COPY

PLANNING DEPARTMENT — COUNTY OF HAWAII
25 AUPUNI STREET — HILO, HAWAII 96720

MAY 10 AM 0:38

May 3, 1988

Mr. Thomas S. Witten, ASLA
PBR Hawaii
Financial Plaza of the Pacific
130 Merchant Street
Honolulu, HI 96813

Dear Mr. Witten:

Punaluu Resort
<u>Final EIS April 1988</u>

We have reviewed Volume I and II of your final EIS which has been submitted in support of a General Plan (GP) amendment for approximately 65 acres of the Resort land mauka of the Hawaii Belt Highway (40 acres to be designated Medium Density from Low Density and 20 acres to be designated Open from Low Density). We have found the EIS satisfies the following criteria:

(1) Procedures for assessment, consultation, review and revisions required for the EIS have been complied with;

(2) Content requirements for a Final EIS have been satisfied; and

(3) Comments submitted during the review process have been responded to satisfactorily and have been incorporated or appended to the EIS.

Acceptance of this Final EIS is with the understanding that separate informational documents will be required to support your proposed actions makai of the Belt Highway. Should there be major changes, a supplemental EIS may also be required.

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

Sincerely,

ALBERT LONO LYMAN
Planning Director

cc: Office of Environmental Quality Control

bcc: Mr. Ben Kudo
Mr. Mufi Hanneman
Mr. Pete Moynihan

Punalu‘u Resort

Volume I
Final Environmental Impact Statement

Punalu‘u, Ka‘u District, County of Hawaii

April 1988

Punalu'u Resort

Volume I

Final Environmental Impact Statement

Punalu'u, Ka'u District, County of Hawaii

April 1988

Prepared For:
C. Brewer Properties, Inc.
P.O. Box 1826 Honolulu, Hawaii 96805

Prepared By:
PBR Hawaii
130 Merchant Street, Suite 1111 Honolulu, Hawaii 96813

FINAL

ENVIRONMENTAL IMPACT STATEMENT

PUNALU'U RESORT

Ka'u, Hawaii

This Environmental Document is Submitted
Pursuant to Chapter 343, HRS

Prepared for:

C. Brewer Properties, Inc.
Honolulu, Hawaii

M. J. Tilker, Chairman and President
C. Brewer Properties, Inc.

April 5, 1988
Date

Prepared by:

PBR HAWAII
Honolulu, Hawaii

FORWARD

This Environmental Impact Statement has been prepared for C. Brewer Properties, Inc. to disclose information on its Punalu'u Resort situated on that certain property at Punalu'u, Ka'u on the Island of Hawaii.

The preparation and submittal of this document is pursuant to Hawaii Revised Statutes, Chapter 343, Environmental Impact Statements, Chapter 200 of Title 11, Environmental Impact Statement Rules, and Chapter 200 of Title 11, Environmental Council Rules of Practice and Procedure.

The County of Hawaii Planning Department reviewed the environmental assessment for a General Plan Amendment Application, which was prepared by PBR HAWAII, and determined that an Environmental Impact Statement is required. The Environmental Impact Statement Preparation Notice appeared in the OEQC Bulletin dated September 8, 1987 and September 23, 1987. The deadline for requests to be a consulted party was October 8, 1987.

A Draft Environmental Impact Statement (EIS) and Final Environmental Impact Statement were prepared and submitted for Punalu'u Resort in October 1986 and January 1987, respectively. Due to issues raised prior to acceptance of the Final EIS by the County of Hawaii Planning Department, C. Brewer Properties, Inc. withdrew the EIS from consideration. Subsequent to withdrawing the Final EIS, C. Brewer Properties, Inc. has revised the master development plan to respond to community concerns and prepared a Draft EIS for that revised Master Plan. The Draft EIS was published in December 1987 and notice of its availability was published in the OEQC Bulletin dated December 8, 1987. The deadline for submittal of review comments on the Draft EIS was January 22, 1988. Comments received and responses thereto are included in Volume II, Chapter XII of this Final EIS.

As noted in the Table of Contents, this Final EIS has been separated into two volumes (Volume I and Volume II) to accommodate the inclusion of all comment letters and responses relative to the EIS Preparation Notice and Draft EIS.

For clarification purposes, the following identifies the major elements of the Revised Punalu'u Resort Master Plan vis-a-vis the Master Plan described in the October 1986 and January 1987 EIS's that were withdrawn by C. Brewer Properties, Inc.

1. Ninole Cove Hotel deleted from Master Plan and replaced by the Village Hotel which will be located on the bluff overlooking the ocean and coastal plain.

2. Ninole Cove restoration deleted from the proposed project because it is no longer necessary to the Master Plan and because of complex and costly permitting procedures.

3. The total number of hotel/condominium units presently planned ranges from 740 to 1,035 units that would occupy approximately 48 acres or 11 percent of the total Resort area and representing a density of 16 to 22 units per acre versus the previously proposed 805 to 1,430 units on 45 acres or 10 percent of the Resort area and representing a density of 18 to 32 units per acre.

4. To accommodate the relocation of Ninole Cove Hotel to the central bluff area, the realigned Punalu'u Road has been adjusted.

5. Two new golf holes (Nos. 8 and 9) would be located on the coastal plain versus one golf hole previously planned.

6. A new vehicular access road and parking area would be constructed on the east side of Ninole Cove to provide vehicular access to the shoreline on the west side of the Resort.

