,875	$1,679,375	$1,882,875	$2,077,125	$2,315,875	$2,354,625
2. STATE INCOME TAXES										
Taxable Personal Income	$7,187,500	$4,535,000	$5,460,375	$11,787,250	$16,413,917	$19,237,250	$25,127,250	$30,063,917	$32,887,250	$34,937,250
Taxable Corporate Profits	$3,230,000	$2,820,000	$357,380	$1,847,412	$1,679,020	$1,709,715	$2,334,141	$2,396,566	$2,283,626	$2,510,869
Personal Taxes Paid	$416,875	$380,190	$316,702	$683,661	$952,007	$1,115,761	$1,457,381	$1,743,707	$1,907,461	$2,142,361
Corporate Taxes Paid	$64,600	$56,400	$11,148	$36,948	$33,580	$34,194	$46,683	$47,971	$45,673	$50,217
TOTAL STATE INCOME TAXES	$481,475	$436,590	$327,849	$720,609	$985,588	$1,149,955	$1,504,063	$1,791,678	$1,953,133	$2,192,578
3. STATE GROSS EXCISE TAX										
Taxable Transactions										
Construction Materials	$9,960,000	$8,640,000	$1,860,000	$4,120,000	$5,400,000	$3,720,000	$5,400,000	$5,140,000	$3,720,000	$3,720,000
Hale/Course Operations						$375,000	$475,000	$775,000	$1,000,000	$1,200,000
Discretionary Expenditures			$134,000	$520,099	$866,832	$4,347,627	$5,201,172	$6,154,717	$8,321,887	$9,882,245
Total Taxable Transactions	$9,960,000	$8,640,000	$1,994,000	$4,640,099	$6,266,832	$8,442,627	$11,276,172	$12,069,717	$13,041,887	$14,802,245
TOTAL STATE EXCISE TAX	$414,934	$359,942	$82,653	$276,427	$261,876	$355,886	$449,765	$503,658	$543,325	$616,662
TOTAL GROSS PUBLIC REVENUES										
To Hawaii County (Item #1)	$264,000	$264,000	$1,105,875	$1,244,625	$1,475,875	$1,679,375	$1,882,875	$2,077,125	$2,315,875	$2,354,625
To State (Items #2 & 3)	$896,409	$796,532	$410,503	$997,235	$1,246,664	$1,505,841	$1,973,829	$2,295,336	$2,496,458	$2,809,239
AGGREGATE TAX REVENUES	$1,160,409	$1,060,532	$1,516,378	$2,241,860	$2,722,539	$3,185,216	$3,856,704	$4,372,461	$4,712,333	$5,163,864
PUBLIC COSTS (Expenses)										
State			$14,545	$43,695	$77,680	$334,995	$412,675	$490,355	$655,425	$781,655
County			$3,471	$10,413	$18,512	$79,833	$98,345	$116,857	$156,195	$186,277
TOTAL PUBLIC COSTS			$18,016	$54,108	$96,192	$414,828	$511,020	$607,212	$811,620	$967,932
TOTAL NET PUBLIC BENEFITS										
To State	$896,409	$796,532	$395,958	$953,540	$1,168,984	$1,170,846	$1,561,154	$1,804,981	$1,841,033	$2,027,584
To Hawaii County	$264,000	$264,000	$1,102,404	$1,234,212	$1,457,363	$1,599,542	$1,784,530	$1,960,268	$2,059,680	$2,168,348
AGGREGATE NET BENEFITS	$1,160,409	$1,060,532	$1,498,362	$2,187,752	$2,626,347	$2,770,388	$3,345,684	$3,765,249	$3,900,713	$4,195,932

Source: The Hallstrom Group, Inc.

ADDENDA I: SUBJECT PROPERTY DATA AND DESCRIPTION

Tax Map Key/Legal Description

The subject property is designated on State of Hawaii Tax Maps as Third Division Tax Map Key 8-1-07, Parcels 1, 54 and 55.

A State of Hawaii tax map showing the approximate location of the subject is displayed on the following page.

We have not been furnished with a comprehensive metes and bounds legal description for the subject holding.

Easements and Restrictions

We are aware of no significant easements or restrictions, beyond basic land use designation guidelines, which would affect the developability of the land or marketability of the finished project.

The proposed Mamalahoa Highway Bypass Road will bisect the project from north to south via an approximately 100-foot-wide right-of-way running about the 950-foot elevation level. The main entries to the project will be through gated roads along this arterial. The bypass will terminate at the Napoopoo Junction of Mamalahoa Highway about one-half mile south of the subject. The bypass right-of-way is integral to the project. The master plan was designed to reflect the presence of the roadway.

State Land Use Classification

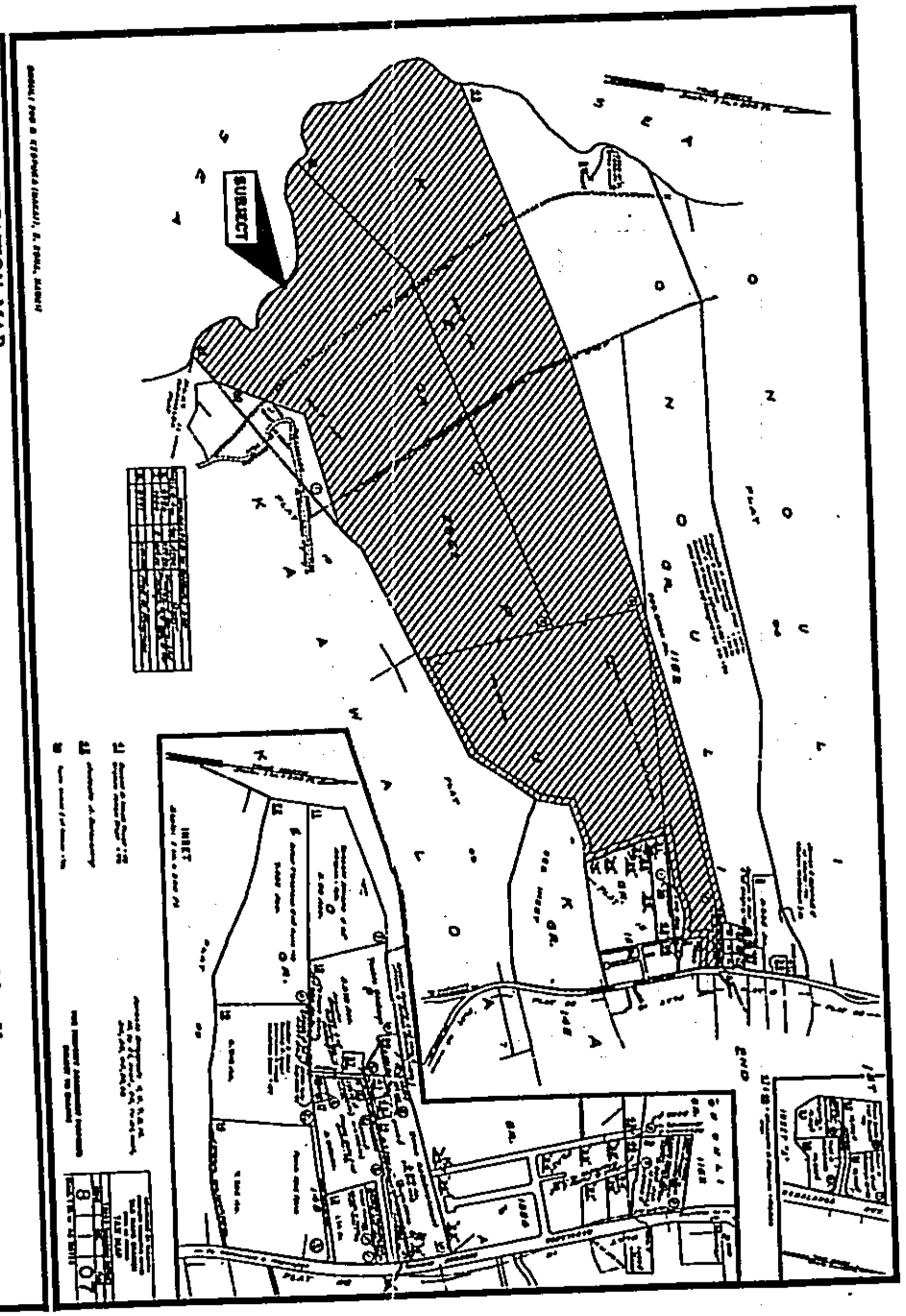
The State Land Use (SLU) classifications, administered by the State Land Use Commission, establish the basic legal framework of land uses in the State of Hawaii. The SLU categorizes real property into four broad "Districts"--**Conservation, Agriculture, Rural and Urban.**

The counties are required to confine their land use designations (General Plan and Zoning) within the stated intents of the SLU district constraints.

TABLE 12
Contd.

PUBLIC COST/BENEFIT SUMMARY TABLE
larket Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	11	12	13	14	15	Total 1 Through 15
PUBLIC BENEFITS (Revenues)						
1. REAL PROPERTY TAXES						
Cumulative Assessed Values						
Improvements	$83,750,000	$91,250,000	$98,750,000	$106,250,000	$113,750,000	
Land	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	
Total Assessed Value	$178,150,000	$185,650,000	$193,150,000	$200,650,000	$208,150,000	
TOTAL REAL PROPERTY TAXES	$2,493,375	$2,633,125	$2,770,875	$2,909,625	$3,048,375	$28,418,625
2. STATE INCOME TAXES						
Taxable Personal Income	$39,810,250	$41,072,250	$45,122,250	$48,552,250	$50,122,250	$450,496,589
Taxable Corporate Profits	$2,754,112	$2,799,720	$2,841,328	$2,882,936	$3,024,544	$38,277,370
Personal Taxes Paid	$2,308,995	$2,382,191	$2,617,091	$2,816,031	$2,907,091	$34,147,300
Corporate Taxes Paid	$55,162	$55,994	$56,827	$57,659	$112,491	$765,547
TOTAL STATE INCOME TAXES	$2,364,157	$2,438,185	$2,673,917	$2,873,689	$3,019,581	$34,913,847
4. STATE GROSS EXCISE TAX						
Taxable Transactions						
Construction Materials	$3,720,000	$3,720,000	$3,720,000	$3,720,000	$3,720,000	$72,300,000
Hale and Course Operations	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$11,725,000
Discretionary Expenditures	$11,442,603	$11,789,335	$12,136,068	$12,482,801	$12,829,533	$95,998,920
Total Taxable Transactions	$16,662,603	$17,009,335	$17,356,068	$17,702,801	$18,049,533	$180,023,920
TOTAL STATE EXCISE TAX	$694,164	$708,609	$723,054	$737,499	$751,944	$7,499,796
TOTAL GROSS PUBLIC REVENUES						
To Hawaii County (Item #1)	$2,493,375	$2,633,125	$2,770,875	$2,909,625	$3,048,375	$28,418,625
To State (Items #2 & 3)	$3,058,321	$3,146,794	$3,396,971	$3,611,188	$3,771,525	$32,412,844
AGGREGATE TAX REVENUES	$5,551,696	$5,779,919	$6,167,846	$6,520,813	$6,819,900	$60,831,469
PUBLIC COSTS (Expenses)						
State	$903,030	$932,160	$961,290	$990,420	$1,019,550	$7,617,495
County	$215,202	$222,144	$229,086	$236,028	$242,970	$1,815,333
TOTAL PUBLIC COSTS	$1,118,232	$1,154,304	$1,190,376	$1,226,448	$1,262,520	$9,432,828
TOTAL NET PUBLIC BENEFITS						
To State	$2,155,291	$2,214,634	$2,435,681	$2,620,768	$2,751,975	$24,795,349
To Hawaii County	$2,278,173	$2,409,981	$2,541,789	$2,673,597	$2,805,405	$26,603,292
AGGREGATE NET BENEFITS	$4,433,464	$4,624,615	$4,977,470	$5,294,365	$5,557,380	$51,398,641



PROPERTY LOCATION MAP
Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii

Third Division Tax Map Key
8-1-07, Parcels 1, 54 and 55

The majority of the subject acreage is currently within the **Agricultural District.** The near-shoreline corridor (approximately 300 feet wide) is contained in the **Conservation District.**

The Agricultural designation is typical of the lower and mid-elevation lands in the South Kona area. The state Department of Agriculture has classified the lands as having fair to poor soil productivity conditions. Virtually all near-oceanfront lands on the Big Island are classified as Conservation.

The proposed master plan is assumed to conform with the existing SLU district guidelines and that no redesignation will be required.

Hawaii County General Plan

The Hawaii County General Plan is implemented to control the overall growth pattern of the Big Island, and is intended to provide general guidelines for the county zoning designations. The plan is to serve as a long-term (10 to 25 year) master-planning resource identifying and servicing evolving land use needs.

The current General Plan Land Use Map identifies the subject lands for Extensive Agriculture (EA), Orchards (OR), and along the shoreline Open Area (O). The Keopuka Lands master plan is intended to generally conform to these uses; however, several permits will be required.

County Zoning

The Hawaii County Zoning Ordinances are designed to standardize the improvements of residential, agricultural, industrial, and other proposed uses in accordance with accepted planning guidelines and community standards. Allowable densities, building heights, set backs, and parking requirements are among the issues addressed.