VOLUME I

PUNALU'U RESORT

FINAL ENVIRONMENTAL IMPACT STATEMENT

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Chapter I: Introduction and Summary

CHAPTER I

INTRODUCTION AND SUMMARY

1. PURPOSE OF THIS DOCUMENT

This environmental impact statement (EIS) has been prepared in accordance with Hawaii Revised Statutes (HRS) Chapter 343 and Title 11, Department of Health, Chapter 200, Environmental Impact Statement Rules, Sections 11-200-14 through 11-200-17. At this time, this EIS only supports a General Plan (GP) amendment for approximately 65 acres of the Resort land mauka of the Hawaii Belt Highway (40 acres to be designated Medium Density from Low Density and 20 acres to be designated Open from Low Density). The GP amendment is required to allow adoption of the Resort Master Plan and facilitate completion of the Resort in compliance with appropriate land use designations. Future actions that will be required to complete Punalu'u Resort will include Change of Zone requests, Special Management Area Use (SMA) permits, a Conservation District Use Permit (CDUP) and a Department of Army Corps of Engineers permit. Those actions will be supported by separate informational documents as required by approving agencies and this EIS to the extent that it is applicable.

This EIS serves as a public information document and describes the General Plan amendment and, to the extent possible at this stage of planning, identifies potential environmental impacts that might result from completion of the Resort; identifies mitigation measures that would be taken to minimize potential adverse impacts; describes the known feasible alternatives of attaining the objectives of the Resort Master Plan; and provides all other information required for an EIS prepared pursuant to HRS Chapter 343 and Title 11, Chapter 200.

2. PROPOSED GOVERNMENTAL ACTION

C. Brewer Properties, Inc. (CBP), is requesting that the County of Hawaii revise the Hawaii County General Plan for approximately 65 acres of Punalu'u Resort land mauka of the Hawaii Belt Highway. The General Plan (GP) amendment (TMK: 9-5-19:24 por.) would redesignate 45 acres of Low Density to Medium Density and 20 acres from Low Density to Open. The requested GP amendment is shown on Figure II-8.

As noted above, future actions by CBP will include Change of Zone requests, SMA Use permit requests, a CDUP and Department of Army Corps of Engineers permit request.

3. PROJECT DESCRIPTION

The goal of the requested GP amendment and land use redesignations that will be requested for Punalu'u Resort is to complete the development of a Hawaiian resort community with a rural ambience and a village character. The Resort Master Plan improves the land use efficiency and the Resort's potential for long-term economic viability. The Resort design increases the quality of the Resort experience by unifying the Resort and providing a cohesive "sense of place" at human/village scaled development. Increased economic viability of the Resort translates into increased employment and economic opportunities for the state and county in general and, specifically, Ka'u District.

The replacement value of the Resort as it now exists is approximately $39 million. Existing infrastructure and facilities at Punalu'u include all necessary components to support the level of development that has occurred to date. Infrastructure components include deep wells and Public Utilities Commission regulated transmission lines to provide potable water; a secondary sewage treatment plant; internal paved roads and underground utilities that service existing facilities; Punalu'u Black Sand Restaurant; 76-unit Colony I condominiums; Aspen Institute for Humanistic Studies Seminar Center; four tennis courts with a convenience store; an 18-hole championship golf course and associated clubhouse; a Resort maintenance service center; Ka'u Center of History and Culture; and the 19-lot Kalana I single-family residential subdivision.

The total Resort project area encompasses approximately 433 acres not including the existing Colony I condominiums and Kalana I single-family residential lots. The following 20 Tax Map Key (TMK) parcels are included within the project area: TMK: 9-5-19:11, 15, 24, 26, 30, 31, 33, 35; 9-6-01:01, 02, 03, 06, 11, 12, 13; 9-6-02:08, 37, 38, 41, 45 por.

The proposed project concept involves creating a low rise, low density, mixed use commercial and residential "Village" on the bluff overlooking the ocean and two proposed shoreline golf holes. The Village Center development is accomplished by relocating five golf holes (2, 3, 4, 8 and 9) and the coastal section of Punalu'u Road (Alanui Road), presently a private road within the Resort that connects to the Hawaii Belt Highway and the County's Punalu'u Road. The plan also provides for, or improves, additional development parcels with increased golf and recreational amenity frontage and/or open views. Resultant development parcels include a mixture of single family residential, multi-family residential, mixed-use multi-family, commercial, hotel and open space recreational amenities. A Visitor Center/Spa/Lagoon Club, located coincident with the existing golf clubhouse that would be expanded and modernized are planned and would be important facilities serving the Resort and nearby communities. Two hotel sites, one adjacent to the Village Center and one adjacent to the existing Punalu'u Black Sand Restaurant, would also be developed. All development activities would occur within land presently designated Urban by the State Land Use Commission. Similarly, the majority of the proposed project would be developed within county general planned and zoned land uses that permit the proposed improvements with the exception of a few parcels that require a change in configuration and allowed density. Table II-1 (Page II-4) indicates the existing and proposed County zoning by project area and acreage. A detailed description of the proposed project is included in Chapter II of this EIS.

4. NEED FOR THE PROJECT

Punalu'u Resort is situated on the Ka'u coastline of the island of Hawaii, approximately 60 miles southwest of Hilo and 70 miles southeast of Kailua-Kona. There are approximately 4,000 lineal feet of shoreline at the Resort, stretching from Punalu'u Harbor on the eastern side to Ninole Cove on the western side of the Resort. The site's natural amenities, rural setting and man made amenities such as the existing championship 18-hole golf course, tennis center, Black Sand Beach Restaurant and other in-place infrastructure provide the fundamental amenities and essential base for continued development of the Resort. The Resort at present, is a major contributor to the social, economic and recreational character of the region.