The subject property is now zoned "Agriculture - 5 acre (A-5a)," which allows subdivision for agricultural uses with a minimum lot size of five acres. It is a common zoning in rural areas of the Big Island and in South Kona.

At 660 acres, the subject could contain up to 132 lots, and the master plan reflects this density level. In order to implement the current plan, with lots as small as one acre, several permits and/or variances will be required.

Utilities and Access

Under the current plan, water, electricity and telecommunications would be extended makai from existing mains on Mamalahoa Highway. On-site wastewater treatment and storm drainage facilities would be constructed as part of the development.

Primary access will be via two entry gates (one mauka, one makai) along the proposed Mamalahoa Highway Bypass Road, located about mid-way along the project right-of-way.

Property Description

A complete description of the subject property and its proposed development is contained in the Keopuka Lands Environmental Assessment and EIS Notice of Preparation (March 2000). Our analyses are based on the descriptions in that document, a copy of which is on file.

ADDENDA II: ENVIRONS AND ECONOMIC BACKGROUND

General Description - The Big Island (Hawaii County)

The county of Hawaii consists of the island of Hawaii (Big Island), the southernmost major island in the Hawaiian chain. Hawaii County is the second most populous of the four counties that make up the State of Hawaii, with the year-end 1999 resident population estimated at 145,000, representing just under 12 percent of the total state population. By far the largest island in the chain, the land area of Hawaii is 4,038 square miles, more than twice the size of the other islands combined.

The subject property is located on the lower flanks of Mauna Loa (one of the five mountain masses forming the Big Island) stretching inward from the shoreline, approximately one-half mile north of Kealakekua Bay.

The island is characterized by many small towns dispersed along the coastline. The island has been divided into nine districts–Puna District, the North and South Hilo Districts, Hamakua District, North and South Kohala Districts, North and South Kona Districts, and Ka'u District.

Two volcanic mountain peaks, the 13,796-foot Mauna Kea and the 13,679-foot Mauna Loa, dominate the central portion of the island. Three other major volcanic emergences combine with Mauna Kea and Mauna Loa to form the island of Hawaii. They are the Kohala Volcano, which is more commonly referred to as Kohala Mountain, the oldest volcanic land mass on the island that forms the extreme northern portion of Hawaii. Hualalai in the west, located northeast of Kailua-Kona. The final volcanic presence is Kilauea Crater, with its associated and yet active East Rift Zone at the far southeastern end of the island.

Hilo, located along the eastern coast, is the principal population, administrative, and civic center on the island. Other population centers include Kailua-Kona on the island's west coast and Waimea situated inland within the northern saddle between Mauna Kea and the Kohala Mountain.

Economic Base

Agriculture

Agriculture is currently one of the island of Hawaii's prime economic industries. Sugar, macadamia nuts, and coffee have historically been the major agricultural products (however, the last of the Big Island's sugar operations shut-down during early 1996). Significant and growing contributions are being made by the state's diversified agricultural crops including papayas, vegetables, cut flowers, and nursery products. Livestock is raised on Hawaii and represents an important contribution to the economy.

Kamehameha Schools/Bernice Pauahi Bishop Estate over the last five years has leased 20,000 acres to Prudential Timber for production of timber/forest products, primarily fast growing eucalyptus trees to be used in plywood, and other wood and wood fiber products. 15,000 of those acres are located within the Hamakua district, while an additional 5,000 acres in Ka'u were leased in June 1998.

Two noteworthy agriculturally related have occurred in the past two years. The University of Hawaii developed a ringspot resistant super papaya variety; this suggests the hopeful re-emergence of the papaya industry on the Big Island. And, Hawaii County recently opened the first operating agricultural crop irradiation plant, which kills a variety of infestations commonly found on Hawaii produce, that will allow greater export potential for Big Island crops.

Employment

Historically, the Big Island's primary employment sector has been associated with the island's agriculturally oriented economy. During the 1980s, with the construction of major resort and hotel properties in West Hawaii, employment opportunities moved into construction and service sector jobs created with the growth of the tourist industry.

With the demise of sugar and the recent loss of major agricultural employment, tourism is becoming increasingly vital to the economy of Hawaii. The prolonged downturn of the early to mid-1990s produced a slump even in this vigorous industry. The number of persons employed at hotels on the Big Island decreased from 6,600 in 1991 to 5,550 by 1995.

The sector has experienced meaningful recovery since late 1996, and is within a definite upcycle, particularly the Kohala Coast, one of the hottest areas in the statewide market.

The infusion of West Coast dollars (much high-tech or stock oriented) into the resort economy has spurred employment in the service and construction sectors.

East Hawaii remains hard hit from the recession, along its Hilo/Hamakua coast, with over 1,000 sugar industry-related jobs lost since 1993. Over 45,000 acres have been taken out of sugar production, with only a small portion to date having been utilized for truck farming (most prominent in the North and South Hilo districts); cattle grazing; and a variety of other start-up, experimental or low capital requirement activities. Few of these efforts employ meaningful numbers of having former sugar workers. These activities account for only a small percentage of the former sugar cane acreage, which now generally lies fallow.

In March 1996, Ka'u Sugar shut down its operation, idling its entire workforce on the southwestern end of the island.

In early March 1996, Bishop Estate announced that it would be leasing 24,000 acres (primarily in the North Hilo and Hamakua districts) of former sugar cane land for a tree farming venture to be operated by Prudential Timber Investment, a subsidiary of Prudential Insurance. Eucalyptus trees will be grown, with the first trees to be harvested in six to seven years.

During 1997 the State of Hawaii and Hawaii County negotiated an agreement that would have allowed Oji Paper Company of Japan to plant and harvest nearly 10,000 acres along the Big Island's Hamakua coast with trees that would be chipped and sent to Japan. However, late in negotiations, public sentiment turned against the project, and in November, the state Board of Land and Natural Resources did not ratify the proposed 55-year lease.

The following table cites historic unemployment on the Big Island. It is estimated that unemployment has dropped to below nine percent during the first quarter of 2000.

UNEMPLOYMENT FIGURES
State and Hawaii County 1993 to Present

	1993	1994	1995	1996	1997	1998	1999
Hawaii State	3.8%	5.2%	6.0%	5.7%	6.4%	5.4%	5.6%
Hawaii County	5.9%	9.6%	7.8%	8.6%	10.2%	8.0%	9.6%

All figures year end.
Source: State of Hawaii Department of Labor and Industrial Relations.

Housing

Based on the number of dwellings and the number of vacant dwellings, also products of the 1990 U.S. Census, we have estimated the percentage of total dwellings occupied and those that are vacant. By dividing the number of dwellings into the total population, we establish the number of individuals per dwelling.

Data on owner occupancy and age have been extrapolated from Hawaii County tax office records on real property tax exemption (homeowners and homeowner's 60 years or older) applications. In Hawaii County, it is estimated that 45.15 percent of all homes are occupant owned, while an estimated 41.83 percent of all owner-occupants are at least 60 years old or physically disabled. Only 12,672 dwellings, or slightly over 26 percent, of all houses in Hawaii County are occupant owned by individuals under 60 years old.

A significant trend illustrated in the population and housing data, highlights the areas within the county that have experienced significant new housing development. All Hawaii County dwellings over 30 years old in the year 1985 are quantified as a percentage of total dwellings, as published by Hawaii County in its update General Plan (1989). The following table helps visualize this trend.

HOUSING UNITS OVER 30 YEARS OLD IN 1985
By District

District	Percentage
North Kohala	61.08
South Kohala	19.63
North Kona	16.91
South Kona	41.64
Ka'u	46.76
Puna	26.79
South Hilo	43.63
North Hilo	68.38
Hamakua	68.53
Hawaii County	37.48

The table clearly illustrates that most new housing have been developed in the South Kohala, North Kona, and Puna districts, which has definitely been the case according to county building permit records. Other districts, meanwhile, have recorded little new residential construction activity over the past several decades. This is a trend that is expected to continue over the next several decades. Puna will continue to grow, because of its excess of affordable land in the form of numerous non-conforming one- to five-acre lot subdivisions created during the 1960s and early 1970s. North Kona and South Kohala will continue to grow given the promising long-term outlook for the area as the core of Hawaii County's tourism industry.

State and Hawaii County housing agencies have recognized that affordable housing requirements mandated in the late 1980s and early 1990s are onerous in today's economy/marketplace and have been a substantial barrier to new construction. In January 1996, Governor Ben Cayetano announced that the state would no longer enforce a requirement that 40 percent of new housing project inventory be classified "affordable."

Likewise, Hawaii County announced in November 1997 proposed changes in the county's affordable housing requirements for developer's seeking rezoning. These changes have been anticipated and discussed for the better part of 1997. Under the rules, developers were required to sell as much as 60 percent of new homes at reduced prices to low-income buyers in compliance with a 1990 affordable housing policy. The County Council lowered the requirement in

January 1998 to 10 percent (a figure commensurate with affordable housing requirements of the early 1980s prior to the development boom of the late 1980s and early 1990), exempting any requirement on projects of less than 10 homes.

Another key change to the existing Hawaii County housing policy is adjusting the in-lieu fee developers may pay as an option to building affordable homes. The $10,601-per-home fee under the 1990 rules was replaced with an average in-lieu fee of $4,720 in 1997 dollars.

Construction

During 1998, government agencies spent $95,115,000 (roughly 50 percent more than 1997) on Big Island construction.

County records indicate that private construction building permits grew to $178,758,000 during 1998. $147,828,000 of the private construction figure represents residential housing. A full 61 percent of that value is concentrated within South Kohala ($20,309,000) and North Kona ($69,998,000). The remaining $30,930,000 in private expenditures was associated with commercial construction; again the majority was concentrated within South Kohala and North Kona (72.4 percent).

The following table cites the total value of Big Island building permits (government and private) by year from 1991 through 1998, with commensurate percent changes from previous years.

CONSTRUCTION PERMITS
Hawaii County 1991 to 1998*

	1992	1993	1994	1995	1996	1997	1998	1999
Dollar Value (in Millions)	$419	$273	$205	$290	$216	$219	$208	$178
Percent Change	4.0%	-34.8%	-24.9%	41.5%	-25.5%	1.4%	-5.02%	-14.42%

* Most recent full year data available.
Source: County of Hawaii Department of Research and Development.

Tourism

Major West Hawaii resort developments include Mauna Kea Beach Resort, South Kohala Resort, Waikoloa Beach Resort, Mauna Lani Resort, Kona Village Resort, and Keauhou Resort. Kailua-Kona also

boasts a number of freestanding hotel properties along Alii Drive. Hilo has several older hotel properties, which have seen increased patronage since the near continuous eruption of Kilauea in the early 1980s.

By 1999, Hawaii County had just under 10,000 guest units, divided between hotel rooms (71 percent) and condominium/other (29 percent), available to tourists. During 1999 the units experienced an average occupancy of 67.43 percent, a slight decrease from the 68.19 percent reached the year before, according to Pannell Kerr Forster (PKF), Trends in the Hotel Industry, Hawaii.

The following table summarizes the four major existing resort holdings on Hawaii, three of which are situated in South Kohala; the Kona Village is in North Kona.

	Kaupulehu/ Kona Village	Waikoloa Beach Resort	Mauna Lani Resort	Mauna Kea/ South Kohala Resorts
Size in Acres	684*	1,383	3,200	1,000
Year Opened	1966/96	1981	1982	1965
Hotel Rooms				
Existing	368	1,786	893	660
Under Construction/ Proposed	--	--	--	--
Condominium Units				
Existing/Proposed	585	415	242	82

* Up to 600 nearby acres have been approved for resort development. The Kona Village Resort contains 125 low density bungalow-type units and The Four Seasons Kaupulehu completed 243 low density hotel units in October 1996.

Visitor arrival data is an important economic indicator.

VISITOR ARRIVALS - ISLAND OF HAWAII		
Year	Visitor Arrivals	Percent Change
1990	1,030,900	+3.18
1991	1,020,390	-1.02
1992	972,720	-4.67
1993	978,440	0.59
1994	933,700	-4.57
1995	917,610	-1.72
1996	1,031,550	12.42
1997	1,102,200	6.85
1998	1,150,000	4.34
1999	1,260,000	9.57

The data in the preceding table indicates a gradual overall decline in visitors to the Big Island between 1990 and 1994, with the downward trend reversing itself in 1996, leading to a strong later decade upcycle. However, virtually all of the growth has been focused towards the up-scale resorts along the Kohala Coast and into the Kailua-Kona to Keauhou corridor. The Hilo side of the island has seen continuing long-term declines as it loses market share to the Kona side projects while the windward side inventory continues to age. Unlike most statewide destinations, eastbound arrivals to West Hawaii remain strong, and the tourism economy has been strengthened by a booming West Coast demographic fueled by high-tech and stock money. The years 1996 through 1999 have been strong years for the Big Island with visitor count increasing by a total of 37.3 percent, much due to the introduction of direct flights from Japan.

Visitor length of stay on the Big Island, another important indicator, has shown a general strengthening since a mid-decade slip, and is now nearly a day above the length of a decade ago at 7.39 days.