A market assessment (included in Chapter II, Section 3.4) has been performed to determine the opportunities for successful development of the Resort as a high quality, low to medium density resort community. The assessment analyzed the market demand for the developments proposed at Punalu'u in light of other planned resort developments in the state and, specifically, on the island of Hawaii.

Based on the market assessment, forecast visitor industry trends statewide indicate continued growth of both west and east bound visitors over the next 20 years. The development of resort destinations on the neighbor islands, coupled with diversification of visitor markets served, improved interisland air service, increased and more effective marketing of neighbor island resorts and increasing disposable incomes in the areas in which visitors reside, indicate that the neighbor islands will continue to capture a greater share of the visitor market. Tourism on the island of Hawaii is expected to experience an increase of 4.8 percent annually to nearly two million visitors per year by 2005. Projected island-wide (Big Island) overnight visitor demand for hotel and condominium units, assuming a 70 percent occupancy, is 19,900 by 2005. The Resort's relatively remote location and natural beauty creates a relaxing and supportive atmosphere for the resort destination planned at Punalu'u. Additionally, the selected market orientation would provide the opportunity for the Resort to capture a segment of the visitor market that is not presently served in Hawaii. The attraction of visitors to Punalu'u would expose potential condominium buyers to the Resort as well as creating demand for use of these units as visitor accommodations. Projections indicate that the total number of planned condominium units at Punalu'u would be sold by approximately the year 2006, assuming 20 percent of the market share of the island's projected condominium sales.

Similarly, projected single-family lot sales at the Resort are expected to be such that the 71 to 78 planned lots would be absorbed by 1996. The following table summarizes the planned units and projected market support for hotel rooms, hotel/condominium, multi-family residential units and single-family developments residential lots at Punalu'u Resort:

Summary of Development Plan and Projected Market Support for Punalu'u Resort (1990 - 2005)

	Approximate Acres	Planned Units	Projected Market Support
Resort Hotels	27	500 - 635	475 - 660
Hotel/Condominium Units	20	240 - 400	525 - 740
Multi-family Residential Units	123	1240 - 1870	955 - 1910
Single-family Residential Lots	45	71 - 78	78 - 78(1)
Village Commercial/Services	23	- - -	- - -
Golf Course, Open Space & Roads	195	- - -	- - -
Total:	433	2051 - 2983	1983 - 3288

Average annual units (includes all classifications) developed, rounded 1988 to 2005 : 124 to 196 units per year.

(1) Expected to be fully absorbed by approximately 1996.

In addition, the market assessment indicates that the following resort support facilities and amenities should be developed to attract and cater to the visitor and resident markets that have been targeted:

- A major freshwater swimming area, including pools, waterfalls and other swimming, sunning and play areas.

- Up to 65,000 square feet of resort oriented commercial shopping area, including specialty and convenience shopping, diverse eating establishments, sports supplies and office space.

- A health spa facility offering a full range of spa activities as well as life style and personal development programs.

- A center for community activities and outdoor performances.

5. SUMMARY OF IMPACTS

In general, because a significant portion of the environment of the project area is presently developed for resort uses including roadways and utilities, an 18-hole golf course, condominiums, tennis courts and restaurant complex, the additional impacts on the physical environment as a result of the proposed project are expected to be beneficial and/or minimal. The summary of major impacts listed below is based on published information concerning the study area; special studies conducted for the proposed project; and projections of the types of activities that would be associated with the proposed project. Additionally, the information presented in this EIS has been developed to the extent possible at this stage of planning for the Resort. Future permit and land use change requests will be supplemented with additional environmental impact information as required and requested by approving agencies. It is noted that a key tenet of the proposed project is C. Brewer Properties' intent and commitment to protect and preserve, for present and future generations, the environmentally sensitive areas and species and significant archaeological and historical sites occurring within the Resort.

5.1 PHYSIOGRAPHY, GEOLOGY, SOILS, CLIMATE AND AGRICULTURAL POTENTIAL

[Note: The term "proposed project", as used herein, refers to the completed Resort per the Master Plan depicted in Figure II-11.]

There would be minimal change to the general physical nature of the project area as a result of the proposed project. The region is underlain by four distinct rock formations with a blanket of ash (Pahala) separating two older basalts (Ninole and Kahuku formations) from younger ones (Ka'u volcanic series). Little mass grading would be required, thereby obviating major changes to the geologic structure of the project area.

With development of the project there would be an increase in vegetation for golf course, hotel and other amenities for landscaping purposes. Soil to support the landscaping would come from the project site as well as off site locations. Although of sufficient quality to support landscaping, the project site soil has been rated as poorly suited for agricultural purposes by the Land Study Bureau. Imported soils would be screened to minimize the importation of pest plants. Native plants would be used to the maximum extent possible in the landscaping plans.

The existing climatic conditions of the project area are not expected to be affected by the proposed project. Rainfall in the project area is about 30 inches per year and mean annual temperature is 72.6 degrees F. Winds are predominantly east-northeast trades with stronger breezes experienced between June and August.

5.2 HYDROLOGY AND DRAINAGE

There are no perennial streams in Ka'u District. Rarely does runoff reach the sea. However, Ninole Stream, which is on the western border of the project site, has flooded during prolonged heavy rains and has contributed to the filling of Ninole Cove with sedimentation, rocks and debris. Based on a flood study for Ninole Stream (Appendix E), flooding and the potential refilling of Ninole Cove would be controlled and prevented by the construction of flood retention basins upstream and the possible construction of crushed rock masonry or earthen berms along raised banks of the stream. Periodic maintenance of the stream mouth and stream bed at Ninole Cove would minimize the potential for additional sediment, rocks, and debris from being deposited into Ninole Cove.