Overall, 1999 was a strong year for Hawaii hotels. Occupancy rates have climbed from at or below the 60 percent level from the early 1980s through 1993, to current rates in the upper-60's percentile (67.43 percent in 1999). Average Daily Room Rates (ADRs) increased a robust 5.35 percent last year to $165.92, up $8-plus from 1998. Kohala now has the highest average ADR among the 14 state sectors, and continues to exhibit positive growth in occupancy.

Energy

The county's infrastructure has not kept pace with rapid development during the late 1980s. During the early 1990s HELCo experienced

increasing difficulties keeping the Big Island's power grid on line. Rolling (scheduled and non-scheduled) blackouts became more common as the company's ability to supply power was compromised by small interruptions in production capacity. HELCo indicated that it had planned on geothermal production supplementing its power production capacity by early 1990. In late April 1993, the Puna Geothermal Venture (PGV) began producing over 10 megawatts of geothermal energy. By mid-May, PGV was producing approximately 25 megawatts of electricity. With the addition of PGV power, blackouts have decreased in number and duration. In mid-1995, there had been renewed talk of rolling blackouts by HELCo; however, there has not been rolling blackouts since July 13, 1992.

During the early 1990s, Waimana Enterprises stated its intention to develop a private 56-megawatt power generation facility on Hawaiian Home Lands at Kawaihae--little has been done to develop this potential energy source. About the same time, Encogen Hawaii LP (dba Ensearch Development Corporation), another private concern, proposed a 60-megawatt facility in Honokaa, which began construction in September 1999.

HELCo has been less than enthusiastic in its acceptance of these proposed private power generation sources, arguing that these private enterprises will have an unfair cost advantage and, therefore, should be paid lower rates by the utility for power accepted unto its power grid. Approximately 38 percent of the Big Island's power supply comes from independent power producers.

In May 1997 HELCo reached an agreement with Ensearch to provide power, details of the plan or when the Ensearch plant will be on-line were not revealed. HELCo plans to expand its 30-megawatt generator station mauka of the Keahole-Kona Airport by an additional 56 megawatts. There has been considerable opposition to expansion of the Keahole site by local residents, who fear that the added pollution generated by the site (no matter how small) is unjustified given VOG (volcanic smog) levels in West Hawaii over the last decade.

Transportation

Two major interisland airlines and several air taxi services provide transportation to and from Hawaii.

East and West Hawaii air traffic is serviced at Hilo International Airport (formerly known as General Lyman Field) and Kona

International Airport (formerly Keahole-Kona Airport), respectively. Direct U.S. Mainland and Japan/Asia service is available from Kona International Airport. Construction of a 4,500-foot runway extension (to 11,000 feet) was completed in October 1993 at a cost of $29.7 million. Airport facilities (increased parking, widened access roadways, and new baggage handling and distribution facilities) have recently been upgraded to accommodate international flights.

Freight service is principally provided by container ships and barges received at deep water ports at Hilo and Kawaihae.

There are approximately 1,450.95 miles of public roadways on the Big Island. The most significant roadway is the Hawaii Belt Highway (aka Mamalahoa Highway and by various highway numbers at differing locales throughout the island). This highway circles the island generally near the coastline and connects East and West Hawaii.

Regional Description - The Kona District

The subject holding is located in the makai, central/northerly area of the Kona District, an expansive region which occupies some 700 square miles in West Hawaii and is the economic focal point of the leeward sections of the island.

The Kona (comprised of the North and South Kona districts) and Kohala (comprised of the North and South Kohala districts) areas, together constitute West Hawaii, the area on the west side of the mountain chain that forms the Big Island. Our primary study emphasis is the Kona area, the North and South Kona districts, which stretch along the coastal plain and western flanks of Mauna Loa and Hualalai for nearly 80 miles. Relatively young geologically, the topography is characterized by lava flows gently sloping from the shoreline to the upper elevations of the inland mountains. Mauna Loa, seasonally snow capped and an active volcano, is the second highest Pacific-island peak with a 13,677-foot summit.

Generally, temperatures in North Kona decrease and rainfall and vegetation increase the further mauka the location. Along the relatively barren coastal plain, temperatures average from 72 to 80 degrees, with rainfall between 20 and 50 inches annually. In the central elevations of the district, from 500 to 2,300 feet above sea level, temperatures are approximately five degrees cooler than at the coastline, with 60 to 70 inches of rain per year. The sunny Kona coastline mainly appeals to tourists and retirees, resulting in intensive

resort-type development between Kailua-Kona and the Keauhou Resort, while the large majority of permanent residents historically have preferred the cooler, agriculturally oriented central elevation areas. Land above the 4,000-foot level is typically ohia lehua and fern rain forest, and sparsely populated.

Kailua-Kona and Kealakekua, the major communities in North Kona today, were significant native Hawaiian settlements--central villages of the large indigenous population, which once resided along the Kona Coast. Captain Cook first landed on Hawaii at Kealakekua Bay in January 1779, and was later killed there during a subsequent visit to the islands.

The town of Kailua (recently renamed Kailua-Kona) was made capital of Kamehameha the Great's kingdom in 1812. In 1820, the first missionaries arrived, and soon oranges, grapes, cattle, horses, and other crops were established. The safe harborage available in the numerous coastal coves resulted in much whaling trade during the early decades of the 19th century.

Tourism is the primary business activity in North Kona, and the major economic stimulus for the entire district. Agriculture, still the main focus of South Kona, has been relegated to a secondary status in the north. Currently, there are approximately 5,100 transient dwelling units available in North Kona, comprising over 50 percent of the island's total inventory.

Many industries, including real estate, commercial, service oriented, and retail in particular, have benefited and expanded due to the income generated through tourism. Through mid-1990, property values in general increased significantly over the preceding decade--a result of the influx of visitor, resident, and retiree capital. This sharp rise in land prices had created concern in the agricultural community; however, over the past five years, real estate prices have generally dropped significantly between 20 and 75 percent, depending on the real estate submarket, with resort oriented and bulk acreage market segments severely impacted.

While the historic base of North Kona has been ranching, fishing, and diversified agriculture, the past three decades have seen a transition in the socioeconomic character of the region from an agrarian lifestyle to a resort and residentially oriented community designed to meet the increasingly urbanized employment needs in the tourism-spurred Kailua-Kona to Keauhou and South Kohala development corridors. Yet, as tourism is generally oriented toward the warm sea coast area, away from upland residential/agricultural neighborhoods, a continued harmony between agricultural and urban/resort development is anticipated.

While many economic sectors in West Hawaii have languished since mid-1990, non-traditional retail shopping has changed dramatically. In late 1993, Price/Costco opened the area's first big-box discounter. Other discounters quickly followed suit, with Kmart and Wal-Mart now available to West Hawaii. This change has positively impacted consumers' purchasing power, but has thrown many traditional area retailers into competition shock, while they attempt to identify niche markets. Many smaller retailers have already been chased from the market.

Ranching, generally considered a poor use of the rocky and relatively expensive land in the district, has given way to a variety of sub-tropical and temperate crop production agricultural uses, although (for tax purposes) many bulk acreage holdings are still marginally classified as grazing. There are expansive macadamia nut orchards in both North and South Kona, with avocados, coffee, citrus, and floral/nursery products also cultivated. Commercial and charter fishing is a traditional and continuing economic activity, and a strong identification source for the Kailua-Kona community.

Kona International (nee Keahole) Airport is located approximately nine miles north of Kailua-Kona and has been handling direct mainland flights (via United Airlines) since July 1983 and direct flights from Japan since 1997. Expanded boat anchorage has been made available at Honokohau Small Boat Harbor. Adjacent to the airport is the Hawaii Ocean Sciences and Technology (HOST) Park. This project, funded by the state, offers private enterprises the opportunity to exploit the potentials of the North Kona coastal waters.

The State of Hawaii Housing, Finance and Development Corporation (HFDC) plans on developing approximately 990 acres makai of Palani Road at Kealakehe (at the northern fringe of Kailua-Kona). The acreage is to be acquired from the state Department of Land and Natural Resources (DLNR) at fair market value as mandated by state law.

The project entitled the Villages of Laiopua calls for the development of a planned community over the next 15 to 20 years. The 4,358-unit master planned community with a golf course emphasizes the development of "affordable" housing with a 60/40 percent mix of "affordable" and market rate housing, combined with neighborhood commercial and governmental facilities. Current projections estimate that 250 housing units constructed on approximately 60 acres will be developed annually. This project has stalled over the last several years because of a dispute between HFDC, the state's development entity, and the state's Office of Hawaiian Affairs (OHA) over compensation for use of state lands and the use of ceded lands (state-owned lands that were once owned by the Hawaiian monarchy).

The first residents of a 225-home Department of Hawaiian Home Lands (DHHL) subdivision (Village III), now called Kaniohale at the Villages of Laiopua development, moved into their completed homes during August 1998. Six different models were offered, with prices ranging from $49,500 for a two-bedroom self-help model to $125,500 for a four-bedroom developer built model. Average lot size is 6,000 square feet. More than 200 native Hawaiian families selected their home sites in a February 1998 lottery. Most of the applicants came from either the Big Island or Oahu.

Educational facilities include elementary and secondary schools located immediately north of Kailua-Kona, with an additional school midway between Kailua-Kona and Keauhou. Konawaena High School is located approximately 12 miles south of the village. Kealakehe High School, situated within the Villages of Laiopua development, was completed during 1997. Its first class of freshmen entered the school in the fall of 1997. A new class has been added to the school in each of the last three years.

All schools have bus service. Police and fire protection is located in Kailua-Kona.

The North Kona water system is primarily supplied by five wells at Kahaluu and Waiaha Streams, with Kahaluu wells providing the bulk of the water. Additional wells are currently in the drilling and testing stages. At present, source output capacity is approximately 9 to 11 million gallons per day; a figure which has grown with the addition of a new well in the area. However, a recent attempt at another well drilling in the field was unsuccessful. Most residences in the Kona area are serviced by individual sewerage (cesspool) facilities, with urban Kailua-Kona and Keauhou being serviced through municipal sewerage systems. Power and telephone utilities are available along major roadways throughout the district.

Tourism is a major contributor to the North Kona economy with a tourism plant that is beginning to age and was generally conceived prior to implementation of the resort concept. For that reason, North Kona only has two resort locales; i.e., the Keauhou Resort south of Kailua-Kona proper and the Kona Village Resort north of the airport designed as a get-away experience. Most hotels in the Kailua-Kona area have been developed as freestanding properties, with little regard to overall planning and ambiance of individual neighborhoods.

Kona Village/Hualalai Resorts

The Kona Village Resort, a 62-acre holding currently improved with a 125-room hotel, 12 miles north of Kailua, is the only developed resort area outside of the Kailua-Kona to Keauhou Corridor within the North Kona district. The isolated village, which has historically achieved high occupancy rates, is a Polynesian-style, low-intensity retreat facility. The village is located within the Kaupulehu ahupua'a along the shores of Kahuwai Bay.

The Hualalai Resort has set a new standard along West Hawaii's "Gold Coast." The resort property has attracted a "well-to-do" clientele and has successfully marketed oceanfront residential sites and condominium units, in an otherwise weak economic climate. Such has been the success of the resort's initial offerings, unlike other upscale Kohala Coast resort recent sales efforts.

A 243-unit low-rise hotel complex consisting of 37 bungalows was completed in October 1996. The new hotel was developed adjacent to the Kona Village Resort and has been named The Four Seasons Resort Hawaii at Hualalai. The new property was developed by Hualalai Development Company, which is owned by Kaupulehu Makai Venture, an affiliate of Tokyo-based Kajima Corporation. The single-family lots and villa units have been exceptionally well-received at very high prices, with most purchasers being West Coast residents. All available inventory has been quickly sold.

The resort is serviced by an 18-hole Par-72 Jack Nicklaus-designed golf course. Plans exist for expansion to a 27-hole course as the need

arises. The resort course is well-situated and private for use of resort unit owners and guests only.

Central Urban Area Kailua-Kona to Keauhou Corridor

Kailua-Kona, the population center of West Hawaii, is developed with hotels, condominiums, and commercial services generally directed toward the visitor industry. In addition to tourism, the village is the commercial hub for residential and agricultural developments in the surrounding area.

The corridor between Kailua Village and Keauhou, stretching from the shoreline up-slope to Mamalahoa Highway, is in a state of evolution, with properties along the ocean being improved with condominiums and high density residential projects. The cooler mauka areas are being developed into single-family residential subdivisions as State Land Use (SLU) and county zoning designations are changed to permit such improvement, and water is made available. Commercial frontage improvements have been made along Alii Drive, Palani Road, and Kuakini Highway.

The recent construction of the Crossroads Shopping Center along Henry Street, has shifted the commercial center of town to a more mauka orientation and away from Kuakini Highway, which has historically approximated the center of town.

Keauhou Resort

The 2,000-acre Keauhou Resort area is in the midst of its third phase of development with planned residential and condominium development centered near the existing hotels, resort multi-family project, and the Kona Country Club. To date, 1,330 hotel rooms and 1,252 condominium units have been constructed in the project.

Extensive non-tourist commercial development has been moderately successful at Keauhou within the original phase of the Keauhou Shopping Center. Phase II of the shopping village, completed in late 1994, remained mostly vacant until late 1996 and 1997 at which time leasing of remaining commercial space occurred, indicative of improving economic times.

Bishop Estate's Kamehameha Investments, which owns the resort, took back the Kona Lagoon Hotel from Azabu in early September 1995 for non payment of lease rent. The hotel had been closed since 1989, when Azabu purchased it in conjunction with the neighboring Keauhou Beach Hotel, which it gave back to Bishop Estate effective

May 1, 1998. It was reported at the end of April 1998, that the Keauhou Beach Hotel would be closing due to a transfer of leasehold ownership to a Arizona real estate group which will start immediate renovations. On March 1, 1999 Aston Hotels and Resorts re-opened the 314-room former Keauhou Beach property.

ADDENDA III: ASSESSMENT OF REAL PROPERTY VALUE EFFECTS

Current Activity

Sales activity and prices for vacant holdings in the subject neighborhood have generally reflected the overall trends evident in the West Hawaii real property market. In the late 1980s, the demand for buildable and subdividable sites in South Kona grew markedly, though to a lesser degree seen in many neighbor island locales.

During the recession of the 1990s, activity slowed considerably and prices fell by upwards of 30 percent, with the sector remaining sluggish until the last several years. Since that time, the number of sales, price ranges and average prices have all moved upwards, the indicators depicting a regional market within an emerging upcycle.

We have studied the sales activity of vacant parcels in the greater Keopuka neighborhood, comprised of Third Division, Zone Eight, Sections 1 through 4, (roughly from Kealakekua to Honaunau), for the past 15 years, focusing on the five year period from 1995 through 1999. The results are summarized on Table III-1. We have excluded the sales at Hokulia from our analysis.

After averaging 11 to 15 sales per year during the early years of the decade and average prices between $105,000 and $115,000, activity picked up in 1997, with 17 transactions for the year, and average prices of $133,425. Although the number of sales dropped back to 11 in 1998, the average price continued to climb, up 15.63 percent for the year.

In 1999, the recovery was complete, with all surveyed indicators up. There were 18 sales for the year (the most since 10 years prior), prices ranged from $136,325 to $925,000, and the average sales price was at $440,751, nearly triple of the previous year. Activity surged in the first 3.5 months of 2000, equating to a yearly sales total of 38 lots, but average prices slumped way down; a trend agents believe to be a lack of quality inventory, with all the best parcels being snapped up in 1999.

From 1995 through 1999, the average price for vacant parcels in the Keopuka area showed appreciation at the exceptionally high rate of 40.69 percent compounded annually. However, the relatively small number of transactions and variances in the inventory available at any time limit the applicability of the analysis.

A better sense of appreciation can be extracted from paired-sales data, wherein the multiple sales of a parcel (or comparable properties) over time is analyzed to determine periodic rates of price increases. Generally, paired sales show prices declining in the sector from early 1991 through late 1994, basically stabilizing in 1995 and 1996.

Appreciation began to occur in 1997, when prices of the same or like properties increased at rates of four to eight percent from the previous year; most data points being at the very low end of this range. In 1998, the escalation continued, with paired sales depicting appreciation of seven to twelve percent from the prior year (most at about 10 percent above 1997).

In 1999, the market showed strong growth, with indicator prices moving up 10 to 20-plus percent from 1998, most in the 15 to 20 percent range. There were several properties which sold at least twice during the year, showing appreciation each time, equaling in one case to a more than 24 percent price escalation over the 12 months.

Historically, such rapid movement in South Kona land prices have been rare, as it has always been outside of virtually all resort/residential type purchaser interest, there were few new full-time residents moving into the community, and much of the land was held by a few major owners. Now, however, there is a significant emergence of vacation homesite buyers and more relocating households.

Several factors have contributed to the recent upsurge in the regional market:

- West Hawaii has emerged as a strongly competitive vacation destination in Hawaii and the Pacific, a product of quality, upscale development, increasing numbers of direct flights, and a diverse and scenic visitor plant.

TABLE III-1

SUMMARY OF VACANT LAND SALES HISTORY IN THE CAPTAIN COOK TO KEALAKEKUA NEIGHBORHOOD 1995 TO 2000
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
Excludes Sales in Hokulia Project

Year	1995	1996	1997	1998	1999	2000
Number of Sales	15	11	17	11	18	38 (1)
Pct. Annual Change		-26.67%	54.55%	-35.29%	63.64%	112.43%
Overall Price Range						
Low	$17,500	$15,000	$25,000	$35,000	$136,325	$31,200
High	$233,000	$299,000	$275,000	$359,000	$925,000	$250,000
Average Sales Price	$112,487	$111,546	$133,425	$154,273	$440,751	$101,019
Pct. Annual Change		-0.84%	19.61%	15.63%	185.70%	-77.08%
Paired Sales Appreciation Analysis		Prices remain unchanged from 1995	Prices show increase of four to eight percent.	Prices increase by seven to twelve percent from 1997.	Prices increase by ten to 20-plus percent from 1998.	Inventory quality drops, comparable prices up six to twelve percent.

(1) Based on extrapolation of sales rate through April 15th. (11 Sales in 105 days).

Source: Hawaii TMK on-line data service, and The Hallstrom Group, Inc.

- A booming economy in the areas from which West Hawaii attracts most of its tourists and resort real estate purchasers (Western US) has stimulated growth faster than seen in other neighbor island regions.
- Spectacular ocean and mauka views, among the best in the State, are available from most sites in the study region, with properties overlooking Kealakekua Bay achieving particularly premium prices.
- Superior climate, in the lee of Mauna Loa, provides warm, relatively dry and typically calm conditions.
- The rural ambience of the area provides a unique second home experience, an agrarian theme seemingly worlds removed but still quite close to Kailua-Kona, the airport, and the coastal resorts.
- South Kona has established name recognition from coffee, macadamia nuts, floral products and arts/crafts which attract outside purchaser interest.
- Numerous well-known individuals have made purchases in the area, creating a greater sense of demand and exclusivity.
- Several large ranches have been broken-up over the last decade, or have been purchased by buyers more interested in the highest and best use of the holdings than past owners. This will, over time, create a greater supply of inventory and more motivation to subdivide and sell.
- Urban Kailua-Kona continues to expand outward, making South Kona a more reasonably-priced suburban location alternative for new and relocating residents.

Projected Value Trends

The characteristics which has driven demand and prices for South Kona vacant land upward since 1997 will continue to exist during the emerging upcycle. The inherent shortage of quality lands in the islands, relative affordability of South Kona homesites, and unique

attributes of the community will move further into the forefront in coming years and stimulate activity.

We foresee activity and price levels in the study area escalating over the next several years, especially as more "trendsetter" types purchase land and build vacation homes. In this regard, the Hokulia project must be viewed as an effect, or result, of the area market, not a cause. It is because the latent demand for homesites in the area is strong and growing that the development has achieved superior market acceptance. Its success did not bring about the conditions under which it has prospered.

We forecast continued appreciation in study area real estate at compounded annual rates of five to ten percent over the next three to five years, with demand escalating at ten to twenty percent each year.

This general level of activity and appreciation will be representative whether or not the Keopuka Land subdivision is undertaken.

In and of itself, the subject project will not generate unduly higher neighborhood property values beyond the spectrum of standard regional escalation. As a private, gated community closed to non-members, the attraction of Keopuka will be in having a membership, which brings access to the course, clubhouse, lodge and amenities. No membership, no access, no effect on nearby properties.

As seen in membership communities in the Southwestern US, virtually all members who desire vacation homes near a project specifically seek to be located in the community, and obtain the resulting exclusivity, prestige and resale values. Members do not typically seek to locate in nearby non-membership developments.

For adjacent properties, the effects on value from Keopuka Lands will also be mitigated. The large size of the project site, buffer areas and open space, done to isolate the subject development from outside influences, has the identical effect on abutting parcels, isolating them from the influences of Keopuka.

As the view throughout the area is superior, the clearing and landscaping of the subject will not enhance area views in a manner to increase values. In fact the view impacts are probably a trade-off, with some properties benefiting from having a more amenitied view (across a golf course and water features), while others are negatively impacted by the presence of additional hillside homes.

Purchasers attracted to the membership community concept are specifically looking for such opportunities and generally will not consider a free-standing homesite as a reasonable alternative. A buyer who found that Keopuka memberships were sold out would not be likely to buy a lot in Napoopoo and build a home just to be in the area, they would seek out another membership community elsewhere.

Agents will undoubtedly use the existence of Keopuka as a sales tool, saying a property is "located near a world-class private golf course", but the actual impact will be quite nominal, as the purchaser would already be attracted to the area before such a comment was meaningful, and the community would be viewed as a sign of the desirability of an area, not the cause of it.

Our studies of private club or community development in Hawaii and the Western US indicates the club/community has an effect only on the immediately associated lands. Once outside the project enclave, the impact quickly disappears. This is reflective of all real property locational amenities, that impact decreases rapidly with distance.

The difference from being on the waterfront versus a short distance inland has a tremendous effect on values, as does the difference between a golf course fronting homesite and interior lot. Outside the sphere of the membership community, the valuable "frontage" would be lost and values free from the influence.

Numerous examples are available near Las Vegas, Phoenix-Scottsdale and Palm Springs wherein there are several membership communities surrounded by non-member developments. Without exception, the residential inventory in the non-member subdivisions was priced based on its competitive attributes with other non-member developments, there were no premiums associated with mere proximity to a membership community. We believe the same would be the case in South Kona.

In Hawaii, there is insufficient market data on membership communities to provide a clear conclusion. The only examples can be taken from resort projects; however, most were planned by bulk acreage landowners specifically to fuel demand for nearby lands. In

the cases where a resort was placed near an existing community, the effects on land values were much less apparent. In example, interior Kihei houselots near Wailea Resort are comparably priced with those elsewhere in the village and do not command a premium due to resort proximity.

With or without the Keopuka Lands project, the study region will still attract increasing numbers of vacation homesite purchasers bringing about appreciation during the emerging upcycle. The net impact of the subject subdivision will be nominal. Not building it will not bring about lower prices or less demand.

ADDENDA IV: ECONOMIC IMPACT ANALYSIS

The development of the Keopuka Lands subdivision will result in significant expenditures that will favorably impact the West Hawaii economy on both a direct and indirect basis, increasing the level of capital investment and capital flow in the region, which will in turn create employment and widen the tax base.

From a direct perspective, the proposed 125 Agricultural lots and finished buildings thereon, golf course facility and 100-room Members Hale will create numerous construction, equipment operator and specialty trade jobs on- and off-site during the planning and emplacement of the infrastructure, and building of the improvements. After completion of the common elements, buildings and support facilities over an estimated 15-year total development period, there will be permanent employment positions created by the course and lodge business operations and the buildings themselves (landscape, service, maintenance, and renovation needs in the course of their use).

Numerous local businesses will enjoy significant profit opportunities arising for contracting companies constructing the improvements, and for local businesses which would supply a substantial portion of the materials needed in the building efforts.

The general island economy also will benefit from the subject development, as its members, guests, employees and businesses will spend large amounts of discretionary vacation and wage income in off-site shops, restaurants, and service establishments throughout the Big Island, and in purchasing goods and services.

Indirectly, as these wages, profits, and expenditures move through the regional economy, they will have a ripple, or "multiplier," effect–increasing the amount of capital flowing to the entire community as a result of the subject.

Members and guests will be generally upper-income and have daily expenditures comparable with those found at Hawaii's most upscale

vacation communities. Local restaurants, shops, recreational and service businesses in West Hawaii will benefit.

Construction, operational and other workers earning wages from the Keopuka Lands project and associated off-site efforts will spend the majority of their income on living and entertainment expenses while supporting and patronizing other island businesses. Much of this spending would be re-directed by these businesses to other island industries, and significant portions of these secondary profits would in turn be put back through the region's economic and tax structure.

These substantial direct and indirect economic impacts associated with the proposed subject project, as quantified in the following sections, are all the result of the capital investment and entrepreneurship necessary to convert undeveloped, fair quality agricultural lands into a low intensity membership community. The Hawaii County economy will be meaningfully stimulated by the capital investments, member spending and business operations of the development.

Capital Investment and Construction Costs

The subject development will bring an estimated $158.9 million in direct development capital into West Hawaii over the 15-year build-out period for the project. A breakdown of the basic expense items, their respective costs and expenditure over time is summarized on Table IV-1.

Also shown are anticipated contractor and supplier profits flowing to local businesses as a result of the project.

Infrastructure cost estimates were at $25 million and golf course and clubhouse construction costs of $20 million, by the developer. These basic systems and facilities would be built in a single phase lasting about two years. The final lot subdivision may be phased according to market demand. Based on our projections, we have assumed all construction would be completed in the initial effort.

The cost of the Members Hale was estimated at $15 million, total, or $150,000 per room (about $200 per square feet), to be built in two phases. The first increment, with about 50 rooms and central/common amenities, would require about two years to build in years 4 and 5 of the development period. The remaining 50 units would be built over two years in years 7 and 8.

Home construction costs would total $96.88 million during the 13 years of house building in years 3 through 15 of the development period. The average home is estimated to have building costs of $775,000, which includes 3,200 square feet of living space (not including garage), having a construction expense of $200 per square foot, and a $75,000 cost allowance for site work, landscaping and amenities.