Direct surface runoff presently flows into two drainageways that bisect the existing golf course and discharge into the ponds adjacent to Ninole Cove and into Punalu'u Harbor.

An existing drainage culvert near Punalu'u Lagoon receives runoff from approximately 18 acres of the planning area and discharges the runoff into the lagoon. The proposed development is anticipated to increase the peak discharge from 13 cubic feet per second (cfs) to 58 cfs. The existing retention basin at the culvert entrance would minimize surge flows into Punalu'u Lagoon and allow the stormwater runoff to dissipate primarily by percolating through the basin bottom. Because of the retention basin, future runoff is expected to have a minimal impact on the lagoon.

Two other drainage culverts--one located along Ninole Cove Road near the existing 9th tee, the second located in

Punalu'u Beach Park--presently discharge runoff into wetland and park areas. These culverts will be abandoned in order to minimize future disturbance of these coastal areas by increased runoff. In their place, future runoff would be diverted to retention basins within the 8th and 9th golf hole fairways, where the runoff would dissipate primarily by infiltration. Although the increase in runoff would be significant, the proposed retention basins would aid in minimizing adverse impacts to the environment.

Basal groundwater underlies the entire region and discharges as springs along the Ka'u District coastline. This water is of high quality in the upper elevations of the project site and is used for drinking and irrigation purposes. The lower level basal water is brackish and unsuitable for potable or irrigation purposes. The U. S. Geological Survey (USGS) has estimated that brackish ground and spring water discharge into the ocean at Punalu'u is in excess of 30 million gallons per day. The proposed project is not expected to adversely affect basal potable water supplies, that are estimated to be over 10 mgd, either through contamination or increased usage. The existing Resort private water system, which consists of two deep wells (rated at 3.0 mgd), a pump station, 1.0 million gallon (MG) storage reservoir and associated underground distribution lines, would be incrementally expanded according to future usage requirements, which are expected to be about 2.1 Mgd.

5.3 NATURAL HAZARDS

There are four major types of natural hazards that affect the project area: (1) seismic/volcanic activity, (2) tsunamis, (3) subsidence, and (4) flooding. Relative to volcanic/seismic activity, the USGS has designated the project area as a risk zone "E", which is the second highest risk area on the island. Land designated "E" is susceptible to burial by lava flows with 0.5 to 0.3 percent of the lands having been buried by lava during various 20-year intervals (since 1880). Based on the distance of the project area from the summit of Mauna Loa and major rift zones, it appears that Punalu'u Resort is on the low end of the risk range with the likelihood of lava flows over the area being 0.005 per 200 years.

In 1975, a tsunami inundated the lower portion of the project area, contributing to the filling of Ninole Cove. Hawaii County Floodway Boundary and Floodway Maps designate the 100-year flood boundary along the shoreline as a Coastal High Hazard area and Flood Insurance Rate Maps (FIRM) define the area as Zones AE, VE and X. Proposed project activities in the high hazard areas would be confined to golf course or other recreational activities. All structures, that may be located in hazard areas, would be constructed on fill above the historical high water level and would be designed according to flood insurance and county building requirements.

Based on an examination of historic shoreline maps, earthquake data and historical subsidence records, it appears that very little, if any, subsidence has occurred at Punalu'u. To prevent damage to structures and facilities that may be subjected to subsidence in the future, appropriate federal, state, and county building codes and regulations would be followed.

Ninole Stream experienced flooding during the 1978 to 1982 period due to four major storms, two of which were classified as 100-year storms. As a result, Ninole Cove has been filled with sediment and debris. Proposed actions that may be impacted by flooding are limited to the relocation of the 8th and 9th golf holes to the coastal zone, thereby replacing a substantial portion of the existing hotel zoned area. Roadway relocations would be mauka, i.e., higher elevation, thereby removing them from the flooding and Coastal High Hazard areas. Based on a flood study for Ninole Stream (Appendix E), flooding problems may be reduced by the possible construction of flood retention basins upstream and the possible construction of crushed rock masonry or earthen berms along raised banks of the stream. Considerable work on confining Ninole Stream flows to the stream bed has been performed, including the deepening and widening of the stream bed, constructing retaining walls and earthen berms with large boulders, lining the stream bed in places, creating a debris basin and the performance of remedial and periodic maintenance work. These activities may be added to as necessary. Future stream bed work, if required, would be performed in accordance with applicable federal, state and county rules and regulations. Proposed residential areas have been located outside the flood hazard area or necessary improvements will be completed to protect them from flooding.

5.4 COASTAL PONDS

There are three coastal ponds at Punalu'u Resort (see Figure IV-19) none of which are defined as anchialine. [Note: anchialine ponds are generally described as small (less than 100 square meters), shallow (less than 1 meter deep) and having an absence of surface connections to the sea, but contain saline water and undergo tidal fluctuations. They also harbor a distinctive biota, which includes opae'ula shrimp (<u>Halocaridina rubra</u> and <u>Metabateus</u> <u>lohena</u>). Both the physical and biological characteristics must be present for the ponds to meet the definition of anchialine.] One of the three ponds has a direct connection to the ocean through a small, natural, discharge stream channel. Estimated discharge flow ranges from about 5 to 20 cubic feet per second. The other two ponds are fed by brackish water subsurface springs or basal water discharge and do not appear to be directly connected to the ocean. The bottom of all ponds is generally covered with a layer of decaying organic material which appears to provide an unfavorable habitat for most fauna. Water quality measurements indicate the ponds are brackish water, unsuitable for irrigation or potable water supplies. The proposed project is expected to have either no impact or beneficial impacts on the three ponds. Pending approval of federal and state agencies, Pond No. 1 and a dry mauka pond would be reconnected and incorporated into, although separated by landscaping, the relocated 8th and 9th golf holes. Pond No. 3 (Punalu'u Lagoon) would be cleared of debris and periodically maintained to enhance its biological, physical and aesthetic character. Pond No. 2 would not be physically altered under the present Master Plan. A Draft Environmental Protection Plan (Appendix H) has been developed and designed to protect the wildlife habitat aspects of the ponds, shoreline and coastal waters. By agreement between the U.S. National Marine Fisheries Service and CBP, the Environmental Protection Plan will be finalized at the time SMA and Corps of Engineers permit applications are prepared and submitted.