The Keopuka Land subdivision will infuse on average an anticipated $10.59 million annually into the Big Island building industry on average over the build-out period. This is the equivalent of a four to nearly seven percent boost over recent yearly construction levels during the mid to late 1990s.

West Hawaii was hard hit by the recession of last decade, and though employment in the depleted construction trades is beginning to rise for the first time in a decade, there is a continuing instability in the Hawaii economy. This has been exacerbated in its recovery efforts by the 1997-98 Asian monetary crises; the reduced asset values and earnings of major in-state companies; and the limited flow of investment capital and developer interest in undertaking major new projects. There are limited favorable near to mid-term opportunities for a resurgence in the commercial construction employment, although residential construction is picking up meaningfully. Many skilled tradesman have left the island or moved into other occupations, failing to pass their knowledge and experience onto the next generation of workers, damaging the long-term health of the foundational construction industry.

Based on building permit data, a total of $178 million of construction was put in-place on the Big Island in 1999, more than $50 million below the level of a decade earlier. All indicators point to a regional construction industry continuing under stress, with limited favorable aspects from an employment perspective. The subject development would be a meaningful component of any major recovery.

TABLE IV-1

CONSTRUCTION COSTS AND CONTRACTOR AND SUPPLIER PROFIT ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
Construction Costs (1)										
Infrastructure (2)	$13,000,000	$12,000,000								
SFR Construction (3)			$3,875,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000
Members Hale Const. (4)				$5,000,000	$3,500,000		$3,500,000	$3,000,000		
Golf/Clubhouse Const. (5)	$11,000,000	$9,000,000								
TOTAL CONSTRUCTION COSTS	$24,000,000	$21,000,000	$3,875,000	$12,750,000	$11,250,000	$7,750,000	$11,250,000	$10,750,000	$7,750,000	$7,750,000
CONTRACTOR'S PROFIT	$2,400,000	$2,100,000	$387,500	$1,275,000	$1,125,000	$775,000	$1,125,000	$1,075,000	$775,000	$775,000
SUPPLIER'S PROFIT	$330,000	$720,000	$155,000	$510,000	$450,000	$310,000	$450,000	$430,000	$310,000	$310,000

Development Year	11	12	13	14	15	Totals
Construction Costs (1)						
Infrastructure (2)						$25,000,000
SFR Construction (3)	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$96,875,000
Members Hale Const. (4)						$15,000,000
Golf/Clubhouse Const. (5)						$20,000,000
TOTAL CONSTRUCTION COSTS	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$7,750,000	$156,875,000
CONTRACTOR'S PROFIT	$775,000	$775,000	$775,000	$775,000	$775,000	$15,687,500
SUPPLIER'S PROFIT	$310,000	$310,000	$310,000	$310,000	$310,000	$6,825,000

(1) Direct costs only for infrastructure ($25,000,000) incurred in Years 1 & 2.
(2) Estimated average construction cost of $775,000 per home, 3,500 square feet at $200 per square foot, plus $75,000 for site work, landscaping and amenities.
(4) Estimated construction cost of $15,000,000 (or $150,000 per room), in two phases, with first phase of $4,500,000. Includes site work, landscaping and amenities.
(5) Direct costs only, estimated @ $20,000,000.

Source: Various, and The Hallstrom Group, Inc.

Employment Opportunities Created

Based on indicators provided by the construction of comparable sized projects and Hawaii industry averages, we have estimated the demand for on- and off-site, full-time equivalent employment positions associated with laying of initial infrastructure systems, building of the finished common area, lodge and homes, the on-going businesses in the project, and in providing continuing services to the occupied buildings.(1)

The employment opportunities created by the subject development will not be "new" jobs requiring new West Hawaii residents but will be new opportunities for resident construction trade workers and local businesses. This is particularly vital for South Kona residents, as employment not requiring a substantive commute are rare.

It is assumed the off-site/indirect work created will be steered towards existing Big Island supply, equipment providers, and other service companies, which despite the up-tick in the county economy over the past two years remain in a "lean" period following the massive development activity of the late 1980s.

According to the State of Hawaii Department of Labor and Industry Relations, the current number of jobs in the Big Island construction industry is about 1,960 positions, a minor increase from the previous year, but well below the annual average of 3,000 jobs that existed during the late 1980s and the first two years of this decade. Overall, unemployment on the island of Hawaii is presently at some nine percent, down more than one point from mid-decade but still several points above the figure of ten years ago. The rate of joblessness in the building trades is estimated to range from 15 to 25-plus percent.

The subject development will provide needed employment opportunities in the construction, supply and building support industries during an estimated 15-plus year planning, site development and building construction period. The planning process, currently underway, is anticipated to require one year; on-site subdivision infrastructure and golf course development, some 24 months; and lodge and home construction, about 13 years.

(1) Only additional jobs, wages, costs and revenues being created as a result of on site activity are shown.

Our employment estimates on are based on full-time "worker/years," although one worker/year (or circa 2,000 working hours) may be comprised of many employees involved in specialized tasks of a much shorter duration.

Estimates based on a 15-year period of project construction and the associated number of employment opportunities created are displayed on the top of Table V-2. Included are the full-time equivalent off-site and support employment opportunities which will be provided to West Hawaii businesses as a result of the project. Also shown are the employees of the golf course and lodge operating businesses, and maintenance/landscaping/trade workers required to service the community improvements over time.

The projections are founded on examples provided by various resort/residential developments undertaken on the neighbor islands over the past decade, and via formulae expressing relationships between total worker wages/benefits and construction task costs.

Infrastructure, golf course, and Members Hale construction employment forecasts are taken from discussions with developers, review of project records and ratios of direct costs to job creation (assuming an average wage of $45,000/year plus benefits equal to 25 percent of wages).

Home construction is anticipated to require five total worker/years per home including site work. The average wage for these construction workers is also $45,000 per year plus benefits.

Business operations are estimated at 42 full-time positions for the golf course (including pro shop, maintenance and a bar/grill) and 80 positions at the Members Hale (including hotel and restaurant departments). The average wage of lodge workers is estimated at $25,000 per year; for golf course employees, the total is $23,000 per year.

The finished homes and community assets will require maintenance, landscaping, service and repair workers which will at build-out total up to the equivalent of some 25 worker/years annually, or one worker/year for every five homes. These workers are estimated to be paid on average $30,000 per year.

Off-site employees were estimated at 50 percent of on-site workers, and are comprised of three groups:

- Numerous off-site building industry positions will also be enhanced by the Keopuka Lands subdivision development, including such jobs as administration, office help, material providers, equipment maintenance and specialty tasks. Analysis of Hawaii County labor trends from 1980 through 1999 demonstrate a linkage equal to about 30 percent between the creation of on-site construction positions and direct off-site employment.
- Off-site support businesses, including contractor/retail/counter sales, fuel providers, shipping, storage and professional services will also benefit. A conservative job creation relationship of five to ten percent relative to on-site positions was used (or, one off-site support worker/year for each ten to 20 on-site worker/years).
- Extrapolation of state Department of Business Economic Development and Tourism (DBEDT) data, along with indicators provided by other state agencies and First Hawaiian Bank studies, demonstrate that each Hawaii worker creates demand for services (and related employment) during and directly attributable to the work day at up to a ten-plus percent ratio. These positions include food businesses, providers of tools and trade goods, payroll/financial and insurance businesses, medical requirements and other secondary indirect/off-site employment.

During the 15-year building period of the project, the number of worker/years created on- and off-site by the development varies from 96 to 295 positions annually, totaling 3,528 worker/years over the entire timeframe. Of this total, 877 worker/years (an annual average of 58.5 positions) are direct construction-oriented, 1,475 total (or 98.33 per year) are on-going, on-site business operating and maintenance positions; and 1,176 are off-site worker requirements.

On a stabilized basis, after the completion of construction (year 15 of the model), the project will generate some 221 permanent full-time equivalent employment opportunities--148 directly related to on-site activities, and 74 indirect positions throughout the island.

The stabilized employment created by the subject development represents only a minor 0.35 percent increase from the total jobs presently available in Hawaii County (221 additional jobs per year to a current job count of 63,000), but could potentially lower unemployment in the construction industry by more than three percent.

Additional secondary direct employment will be created by the lodge and golf course operating businesses. These businesses at stabilization will generate some $15 million annually in revenues. Most of the non-wage expenses of the lodge and golf course will go to local suppliers and service providers. Based on DBEDT data stating each $65,000 to $80,000 spent creates one position, an additional 188 to 231 secondary jobs will be supported on the island as a result of the subject property businesses.

Wage Income Generated

In accordance with data compiled by the state Department of Labor and Industry Relations, as tempered through our analysis, we have estimated the personal income (in the form of wages) which will flow to West Hawaii workers as a result of the Keopuka Lands project.

The 2000 average wage of a full-time infrastructure construction worker is estimated at $45,000 per year. For lodge, clubhouse and home construction workers, the average annual pay will also be about $45,000. The lodge and course business operating personnel are assumed to be paid $25,000 and $23,000, respectively, per year on average ($11 to $12.50 per hour), home maintenance and grounds/landscape workers are projected to receive average pay equivalent to $30,000 per year. Off-site building and support industry jobs were estimated to receive an average pay of $25,000 annually.

Overall project average wages are equal to $29,900 per worker/year created.

Application of these wage estimates to the employment forecasts generates personal income (wage) projections directly resulting from subject development as shown at the bottom of Table IV-2. The wage figures are all presented in constant 2000 dollars, and will undoubtedly escalate over time in accordance with inflationary pressures.

In the first year of development, the "Total Annual Wages Generated" by the subject development effort would be $7,187,500, increasing to as high as $8.63 million in year 8, as the number of construction, business operations and maintenance/service workers peaks. After completion of all construction, the on-going operational, maintenance, off-site and indirect employment would result in average annual wages of $5.55 million thereafter in uninflated 2000 dollars.

Over the first 15 years of the development, on- and off-site, direct and indirect worker wages would total $105.49 million.

Development Costs as Profit Income

While the significant majority of the materials needed to build the subject industrial and commercial structures must be imported to the Big Island, a portion of the construction costs spent in the development will flow to local businesses in the form of contractor profits and supplier profits.

Typically, within the industry net contractor profit margins are expected to be at 8 to 20 percent of total construction costs. We have used a conservative ten percent figure. Supplier profits were extrapolated at four percent of total costs (supplies/materials equate to 50 to 60 percent of total cost, with a profit margin for the supplier of six to eight percent).

Application of these estimates to the forecast development parameters of the subject project was shown on Table IV-1.

The total Contractor's Profit ranges from $387,500 to $2,400,000 per year, with a cumulative profit of $15.69 million over the construction period. The total annual Supplier's Profit ranges from a low of $155,000 to a high of $830,000, and equates to $6.03 million over the 15-year development time-frame.

Population, Income and Expenditures

The homes of Keopuka Lands will be a collection of primary and second home residences, primarily comprised of the latter. These households, members staying at the lodge, and their guests will contribute to the West Maui economy during the stays in the

TABLE IV-2

EMPLOYEE JOBCOUNT AND WAGE ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
Worker Requirements (1)										
Infrastructure	70	63								
SFR Construction			21	43	43	43	43	43	43	43
Members Hale Construction				32	21		32	21		
Members Hale Operation					40	40	40	80	80	80
Golf/Clubhouse Construction	55	51								
Golf/Clubhouse Operation			42	42	42	42	42	42	42	42
Home Maint. & Services			1	3	5	7	9	11	13	15
Off-Site Employees (2)	63	57	32	60	75	64	83	98	79	90
TOTAL EMPLOYMENT CREATED	188	171	96	179	226	197	248	295	266	289
Worker Wages										
Infrastructure	$3,130,000	$2,835,000	$0	$0	$0	$0	$0	$0	$0	$0
SFR Construction	$0	$0	$956,250	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500
Members Hale Construction	$0	$0	$0	$1,440,000	$960,000	$0	$1,440,000	$960,000	$0	$0
Members Hale Operation	$0	$0	$0	$0	$1,000,000	$1,000,000	$1,000,000	$2,000,000	$2,000,000	$2,000,000
Golf/Clubhouse Construction	$2,475,000	$2,295,000	$0	$0	$0	$0	$0	$0	$0	$0
Golf/Clubhouse Operation	$0	$0	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000	$966,000
Home Maint. & Services	$0	$0	$30,000	$90,000	$150,000	$210,000	$270,000	$330,000	$390,000	$450,000
Off-Site Employees	$1,582,500	$1,425,000	$803,125	$1,493,750	$1,825,417	$1,643,750	$2,068,750	$2,460,417	$2,218,750	$2,243,750
TOTAL ANNUAL WAGES PAID	$7,187,500	$6,555,000	$2,755,375	$5,902,250	$6,813,917	$5,732,250	$7,657,250	$8,628,917	$7,487,250	$7,572,250

Development Year	11	12	13	14	15	Total Years 1-15	Stabilized
Worker Requirements (1)							
Infrastructure						133	
SFR Construction	43	43	43	43	43	511	
Members Hale Construction						107	
Members Hale Operation	80	80	80	80	80	760	80
Golf/Clubhouse Construction						106	
Golf/Clubhouse Operation	42	42	42	42	42	546	42
Home Maint. & Services	17	19	21	23	25	189	25
Off-Site Employees (2)	91	92	91	94	95	1,176	74
TOTAL EMPLOYMENT CREATED	273	275	278	281	284	3,528	221
Worker Wages							
Infrastructure	$0	$0	$0	$0	$0	$5,965,000	
SFR Construction	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$1,912,500	$23,906,250	
Members Hale Construction	$0	$0	$0	$0	$0	$4,800,000	
Members Hale Operation	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$2,000,000	$19,000,000	$2,000,000
Golf/Clubhouse Construction	$0	$0	$0	$0	$0	$4,770,000	
Golf/Clubhouse Operation	$966,000	$966,000	$966,000	$966,000	$966,000	$12,558,000	$966,000
Home Maint. & Services	$510,000	$570,000	$630,000	$690,000	$750,000	$5,070,000	$750,000
Off-Site Employees	$2,268,750	$2,293,750	$2,318,750	$2,343,750	$2,368,750	$29,398,918	$1,837,500
TOTAL ANNUAL WAGES PAID	$7,657,250	$7,742,250	$7,827,250	$7,912,250	$7,997,250	$105,488,208	$5,553,500

(1) All jobcounts expressed as "full-time" equivalent positions.
(2) Includes all off-site jobs created by work efforts at the project, direct and indirect.

Source: Various, and The Hallstrom Group, Inc.

community in the form of discretionary expenditures and (for full-time residents) household income levels.

Table IV-3 displays our population, discretionary expenditures, and household income estimates for the subject project.

Just less than seven percent of the homes in the development are estimated to be used by full-time resident households, with the remaining 93-plus percent being second/vacation homes. This general ratio is evident in various mid to upscale resort/residential projects throughout the state (including Kaanapali Beach, Mauna Lani, Mauna Kea Beach and elsewhere).

Overall, it is estimated that approximately 20 percent of the homes will be occupied by guests, on average, at any given time, including both full and part-time resident club members. The average party size is estimated at 31 persons; larger for part-time users, smaller for full-time households. At build-out, the average population in the homes will be 78 persons, about one-third of whom would be permanent residents (26 persons). Of this number, some one-sixth (or five persons total) would be expected to be school age. Given the economic status required to support a subject home, it would be expected that all school age children in the project would be privately educated.

At stabilization, it is estimated the Members Hale will achieve occupancies approaching 70 percent on average. Assuming each room has 1.9 guests, the de facto population supported by the lodge will be a maximum of 133 persons.

The resident population will be 78 persons upon build-out, and the total de facto resident population of Keopuka Lands upon completion of development will be, on average, 211 persons. Of the full-time residents, approximately five will be in the juvenile school age group.

The population of the project will place significant discretionary expenditure dollars into the West Hawaii economy. In light of the cost of the finished homes, the residents and other users will be in the top household income brackets with substantial available income for such spending. The vacation/guest orientation of the users will further contribute to the high amount of discretionary funds.

TABLE IV-3

POPULATION, DISCRETIONARY EXPENDITURES AND RESIDENT INCOME ESTIMATES
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	3	4	5	6	7	8	9	10	11
Cumulative Residential Development									
Single Family Homes	5	15	25	35	45	55	65	75	85
Total Residential Units	5	15	25	35	45	55	65	75	85
Average Resident/Guest Population									
Single Family	3	9	16	22	28	34	40	47	53
Members Hale Guests	0	0	0	48	57	67	95	114	133
Total De Facto Population (1)	3	9	16	69	85	101	135	161	186
Total Resident Population (2)	3	3	5	7	9	11	13	15	18
Estimated School Age Children	1	1	1	1	2	2	2	3	3
RESIDENT/USER DISCRETIONARY EXPENDITURES	$124,000	$520,099	$966,832	$4,347,627	$5,381,172	$6,154,717	$8,321,887	$9,882,345	$11,442,683
FULL-TIME RESIDENT INCOME	$310,000	$309,690	$516,130	$722,610	$929,070	$1,135,530	$1,341,990	$1,548,450	$1,754,910

Development Year	12	13	14	15
Cumulative Residential Development				
Single Family Homes	95	105	115	125
Total Residential Units	95	105	115	125
Average Resident/Guest Population				
Single Family	59	65	71	78
Members Hale Guests	133	133	133	133
Total De Facto Population (1)	192	198	204	211
Total Resident Population (2)	20	22	24	26
Estimated School Age Children	4	4	4	5
RESIDENT/USER DISCRETIONARY EXPENDITURES	$11,789,335	$12,134,068	$12,482,801	$12,829,533
FULL-TIME RESIDENT INCOME	$1,961,370	$2,167,830	$2,374,290	$2,580,750

(1) Average daily resident and overnight guest population in project.
(2) Full-Time residents only.

Source: Various, and The Hallstrom Group, Inc.

We estimate that full-time resident households will spend about 40 percent of their total income on local discretionary items. The daily per capita spending by second-home users and guests in the Big Island economy will be on average $175; or slightly above what the typical West Hawaii visitor spends daily on non-lodging purchases (commensurate with project quality). This pays for all food, entertainment, household goods, locally purchased fixtures and furnishings, utilities, clothing and other daily items.

By build-out, the total resident/guest discretionary expenditures made by subject project users in the local market will be at $12.83 million annually on a stabilized basis, in 2000 dollars. During the 15-year development and stabilization model period, the total sum of the expenditures will be $96 million.

The total full-time resident income amount was quantified for use in estimating state income taxes to be paid. In order to conventionally qualify for a home or unit with an average price/cost in excess of $1.2 million as is likely at Keopuka Lands, a household income of more than $300,000 per year is necessary. We have assumed a resident per capita income of $100,000. We recognize this amount could range widely upwards, and consider these projection conservative to moderate.

On a stabilized basis after build-out, the total annual full-time resident income at the subject would be some $2,580,785. Virtually all of the resident and guest expenditures will be "new" dollars in West Hawaii, providing a true economic expansion.

Summary of Direct, Local Economic Impacts

The various direct, local economic impacts which will flow to the subject region as a result of the subject development are summarized on Table IV-4.

The annual Total Base Economic Impact increases ranges from $3,421,875 in year 3 of the development effort to a high of $21,911,783 by year 15 (in 2000 dollars). Over the development and stabilization period, the total is $223.2 million. Fueled by member and guest discretionary expenditures and business operations, the estimated stabilized annual base impact thereafter is $18,383,033 million. This

TABLE IV-4

SUMMARY OF ECONOMIC IMPACTS ASSOCIATED WITH DEVELOPMENT
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
ANNUAL WAGES GENERATED	$7,187,500	$6,555,000	$2,755,375	$5,902,250	$6,873,917	$5,732,250	$7,657,250	$8,628,917	$7,487,250	$7,572,250
CONTRACTOR'S PROFIT	$2,400,000	$2,100,000	$387,500	$1,275,000	$1,125,000	$775,000	$1,125,000	$1,075,000	$775,000	$775,000
SUPPLIER'S PROFIT	$830,000	$720,000	$155,000	$510,000	$450,000	$310,000	$450,000	$430,000	$310,000	$310,000
DISCRETIONARY EXPENDITURES			$124,000	$520,099	$866,832	$4,747,627	$5,201,172	$6,154,717	$8,321,887	$9,882,245
TOTAL BASE ECONOMIC IMPACT	$10,417,500	$9,375,000	$3,421,875	$8,207,349	$9,315,748	$11,564,877	$14,433,422	$16,288,634	$16,894,137	$18,539,495
Multiplier Effect Ratio	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL OVERALL IMPACT	$20,835,000	$18,750,000	$6,843,750	$16,414,698	$18,631,497	$23,129,754	$28,866,844	$32,577,268	$33,788,275	$37,078,990

Development Year	11	12	13	14	15	Total 1 Through 15	Stabilized
ANNUAL WAGES GENERATED	$7,657,250	$7,742,250	$7,827,250	$7,912,250	$7,997,250	$105,488,308	$5,553,500
CONTRACTOR'S PROFIT	$775,000	$775,000	$775,000	$775,000	$775,000	$15,687,500	
SUPPLIER'S PROFIT	$310,000	$310,000	$310,000	$310,000	$310,000	$6,025,000	
DISCRETIONARY EXPENDITURES	$11,442,603	$11,789,335	$12,136,068	$12,482,801	$12,829,533	$95,998,920	$12,829,533
TOTAL BASE ECONOMIC IMPACT	$20,184,853	$20,616,585	$21,048,318	$21,480,051	$21,911,783	$223,199,628	$18,383,033
Multiplier Effect Ratio	2.0	2.0	2.0	2.0	2.0	2.0	2.0
TOTAL OVERALL IMPACT	$40,369,705	$41,233,171	$42,096,636	$42,960,102	$43,823,567	$446,399,256	$36,766,066

Source: Various, and The Hallstrom Group, Inc.

does not include the more than $36 million annually in business operations activity by the lodge and golf course.

These dollars will be spent, than re-spent, on goods and services on the island, diminishing in impact on the local economy with each turnover as a portion flows off the Big Island for goods, services and financing commitments. First Hawaiian Bank studies have concluded the appropriate economic multiplier rates in Hawaii are from 1.2 to 3.5 times (or 20 to 250 percent) of the base impact amount. Mainland studies (by the Urban Institute and others) tend toward the upper end of this range, and reach multipliers as high as 4.0.

Due to the need to import more than 80-plus percent of supplies/goods used on Big Island, the multiplier impact for the island is not as great as for mainland locales, particularly for construction-based expenditures. We have therefore tested multiplier rates at the mid-point of the market spectrum, ranging from 1.5 to 3.5 times.

On a conservative basis, using a relatively low-end multiplier effect ratio of 2.0, the total overall direct impact on the Hawaii County economy resulting from the Keopuka Lands project would be $446.4 million over the 15-year projection period (in constant 2000 dollars). On a stabilized annual basis thereafter, the overall impact would be at $36.8 million.

This is equivalent to a moderate size hotel operation.

ADDENDA V: PUBLIC COST/BENEFIT ASSESSMENT

The purpose of this analysis is to delineate the direct areas in which the proposed subject membership community development will potentially impact the sphere of public agency resources, and quantify (where possible) the costs of providing expanded services to the project, versus the economic benefits that accrue to the community through an increase in local and state tax payments.

For most developments, potential direct costs to governmental services and programs include:

- Police Protection
- Fire Protection
- Public Oversight Agencies
- Infrastructure Services
- Recreational Demands
- Educational Needs
- Infrastructure Costs
- Various Other Services and Financial Commitments

As a privately built project some of these costs will not be increased on the state or county levels as a result of the proposed Keopuka Lands subdivision. Further, the low occupancy of the homes means the majority would not need services a majority of the time; and the upper income orientation will lessen the need for public support. There will be no increased educational or recreational needs directly attributable to the subject development; the major public infrastructure items (highway and primary water/sewer mains) are already in place or proposed; and the development will require no specific public subsidies, welfare services, bonding or capital improvements.

Direct tax benefits to the state and county coffers will primarily flow from the project and its operation over time from three major sources:

- Real Property Taxes
- Gross Excise Tax Receipts
- State Income Taxes

Some cost/benefit issues are considered as off-setting, or "a wash," as the cost of the services to the government is theoretically directly reimbursed in the form of user fees. Building permits and utility hook-up fees are two prime examples. Other such items include workers compensation premiums and benefits, utility operations and associated use billing rates, and business oversight/registration verses licensing fees. These items are excluded from this study.

A concern of this analysis is the integration of the subject project into the overall state and Hawaii governmental services plan on both an actual and pro rata perspective.

From an actual public service cost perspective to the Big Island and state agencies, the Keopuka Lands will represent only a fraction of the county lands in use. Given the vast number of housing units, resorts, businesses, and agricultural lands on the island, it is difficult to assert that of themselves the subject 125-lot community and users will create the need for expansion of existing public services.

No new schools, parks, highways, recreational facilities, service agencies, hospitals, or other public enterprises will be required specifically because of this project. The impact on the total regional land base will be minimal. Public safety facilities at Kealakekua and Captain Cook are proximate and have the personnel and equipment in-place to service the homes and minor businesses in the project.

However, the need for additional services is a cumulative effect, each project, each resident, tourist and, to a lesser degree, business adds a little bit to the community base until increased "need thresholds" are reached.

In regards to some services, the effective actual impact may not be apparent from a cost perspective, merely creating nominally greater demands which can be readily met through existing agencies and facilities without the need for additional workers or funds.

Our analysis of Hawaii County and state budgets indicate the actual effect of governmental services relating to Keopuka Lands would not directly create the need to expand county and state services.

As an alternative to actual cost estimates, which are often disparate as inherently cannot provide for unexpected and/or atypical items, it is

most common to project public costs on a per capita allocation. This is wholly appropriate for residential and resort developments, as public costs and services generally accrue to where a person lives (or in the case of a tourist, where they are lodging).

Government services are holistic in nature, providing a foundation throughout a community, regardless of any actual or specific impact on any given land holding. Parks and schools are essential to the residents (full or part-time), workers and tourists, whether or not they specifically use them, as these facilities create the climate in which local businesses and the general economy operates. Similarly, government administration, capital projects and public welfare items may have no direct relation to a particular project, but provide the economic underpinnings that enhances overall regional success.