5.5 MARINE RESOURCES

The impacts of site development on the marine resources of the project area could primarily be the result of increased nutrient loading, sedimentation and minor changes in storm runoff patterns. No modifications to the shoreline are planned.

The water quality characteristics of the entire Punalu'u Harbor and Ninole Cove shoreline are significantly influenced by intertidal and subtidal fresh water springs and the discharge from one of the coastal ponds. Collectively, these discharges account for the wide variation in the physical and chemical properties of the nearshore waters and the relatively low diversity of marine flora and fauna. Based on water sample analyses conducted, it appears that the coastal pond and offshore waters at Punalu'u are nutrient saturated due to the inflow of basal ground water containing high levels of nutrients.

Increased access to, and use of Punalu'u Resort, would occur as a result of the proposed project. This would include an increase in the number of visitors (hotel and/or multi-family residence guests) and Hawaii County residents using the shoreline. Punalu'u Village water play areas have been designed as the primary "beach" and water contact areas for resort guests and residents, thereby potentially reducing visitor use of the shoreline. At present, and for the foreseeable future, Hawaii County residents are expected to be the largest users of the shoreline for fishing, picnicking and sunbathing. Based on analyses conducted, the beach and shoreline appear to have the carrying capacity to accommodate expected increased usage.

5.6 TERRESTRIAL FLORA

The flora within the Resort is composed largely of introduced exotic species. Four broadly defined vegetation types are found within the project area (see Figure IV-18): (1) Koa-haole scrub, (2) open scrub, (3) wetland and (4) strand. No rare, endangered or threatened species of plants have been found in the project area although a new species of bryophyte (liverwort) was recently collected fróm the project site near the coastal ponds. One of the ponds was considered to be a wetland area. However, the flooding, noted previously, apparently has reconfigured the pond such that this wetland zone either does not exist at present or is only marginally typical of Hawaiian coastal wetlands.

Any improvements within the strand or wetland areas would be limited to minimize impacts. Landscaping around the 8th and 9th golf holes would utilize native vegetation types characteristic of the strand/wetland zones to the greatest extent possible to maintain a consistent natural setting and to provide wildlife habitat.

5.7 FAUNA

Five basic faunal habitats, each defined in part by associated vegetation types, have been identified in the project area: (1) Koa-haole/Monkeypod scrub, (2) golf course, (3) resort area, (4) grassland and (5) coastal zone and brackish pond habitats. No rare, endangered or threatened species of birds or mammals were sighted in the project area during the faunal survey. However, the coastal zone and brackish pond habitat is known to be frequented by the Hawaiian coot, Hawaiian duck, Hawaiian hawk, Hawaiian black-necked stilt and the Hawaiian bat. Also, the Hawaiian short-eared owl may frequent the project area and green and hawksbill turtles occur in Punalu'u Harbor. Adverse impacts to any of the above species are not expected due either to (1) the lack of activities planned in the animals' respective habitats or (2) precautionary and mitigating measures to be taken to preserve appropriate habitats, such as the coastal zone and brackish ponds, and existing beaches.

5.8 PROTECTED SPECIES

Rare, endangered or threatened species occurring or potentially occurring at Punalu'u include the threatened green turtle (<u>Chelonia</u> <u>mydas</u>); endangered Hawaiian hawksbill turtle (<u>Eretmochelys</u> <u>imbricata</u>); endangered Hawaiian hoary bat (<u>Lasiurus</u> <u>cinereus</u> <u>semotus</u>); and endangered Hawaiian duck (<u>Anas</u> <u>wyvilliana</u>), Hawaiian hawk (<u>Buteo</u> <u>solitarius</u>), Hawaiian coot (<u>Fulica</u> <u>americana</u> <u>alai</u>) and Hawaiian Black-necked stilt

(_Himantopus mexicanus knudseni_). Several species of protected whales and dolphins inhabit the coastal waters offshore of the Resort.

The threatened green turtle utilizes the Punalu'u coastline for foraging and resting and the Hawaiian hawksbill turtle uses the coastline for foraging, resting, breeding and nesting. To protect and preserve these species and their habitat, a Draft Environmental Protection Plan (Appendix H) has been developed in consultation with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. The Plan delineates specific areas within the Resort boundaries that will be protected and preserved; identifies the types of activities that may occur in these areas; and provides for a Manager who will be responsible for the implementation of the Plan. Additionally, other specific measures would be taken by CBP to ensure the habitat integrity of the coastal pond, shoreline and coastal waters for the turtles and other marine species. These measures would include, but not be limited to, the shielding of lighting such that direct lighting of the beaches, shoreline and coastal waters does not occur; coastal pond, shoreline and coastal water quality monitoring; and closure of the shoreline area to vehicular access.

It is expected that the endangered terrestrial species (birds and mammals) would be positively affected by the proposed project through improvements to and/or maintenance of their habitats. It is also expected that the landscape buffers to be established around the coastal ponds and the increased landscaped areas around other Resort amenities would provide additional habitat or provide cover for feeding and resting areas.