We have therefore looked at the public costs issue from both perspectives, on an actual cost basis, which we believe to be a secondary indicator, and on a per capita allocation basis, which (though providing higher subject costs) is the appropriate method and the focus of our analysis.

Public Costs

Actual Costs

The county of Hawaii will directly incur several areas of cost increases as a result of the Keopuka Lands subdivision, primarily in regards to emergency services. Based on analysis of response frequencies, time/cost data, and discussions with affected agencies we have made general allowances for these items as summarized below.

Police/Enforcement – Using a base cost of $125 per hour for a responding officer (wages, benefits, overhead and amortized equipment), we estimate the annual additional police/enforcement cost to the county of Hawaii on a stabilized basis after project build-out will be $29,750.

This is comprised of:

- One miscellaneous call every other week at an average of three total officer hours each. (3 hrs. x $125/hr. x 26)
- One "minor" traffic accident each month requiring on average six hours of officer time. (6 hrs. x $125 x 12)

- One "major" traffic accident each quarter requiring on average of 22 hours of officer time. (22 hrs. x $125 x 4)

Response times are minimized by the proximity of the subject to the Captain Cook substation. This demand is the equivalent of about .15 to .25 new officer positions.

Fire Protection -- This based on a crew cost of $750/hour (four to five firemen, wages, benefits, overhead and amortized equipment). We estimate that at build-out, the yearly additional costs to Hawaii County resulting from the project is $42,000 per year.

This is comprised of:

- One "minor" fire/rescue per month requiring one crew for a total of three hours (response and clean-up). (3 hrs. x $750/hr. x 12)

- One "major" fire/rescue each year requiring two crews for a total of ten hours each. (2 crews x 10 hrs. x $750/hr. x 1)

Emergency Medical Response -- This is based on average cost per response of $500, with an average of one call every other week. The total cost to the county would be $13,000 per year on a stabilized basis after build-out. ($500/response x 26)

Road Maintenance -- An allowance of $15,000 per year was made for this item.

The total annual cost to the county on a stabilized basis at build out of the subject development would be $99,750.

State of Hawaii costs would include minor highway frontage work, health inspections of the hotel and clubhouse food and beverage establishments and other minor oversight duties. An allowance of $20,000 per year was made for these items.

Per Capita Costs

An alternative method for determining public costs is through per capita expenditures incurred by the State of Hawaii and Hawaii County in accordance with the de facto population area of the jurisdiction. This is founded on the principal that each individual on the island equitably benefits from all governmental costs, regardless of type or

focus throughout the day, with each new member of the community (whether resident or visitor) creating a proportionate new cost burden in their daily home and working life.

This is a typical application as most costs are viewed as accruing to residential aspects of a persons lifestyle and land use. We have included it as the best means of demonstrating the maximum overall public fiscal impact potential of the proposed subject project. We judge this method as setting the absolute upper limit on all public costs (actual, indirect and inferred).

According to the state Financial Services database, the state expects to spend a total of $6.7 billion on services, salaries, infrastructure, and financing in 2000. The total de facto population in the state on an average daily basis at year-end 1999 was about 1,380,000 persons, including residents, tourists, and military personnel.

The per capita expenditure by the state will thus be about $4,855 for 2000, an increase of over four percent from 1999. From 1979 through 1999, costs increased at a rate of just over five percent annually compounded.

The average de facto population (residents, members and guests) at the subject at build-out will be 221 persons, a figure reached in year 15 of the development process. The annual total "costs" to the public purse from Keopuka Lands at stabilization using the per capita allowance method would be $1.02 million in constant year 2000 dollars.

Analyzed on a similar basis, the county of Hawaii's budget for the island government in year 2000 is $186,264,404, which represents an escalation over time at 4.83 percent compounded annually since 1995.

The current de facto population on the Big Island is some 161,000 persons (comprised of 145,000 residents and 16,000 visitors). The resulting de facto per capita county expenditure for this year is therefore anticipated to be $1,157.

Application of this figure to the total on-site de facto population at subject build out would be $242,970 annually in costs to the county government on a stabilized basis (221 workers x $1,157).

Total Public Costs -- On an actual cost basis, the state and county expenses associated with the subject development would range upwards to a stabilized maximum of $120,000 annually at build-out in year 15 in year 2000 dollars.

On a per capita allowance basis, at build-out the total governmental costs to the state and county would be $1.26 million annually.

Public Fiscal Benefits

Real Property Taxes -- Property taxes paid by landowners in the subject project were calculated using the 1999-2000 tax rates for both land and buildings, improved and unimproved.

Assessed values for the lots are based on an average sales prices of $900,000 for the homesite lots, $50,000 per unit for the hotel site, and $15 million for the golf course site. The improvement assessments are based on the projected development/construction costs of the finished buildings (at $750,000 per home on average, $15 million for the Members Hale, and $5 million for the clubhouse). This may result in a slight understatement of assessments on the home improvements, as market value often exceeds reproduction expense.

It was assumed the land would be taxed at an average rate of $10.00 annually per $1,000 of assessed value. The improvements would have average tax rates of $8.50 per $1,000 of assessment.

Land taxes are based on an unserviced value of $40,000 per acre for 660 useable acres of the subject site in years 1 and 2, increasing to $94,400,000 per acre in year 3 as the subdivision infrastructure is finished and is being absorbed at market lot prices. The assessed values of the finished improvements are added as of the year of their construction.

All real property value of the subject holding is assumed to be vested in the completed "salable" components, with no assessment placed against open spaces, roads, or other community systems.

The total real property tax to be paid to Hawaii County in 2000 dollars ranges from $264,000 in year 1 of development, to a stabilized level of $3,048,375 at build-out in year 15 and beyond. The aggregate taxes paid over the development time-frame will be $28.42 million.

State Income Tax -- The state will receive income taxes from three sources:

- the wages of the workers associated with the construction, maintenance, and operation of the Keopuka Lands subdivision components;
- the corporate profits from contractors and suppliers serving the construction and maintenance phases of the development, and as generated by on-going golf and lodge operations; and
- the income of full-time residents of the development.

According to DBEDT data, individual State of Hawaii income tax liability as a ratio to gross income has ranged from 5.62 to 5.80 percent during the past decade, with the more current figures tending toward the mid to upper-end of the range. We have employed an effective tax rate of 5.80 percent of gross income for individual workers and full-time residents.

The effective tax rate for the corporate income is estimated at 2.00 percent of gross operating profits, based on available DBEDT statistics.

The total income tax revenues to be received by the state are projected at $481,475 in the first year of construction increasing to a maximum level at year 15 of $3.02 million annually in constant 2000 dollars.

On a stabilized basis, after build-out, the permanent worker incomes, building maintenance and off-site workers, and operating businesses, would pay an annual state income tax of about $3 million.

Over the 15-year study period, the cumulative income taxes paid are estimated at $24.9 million.

We have not included any corporate income or other taxes which will be paid by the Pacific Star LLC venture as a result of its profits from undertaking the Keopuka Lands development, or from the secondary jobs created by the discretionary spending of members, guests, workers and businesses. Such items have the potential to be substantial contributions to the state coffers.

State Gross Excise Tax – This 4.166 percent of expenditures tax was applied against:

- the total estimated construction contract costs;
- the total gross sales of the lodge and golf course operating businesses; and
- the discretionary expenditures of the de facto population of the subject.

The anticipated state excise tax receipts arising from the subject development range from an estimated low of $82,653 in year 3 of the development to a peak of $751,944. Over the 15-year study period, the receipts total $7.5 million and stabilize at circa $600,000 per year.

We have not included any excise tax revenues associated with the direct, local "multiplier effect" expenditures on the Big Island, or those created in the secondary market by the suppliers to the operating businesses or secondary worker expenditures.

Total Public Benefits (Revenues) – In constant 2000 dollars, the aggregate annual tax revenues flowing from the subject development at full project build-out range from:

- $264,000 to $3,048,375 per year for the county of Hawaii, stabilizing over time at the higher figure, totaling $28.42 million over the 15-year development projection time-frame;
- $410,503 to $3,771,525 annually for the State of Hawaii, stabilizing at $3.6 million per year, and cumulatively at $32.41 million over the 15-year projection period; and
- $1,060,532 to $6,819,900 per year for total tax receipts (county and state), totaling $60.83 million for the first one and a half decades of the Keopuka Lands membership community.

Correlation

Our public cost/benefit assessment is comprehensively displayed on Table V-1, which also contains the correlation of public service costs (per capita basis) with the anticipated tax revenue benefits.

As can be seen, regardless of the cost methodology adopted, in no single year does public coffers suffer a net loss.

TABLE V-1
Contd.

PUBLIC COST/BENEFIT SUMMARY TABLE
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	11	12	13	14	15	Total 1 Through 15
PUBLIC BENEFITS (Revenues)						
1. REAL PROPERTY TAXES						
Cumulative Assessed Values						
Improvements	$83,750,000	$91,250,000	$98,750,000	$106,250,000	$113,750,000	
Land	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	
Total Assessed Value	$178,150,000	$185,650,000	$193,150,000	$200,650,000	$208,150,000	
TOTAL REAL PROPERTY TAXES	$2,493,375	$2,632,125	$2,770,875	$2,909,625	$3,048,375	$28,418,625
2. STATE INCOME TAXES						
Taxable Personal Income	$39,810,250	$41,072,250	$45,122,250	$48,552,250	$50,122,250	$450,496,560
Taxable Corporate Profits	$2,758,112	$2,799,720	$2,841,328	$2,882,936	$5,624,544	$38,277,370
Personal Taxes Paid	$2,308,995	$2,382,191	$2,617,091	$2,814,031	$2,907,091	$24,147,900
Corporate Taxes Paid	$55,162	$55,994	$56,827	$57,659	$112,491	$765,547
TOTAL STATE INCOME TAXES	$2,364,157	$2,438,185	$2,673,917	$2,873,689	$3,019,581	$24,913,447
4. STATE GROSS EXCISE TAX						
Taxable Transactions						
Construction Materials	$3,720,000	$3,720,000	$3,720,000	$3,720,000	$3,720,000	$72,300,000
Hale and Course Operations	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$1,500,000	$11,725,000
Discretionary Expenditures	$11,442,603	$11,789,335	$12,136,068	$12,482,801	$12,829,533	$95,998,920
Total Taxable Transactions	$16,662,603	$17,009,335	$17,356,068	$17,702,801	$18,049,533	$180,023,920
TOTAL STATE EXCISE TAX	$694,164	$708,609	$723,054	$737,499	$751,944	$7,499,796
TOTAL GROSS PUBLIC REVENUES						
To Hawaii County (Item #1)	$2,493,375	$2,632,125	$2,770,875	$2,909,625	$3,048,375	$28,418,625
To State (Items #2 & 3)	$3,058,321	$3,146,794	$3,396,971	$3,611,188	$3,771,525	$32,412,844
AGGREGATE TAX REVENUES	$5,551,696	$5,778,919	$6,167,846	$6,520,813	$6,819,900	$60,831,469
PUBLIC COSTS (Expenses)						
State	$903,030	$932,160	$961,290	$990,420	$1,019,550	$7,617,495
County	$215,203	$222,144	$229,086	$236,028	$242,970	$1,815,333
TOTAL PUBLIC COSTS	$1,118,233	$1,154,304	$1,190,376	$1,226,448	$1,262,520	$9,432,828
TOTAL NET PUBLIC BENEFITS						
To State	$2,155,291	$2,214,634	$2,435,681	$2,620,768	$2,751,975	$24,795,349
To Hawaii County	$2,278,173	$2,409,981	$2,541,789	$2,673,597	$2,805,405	$26,603,292
AGGREGATE NET BENEFITS	$4,433,464	$4,624,615	$4,977,470	$5,294,365	$5,557,380	$51,398,641

TABLE V-1

PUBLIC COST/BENEFIT SUMMARY TABLE
Market Study, Economic Impact Analysis and Public Costs/Benefits Assessment
of the Proposed Keopuka Lands Subdivision
Keopuka, South Kona, Hawaii
In Constant Year 2000 Dollars