The offshore protected species are not expected to be affected by the proposed project due to the lack of planned activities in the coastal waters.

5.9 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Several archaeological surveys have been conducted in the project area, each documenting the presence of both prehistoric and historic period archaeological sites. The final Full Archaeological Reconnaissance Survey report prepared specifically for this Final EIS is included as Appendix A. Several sites have been recommended for preservation. These sites generally fall into two general categories. One consists of habitation associated features and the other either definite or probable burial sites. Planned preservation, stabilization and integration of these features into an interpretive plan exemplifying the history of Ka'u District would provide a valuable amenity to the Resort development to be enjoyed by both visitors and residents.

The possibility of encountering additional archaeological sites during grading and site preparation activities appears to be remote. Therefore, no significant impacts to archaeological sites are anticipated at this time. However, should additional sites be found, appropriate measures would be taken to preserve or record those sites. It is CBP's intent to follow the consulting archaeologist's recommendations, as included in Appendix A, regarding the protection, preservation and recordation of significant archaeological and historical sites and features occurring within the Resort boundaries.

5.10 SOCIOECONOMIC CONSIDERATIONS

The evaluation of the effect of the proposed project on the socioeconomic character of the project area was performed through economic and sociological analyses of the project, Ka'u District and in some cases the island of Hawaii. The complete results of these analyses are included in Chapter IV, Section 4.

In general, the economic and fiscal impacts of the proposed project are expected to be positive. Increased employment opportunities would be provided by the proposed project resulting in increased personal and household income levels. The proposed project would increase population levels in the district and place additional pressures on some public services, e.g., schools, medical services and recreational facilities. However, state and county tax revenues to be generated by the proposed project exceed expected public expenditures that may be required to increase public services. Increased pressures would also be placed on the availability of appropriate housing in the district. There exists adequate, urban-zoned property in the district on which new housing could be constructed as required. Potential direct social impacts of the proposed project include a higher percentage of females in the work force and a higher percentage of males in service activities; family logistical problems resulting from weekend and split shift work hours; possible sense of competition for jobs between longtime residents and newcomers; and increased competition for recreational facilities due to increased population levels.

Mitigation measures proposed to alleviate adverse social impacts include the development of a Draft Punalu'u Resort Planning Process for a Program to Maximize Ka'u Resident Employment and Economic Benefits (Appendix I); ensuring that the present residents are made aware of job training programs and ensuring that job training programs are geared to the operational needs of the Resort; ensuring continued access to, and use, of existing public recreational facilities; programs included within the Environmental Protection Plan (Appendix H) to inform visitors of the local culture as well as the historical cultural resources and the need to protect, respect and preserve those cultures and resources; improving communication with local groups and organizations so that those groups and organizations are aware of the Resort facilities that are available to them; the possibility, if a demonstrated need is shown, of establishing an employee shuttle bus system and child care centers; and continuing to work with appropriate state and county agencies such that appropriate housing requirements are properly addressed and met. It is the developer's intent to be sensitive to the cultural and ecological resources of the area and to protect and preserve those resources for the benefit of the community and the proposed project.

5.11 TRANSPORTATION FACILITIES

The Hawaii Belt Highway provides access to Punalu'u Resort from all points on the island. Existing private roadways within the site include Punalu'u Road (Alanui Road) that loops through the makai portion of the Resort and connects with the county portion of Punalu'u Road, and Alahaki Road that provides access to the mauka portions of the Resort. Planned improvements include the addition of streets in new residential areas, the mauka realignment of Punalu'u Road and the construction of two new access roads. Existing county roadways provide access to the lands immediately to the east of the project site. Access to the county beach park and C. Brewer owned boat launch ramp would be maintained.

The increase in traffic expected as a result of the proposed project would have its greatest impact at street intersections, especially the Hawaii Belt Highway and Punalu'u Loop Road (Resort Entrance) and formerly known as Alanui Road intersection. Traffic studies conducted for the project indicate that the present approach volume capacity of this intersection can adequately serve the expected traffic increase. CBP would continue to work with the State Department of Transportation and County Department of Public Works to ensure that the Highway and roadways are adequate to serve the Resort and provide safe and efficient ingress/egress to the Resort.

Air transportation facilities on the island (Hilo and Ke'ahole) are more than adequate, as are harbor facilities (Hilo and Kawaihae), to serve the island and commercial needs of the proposed project.

5.12 AIR QUALITY

The greatest impact on air quality at the project site would be the result of indirect sources of air pollution, primarily vehicular traffic. Minor, short-term impacts during construction, such as fugitive dust during grading operations, would also be experienced. Existing air quality is good and no significant adverse impacts are expected. Off site air quality impacts may be experienced as a result of increased electrical power generation requirements for the Resort and volcanic activity by Kilauea Volcano. Applicable state and county air quality protection and maintenance rules and regulations will be complied with during construction and operation of the Resort.

5.13 NOISE

Vehicular traffic is expected to be the only significant long-term source of noise associated with the proposed project. The most significant adverse noise impacts are expected to be short-term and occur during the construction period. Planned landscaping, buffer zones and setbacks would minimize traffic noise. It is expected that all noise levels would remain within state and federal standards.

5.14 INFRASTRUCTURE

5.14.1 Water

As noted previously, two deep wells, a pump station, 1.0 MG storage reservoir and associated Public Utility Commission regulated underground transmission and distribution lines serve the Resort. Planned improvements include additional underground transmission and distribution lines, a new 1.1 MG storage reservoir and a new booster pump station. All Resort water requirements would be served by the existing wells and no impact to the island or regional water supply system or supply is expected due to the large quantity of the basal water supplies versus expected low usage requirements. Modifications to the Resort water system would comply with the provisions of Chapter 20, Title 11, Administrative Rules and subject to the approval of the State Director of Health, as well as the State Department of Land and Natural Resources; Administrative Rule Title 13, Chapter 166.

5.14.2 Sewage Disposal

The existing wastewater collection system consists of gravity flow sewer lines, force mains and two lift stations that transport wastewater to an on-site, self-contained, secondary treatment, wastewater reclamation plant. This system would be expanded incrementally to accommodate future requirements. Present and future effluent discharge of the treated sewage following retention in existing ponds along the 17th fairway, would be utilized on the golf course and landscape areas for irrigation purposes. Future elements of the wastewater collection and treatment system would be designed in accordance with appropriate state standards and would comply with Act 282.

5.14.3 Solid Waste Disposal

At present, and for the foreseeable future, solid waste generated by the Resort would be collected and disposed of in accordance with the services and standards imposed on the community and the Resort. Should the county be unable to provide disposal services, the solid wastes generated by the Resort would be handled privately and hauled to the nearest available approved sanitary landfill. CBP would continue to work with the County Department of Public Works to determine the method of collection and disposal site.

5.14.4 Power/Telephone

Power and telephone utilities are and would be provided by Hawaii Electric Light Company and Hawaiian Telephone Company, respectively. All utility distribution lines would be buried in underground conduits and would be installed according to the standards of each utility. Significant adverse impacts due to the installation and/or increased requirements on the systems are not expected. Air quality in the vicinity of power generation stations may be impacted due to the increased power requirements of the Resort. As an added conservation measure, the developer would analyze the possibility of utilizing roof mounted solar panels for hot water, and possibly air conditioning, purposes.

5.14.5 Access

As discussed previously, the Hawaii Belt Highway provides access to the Resort from other points on the island and is sufficiently sized to adequately serve the Resort. Also as noted, Punalu'u Road and the roads within the Resort would provide access to the various project activity areas, including the public shoreline. Roads within the Resort would be constructed in accordance with County design standards with some modifications as noted in Chapter IV, Section 3. As presently planned, Resort internal roadways would have a maximum 15 mile per hour speed limit that would be enforced by Resort security forces and street signage, including stop signs. Improved access to both public and private resort activity areas would result in beneficial and positive impacts. As noted previously, CBP would continue to work with the State Department of Transportation and County Department of Public Works to ensure that adequate, safe and efficient access is provided.

5.15 PUBLIC SERVICES AND FACILITIES

5.15.1 Schools

The Ka'u School Complex (K-12) located in Pahala and Na'alehu School (K-8) presently serve the Resort area. The increased population (employees and families) resulting from the proposed project would have an impact on the school system. The State Department of Education estimates that the proposed development would result in an additional enrollment of 50-100 students in grades K-6, 20-30 students in grades 7-8 and 25-40 students in grades 9-12 at the Ka'u School Complex. It is difficult at this time to predict future required staffing levels and/or facility requirements. It is expected that there would be a positive impact on the school system through increased school services employment.

5.15.2 Health Care Facilities

Ka'u Hospital, a 15-bed public hospital located in Pahala, presently serves the project area. Based on average occupancy rates experienced by the hospital to date, it appears that the hospital is more than adequate to serve the expected increased population. Persons in need of critical medical attention are presently transported to Hilo hospitals, which would also adequately serve expected population increases.

5.15.3 Police Protection

Police protection is provided by the county forces stationed in Na'alehu (with a substation at the Pahala Fire Station) and private security companies in the area, including personnel employed by the Resort. Increased county services are not expected to be required directly as a result of the proposed project. The Resort security force would be increased as required to provide on site police protection. The County Police Department foresees no adverse effects from the requested land use. A new County Police Station and Fire Substation (TMK: 9-5-12:02) is planned for an area east of Na'alehu.

5.15.4 Fire Protection

Fire protection in Ka'u District is provided by county forces in Pahala and volunteer backup forces in Pahala, Na'alehu and Hawaiian Ocean View Estates. The military camp in the volcano area also provides support as required. Fire protection service is adequate at present, but as the Resort expands, additional county or volunteer manpower may be required. All Resort

Facilities would be designed and constructed in compliance with applicable fire codes.

5.15.5 Recreational/Cultural Facilities

Neighborhood parks and school yards in Pahala and Na'alehu provide limited recreational opportunities for the residents of Ka'u District. Safe beach swimming areas in Ka'u include Whittington Beach Park and Punalu'u Beach Park. Neither of these beaches are considered "safe" by the County Department of Parks and Recreation. Kaulana Bay, at South Point is the only public boat launch ramp in Ka'u. The county Kamaoa Park site is presently undeveloped. Manuka State Botanical Park, the Kilauea State Recreational Area and Hawaii Volcanoes National Park offer public recreational opportunities. Both the 18-hole Volcano Golf Course and Punalu'u Resort Golf Course are privately owned but open to the public.

Existing archaeological/historical/cultural sites within or adjacent to the project area include Punalu'u Nui (Kane'ele'ele) and Ka'ie'ie heiau on the east and west sides of the Resort respectively, the Hawaiian Evangelical Association Cemetery and Chapel, some 30 archaeological sites, the Ka'u Center of History and Culture, Punalu'u County Beach Park, Aspen Institute for Humanistic Studies and the remains of the old sugar railroad and wharf. [Note: The chapel and cemetery (Henry Opukaha'ia Memorial Chapel and Cemetery) are owned by the Hawaii Conference Foundation of which the Hawaiian Evangelical Association is a member. Throughout the text, the chapel and cemetery are noted as being part of the Hawaiian Evangelical Association.] It is the developer's intent to follow the archaeological consultant's recommendations contained in Appendix A concerning future field work and to preserve, with some level of interpretive development, the sites recommended for preservation. These sites would be integrated into the Resort as important cultural resources. Except for maintenance and restoration, the existing cemetery and chapel would not be altered by the proposed project and the Ka'u Center of History and Culture would continue to be an important part of the Resort. The county beach park would be expanded and improved to accommodate expected increased usage and dedicated in fee to the county. Also, a new shoreline access roadway and parking area would be constructed on the east side of Ninole Cove, pending approval by appropriate agencies, thereby providing direct vehicular access to the shoreline. In addition, the Resort would include a performing arts facility, hula and luau areas and art gallery. These facilities would also be open and available to the public.