Development Year	1	2	3	4	5	6	7	8	9	10
PUBLIC BENEFITS (Revenues)										
1. REAL PROPERTY TAXES										
Cumulative Assessed Values										
Improvements			$8,750,000	$16,250,000	$28,750,000	$39,750,000	$50,750,000	$61,250,000	$68,750,000	$76,250,000
Land	$26,400,000	$26,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000	$94,400,000
Total Assessed Value	$26,400,000	$26,400,000	$103,150,000	$110,650,000	$123,150,000	$134,150,000	$145,150,000	$155,650,000	$163,150,000	$170,650,000
TOTAL REAL PROPERTY TAXES	$264,000	$264,000	$1,105,875	$1,244,625	$1,475,875	$1,679,375	$1,882,875	$2,077,125	$2,215,875	$2,354,625
2. STATE INCOME TAXES										
Taxable Personal Income	$7,187,500	$6,555,000	$5,460,375	$11,787,250	$16,413,917	$19,237,250	$25,127,250	$30,063,917	$32,887,250	$34,937,250
Taxable Corporate Profits	$3,230,000	$2,830,000	$557,380	$1,847,412	$1,679,020	$1,709,715	$2,334,141	$2,398,566	$2,283,626	$2,510,869
Personal Taxes Paid	$416,875	$380,190	$316,702	$683,641	$952,007	$1,115,761	$1,457,381	$1,743,707	$1,907,461	$2,142,361
Corporate Taxes Paid	$64,600	$56,400	$11,148	$36,948	$33,580	$34,194	$46,683	$47,971	$45,673	$50,217
TOTAL STATE INCOME TAXES	$481,475	$436,590	$327,849	$720,589	$985,588	$1,149,955	$1,504,063	$1,791,678	$1,953,133	$2,192,578
3. STATE GROSS EXCISE TAX										
Taxable Transactions										
Construction Materials	$9,960,000	$8,640,000	$1,860,000	$6,120,000	$5,400,000	$3,720,000	$5,400,000	$5,160,000	$3,720,000	$3,720,000
Hale/Course Operations						$575,000	$675,000	$775,000	$1,000,000	$1,200,000
Discretionary Expenditures			$124,000	$520,099	$864,832	$4,247,627	$5,201,172	$6,154,717	$8,321,887	$9,882,345
Total Taxable Transactions	$9,960,000	$8,640,000	$1,984,000	$6,640,099	$6,264,832	$8,542,627	$11,276,172	$12,089,717	$13,041,887	$14,802,345
TOTAL STATE EXCISE TAX	$414,934	$359,942	$82,653	$276,437	$261,876	$355,886	$469,765	$503,658	$543,325	$616,643
TOTAL GROSS PUBLIC REVENUES										
To Hawaii County (Item #1)	$264,000	$264,000	$1,105,875	$1,244,625	$1,475,875	$1,679,375	$1,882,875	$2,077,125	$2,215,875	$2,354,625
To State (Items #2 & 3)	$896,409	$796,532	$410,503	$997,235	$1,246,664	$1,505,841	$1,973,829	$2,295,336	$2,496,458	$2,809,239
AGGREGATE TAX REVENUES	$1,160,409	$1,060,532	$1,516,378	$2,241,860	$2,722,539	$3,185,216	$3,856,704	$4,372,461	$4,712,333	$5,163,864
PUBLIC COSTS (Expenses)										
State			$14,565	$43,695	$77,680	$334,995	$412,675	$490,355	$655,425	$781,615
County			$3,471	$10,413	$18,512	$79,833	$98,345	$116,857	$156,195	$186,277
TOTAL PUBLIC COSTS			$18,036	$54,108	$96,192	$414,828	$511,020	$607,212	$811,620	$967,932
TOTAL NET PUBLIC BENEFITS										
To State	$896,409	$796,532	$395,938	$953,540	$1,168,984	$1,170,846	$1,561,154	$1,804,981	$1,841,033	$2,027,584
To Hawaii County	$264,000	$264,000	$1,102,404	$1,234,212	$1,457,363	$1,599,542	$1,784,530	$1,960,268	$2,059,680	$2,168,348
AGGREGATE NET BENEFITS	$1,160,409	$1,060,532	$1,498,342	$2,187,752	$2,626,347	$2,770,388	$3,345,684	$3,765,149	$3,900,713	$4,195,932

Source: The Hallstrom Group, Inc.

LIMITING CONDITIONS AND ASSUMPTIONS

The research, analysis, conclusions, and certification performed by The Hallstrom Group, Inc. are subject to and influenced by the following:

- The report expresses the opinion of the signers as of the date stated in the letter of transmittal, and in no way has been contingent upon the reporting of specified values or findings.

- Any sketches, maps, plot plans, and photographs included in the report are intended only to show spatial relationships and/or assist the reader in visualizing the property. They are not measured surveys or maps and we are not responsible for their accuracy or interpretive quality.

- It is assumed that the subject property is free and clear of any and all encumbrances other than those referred to herein, and no responsibility is assumed for matters of a legal nature. The report is not to be construed as rendering any opinion of title, which is assumed to be good and marketable. No title information or data regarding easements which might adversely affect the use, access, or development of the property, other than that referenced in the report, was found or provided. The property is analyzed as though under responsible ownership and competent management.

- Preparation for, attendance, or testimony at any court or administrative hearing in connection with this report shall not be required unless prior arrangements have been made therefor.

- If the report contains a valuation relating to a geographical portion or tract of real estate, the value reported for such geographical portion relates to such portion only and should not be construed as applying with equal validity to other portions of the larger parcel or tract; and the value reported for such geographical portion plus the value of all other

geographical portions may or may not equal the value of the entire parcel or tract considered as an entity.

- It is assumed that there are no hidden or inapparent conditions of the property, subsoil, or structures which would render it more or less valuable; we assume no responsibility for such conditions or for engineering which might be required to discover such factors.

- Information, estimates, and opinions provided by third parties and contained in this report were obtained from sources considered reliable and believed to be true and correct. However, no responsibility is assumed for possible misinformation.

- Possession of the report, or a copy thereof, does not carry with it the right of publication, and the report may not be used by any person or organization except the client without the previous written consent of the appraiser, and then only in its entirety. If the client releases or disseminates the reports to others without the consent of the appraiser, the client hereby agrees to hold the appraiser harmless, and to indemnify the analysts from any liability, damages, or losses which the analysts might suffer, for any reason whatsoever, by reason of dissemination of the report by the client. Further, if legal action is brought against the analyst by a party other than the client concerning the report or the opinions stated therein, the client agrees, in addition to indemnifying the analysts for any damages or losses, to defend said analysts in said action at client's expense. However, nothing herein shall prohibit the client or analysts from disclosing said report or opinions contained therein as may be required by applicable law.

- Disclosure of the contents of this report is governed by the By-Laws and Regulations of the Appraisal Institute. Neither all nor any part of the contents of this report (especially any conclusions as to value, the identity of the appraisers or the firm which they are connected, or any reference to the Appraisal Institute or to the MAI designation) shall be disseminated to the public through advertising media, public relations media, news media, sales media, or any public means of communication without the prior consent and approval of the appraisers.

- Unless otherwise stated in this report, the existence of hazardous material, which may or may not be present on the property, was not observed by the appraiser. The appraiser has no knowledge of the existence of such materials on or in the property. The appraiser, however, is not qualified to detect such substances. The presence of substances such as asbestos, urea-formaldehyde foam insulation, or other potentially hazardous materials may affect the value of the property. The value estimate is predicated on the assumption that there is no such material on or in the property that would cause a loss in value. No responsibility is assumed for any such conditions, or for any expertise or engineering knowledge required to discover them. The client is urged to retain an expert in this field, if desired.

- The Americans with Disabilities Act (ADA) became effective January 26, 1992. We have not made a specific compliance survey and analysis of this property to determine whether or not it is in conformity with the various detailed requirements of the ADA. It is possible that a compliance survey together with a detailed analysis of the requirements of the ADA could reveal that the property is not in compliance with one or more of the requirements of the act. If so, this fact could have a negative effect upon the value of the property. We did not consider possible noncompliance with the requirements of ADA in estimating the value of the property.

CERTIFICATION

The undersigned do hereby certify that, to the best of our knowledge and belief, the statements of fact contained in this report are true and correct. It is further certified that the reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are our personal, impartial, and unbiased professional analyses, opinions, and conclusions. We further certify that we have no present or prospective interest in the property that is the subject of this report, and have no personal interest with respect to the parties involved. We have no bias with respect to the property or the parties involved with this assignment. Our engagement was not contingent upon developing or reporting predetermined results. Our compensation is not contingent on an action or event resulting from the analyses, opinions, or conclusions in, or the use of, this report. The analyses, opinions, and conclusions were developed, and this report has been prepared, in conformity with the requirements of the Code of Professional Ethics and Standards of Professional Appraisal Practice of the Appraisal Institute, and the Uniform Standards of Professional Appraisal Practice. The use of this report is subject to the requirements of the Appraisal Institute relating to review by duly authorized representatives. The undersigned certify that they have made personal inspections of the property that is the subject of this report. No other persons provided significant professional assistance other than the undersigned.

The Appraisal Institute conducts programs of continuing education for their designated members. As of the date of this report, James E. Hallstrom, Jr. has completed the requirements of the continuing education program of the Appraisal Institute.

THE HALLSTROM GROUP, INC.

James E. Hallstrom, Jr., MAI, CRE
Hawaii State Certified
General Appraiser, CGA-178
Exp. Date December 31, 2001

Tom W. Holliday /sht
Tom W. Holliday

/as 4102_R01

THE HALLSTROM GROUP INC.
REAL ESTATE CONSULTANTS & APPRAISERS

PROFESSIONAL BACKGROUND AND SERVICES

The Hallstrom Group, Inc. is a Honolulu based independent professional organization that provides a wide scope of real estate consulting services throughout the State of Hawaii with particular emphasis on valuation studies. The purpose of the firm is to assist clients in formulating realistic real estate decisions. It provides solutions to complex issues by delivering thoroughly researched, objective analyses in a timely manner. Focusing on specific client problems and needs, and employing a broad range of tools including after-tax cash flow simulations and feasibility analyses, the firm minimizes the financial risks inherent in the real estate decision making process.

The principals and associates of the firm have been professionally trained, are experienced in Hawaiian real estate, and are actively associated with the Appraisal Institute and the Counselors of Real Estate, nationally recognized real estate appraisal and counseling organizations.

The real estate appraisals prepared by The Hallstrom Group accomplish a variety of needs and function to provide professional value opinions for such purposes as mortgage loans, investment decisions, lease negotiations and arbitrations, condemnations, assessment appeals, and the formation of policy decisions. Valuation assignments cover a spectrum of property types including existing and proposed resort and residential developments, industrial properties, high-rise office buildings and condominiums, shopping centers, subdivisions, apartments, residential leased fee conversions, special purpose properties, and vacant acreage, as well as property assemblages and portfolio reviews.

Market studies are research-intensive, analytical tools oriented to provide insight into investment opportunities and development challenges, and range in focus from highest and best use determinations for a specific site or improved property, to an evaluation of multiple (present and future) demand and supply characteristics for long-term, mixed-use projects. Market studies are commissioned for a variety of purposes where timely market information, insightful trends analyses, and perceptive conceptual conclusions or recommendations are critical. Uses include the formation of development strategies, bases for capital commitment decisions, evidence of appropriateness for state and county land use classification petitions, fiscal and social impact evaluations, and the identification of alternative economic use/conversion opportunities.

ARBITRATION VALUATION AND MARKET STUDIES

PROFESSIONAL QUALIFICATIONS OF JAMES E. HALLSTROM, JR., MAI, CRE

Business Background

Chairman	The Hallstrom Group, Inc. Honolulu, Hawaii
Former Senior Vice President and Treasurer	Hastings, Martin, Hallstrom and Chew, Ltd., Honolulu, Hawaii (1972-1980)
Former Real Property Appraiser and Analyst	Administration, Inc., a subsidiary of C. Brewer and Company, Limited Honolulu, Hawaii (1971-1972)
Former Senior Real Property Appraiser and Analyst	Opitz Realty, Madison, Wisconsin (1969-1971)

National Designations and Memberships

- CRE Designation (1998) - The Counselors of Real Estate
- MAI Designation (1976) - American Institute of Real Estate Appraisers
- SRPA Designation (1975) - Society of Real Estate Appraisers

The American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated in 1991, forming the Appraisal Institute (AI).

Education

- M.S. (Real Estate Appraisal and Investment Analysis) 1971, University of Wisconsin at Madison
- B.A. (Economics) 1969, Brigham Young University at Provo
- Additional numerous specialized real estate studies in connection with qualifying for national professional designations, and continuing uninterrupted Continuing Education.
- Completed Continuing Education requirements with the Appraisal Institute through December 31, 2002.

Professional Involvement

- Former President and Officer for Hawaii AIREA and SREA Chapters
- Instructor for Society of Real Estate Appraisers Course 101, "Introduction to Appraising Real Property" and Course 201, "Principles of Income Property Appraising"
- Contributing author to the "Hawaii Real Estate Investor"
- Lecturer at many professional seminars and clinics.
- Appointed numerous times as an Arbitrator and Mediator.

Qualified Expert Witness

Federal and State Courts
State Land Use and County Hearings
Arbitration Proceedings

State of Hawaii Certification

Certified General Appraiser, License Number CGA-178, Exp. Date December 31, 2001

Community Service

Active registered member of the Boy Scouts of America; Officer and Director of Le Jardin Academy; former Advisory Board Member of the School of Business, Brigham Young University, Hawaii Campus.

PROFESSIONAL QUALIFICATIONS OF THOMAS W. HOLLIDAY

Business Background	Senior Analyst	The Hallstrom Group, Inc. Honolulu, Hawaii
	Former Staff Appraiser	Davis-Baker Appraisal Co. Avalon, Santa Catalina Island, California

Education

- B.A. (Communications/Journalism) 1978 California State University at Fullerton
- SREA Course 201 - Principles of Income Property Appraising
- Numerous professional seminars and clinics
- Contributing author to **Hawaii Real Estate Investor**, Honolulu Star Bulletin

On January 1, 1991, the American Institute of Real Estate Appraisers (AIREA) and the Society of Real Estate Appraisers (SREA) consolidated, forming the Appraisal Institute (AI).