During site grading, all archaeological sites within the area would be flagged and a sufficient buffer established to protect the resources. Should subsurface features be encountered, site grading in that area would cease and appropriate county agencies notified. A professional archaeologist would examine the finds and recommend appropriate mitigative actions. A cultural resource management plan would be developed to ensure future protection and preservation of significant archaeological sites.

5.16 VISUAL CHARACTER

The existing visual character of the Resort area, as seen from the Hawaii Belt Highway and/or ocean, is one of a low level golf course/multi-family residential development with appropriate landscaping, ocean and rugged coastline views. This character would be continued as a result of the proposed project. Resort improvements, such as an increased number of buildings, may be seen from a limited number of view points along the Belt Highway, while the majority of the Resort would be seen from the ocean. All buildings would be designed to fit in with the existing topography of the site and the visual character of the area would be improved through the extensive use of appropriate landscape materials. The final Resort appearance would be planned to provide travelers along the Belt Highway, as well as visitors to the Resort, an enjoyable and pleasant experience.

6. SUMMARY OF PROPOSED MITIGATION MEASURES

Mitigation measures for those aspects of the proposed project that may induce potential adverse environmental impacts include the following:

- Erosion control measures, including the use of vegetation and sediment collection basins, would be employed to minimize erosion during and after construction.

- Retention basins would be constructed at the downstream end of the drainage system to minimize roadway contaminants from storm runoff entering the ocean or coastal ponds.

- Punalu'u Road would be relocated to higher elevations and the developable area of the Resort would be reduced by relocating the 8th and 9th golf holes to the coastal zone, thereby reducing potential storm hazards. Appropriate structural measures would be taken to reduce potential damage to buildings as a result of volcanic/seismic/subsidence activity.

- To minimize impacts on the coastal and shoreline areas, the water play area of Punalu'u Village has been designed to reduce visitor's usage of the black sand beach area; interpretive displays indicating the ecological importance of the shoreline and coastal pond areas would be provided; and wastewaters to be used for irrigation of the golf course would be secondarily treated and properly applied; and landscape buffers would be planted around the ponds incorporated into the golf course. Implementation of the Environmental Protection Plan (Appendix H) would provide additional mitigation for potential adverse impacts.

- Reconnecting the dry "mauka" pond to Pond No. 1 would provide new wetland and pond habitat for migratory and resident waterbirds and pond shoreline and benthic organisms.

- To minimize adverse impacts to the vegetation of the area, the proposed golf course modifications adjacent to the wetland and strand areas would use native vegetation types characteristic of those areas, and added landscaping would serve as additional available wildlife habitat.

- Landscape buffers would be placed around coastal ponds to protect the waterbirds using the ponds and small islets may be constructed in the ponds to provide predator protection, and closure of vehicular access to the coastal areas would protect hawksbill turtle nesting sites as well as sensitive strand plants.

- It is the developer's intention to preserve, in accordance with the archaeological consultant's recommendations as contained in Appendix A, those sites recommended for preservation. Sites with significant interpretive and cultural value would be incorporated into a cultural resource management plan that would be formulated with assistance from appropriate state and county agencies. During grading operations, archaeological sites would be flagged and a sufficient buffer established to protect the resources.

- Potential adverse socioeconomic impacts would be minimized by implementing the program to maximize Ka'u residents employment and economic benefits (Appendix I); the provision of information regarding job training programs; the possible establishment of child care facilities and some form of employee transportation assistance; improved community communication links; and development of or causing development of appropriate housing opportunities.

- To minimize adverse air quality impacts during construction, dust control measures, including water spraying and the possible use of dust pallitives, would be employed. Adverse impacts, as a result of the proposed project, during the operational phase are not expected.

- To minimize potential adverse noise impacts, landscape buffers and roadway setbacks would be employed. Buildings would be designed and constructed such that outdoor noises are not intrusive.

- Potential adverse impacts on recreational facilities would be minimized by encouraging county and state improvements to Kaulana boat launching ramp; the provision of additional tennis courts at the Resort; improvements to Punalu'u County Beach Park; the construction of a new shoreline access roadway and parking area along the east side of Ninole Cove; development of a major water play area in Punalu'u Village; and development of a policy for improving use of the Punalu'u boat launch ramp.

- Potential adverse visual impacts would be minimized through the design of aesthetically pleasing structures, maintenance of open spaces and the use of landscaping materials to complement the natural setting.

7. SUMMARY OF ALTERNATIVES

Known alternatives which could "feasibly" attain the objectives of the Resort Master Plan and proposed project have been considered and are described in detail in Chapter III. "Feasible" actions that potentially reduce or eliminate environmental risks or costs have been evaluated. The alternatives investigated and analyzed have included the following:

- Alternative 1 - Revised Physical Plan (Preferred Alternative)

  Modify the existing resort infrastructure and amenities (roads and golf course) and complete the development of the resort based on current "Minor Resort" designation under the General Plan and related zoning.

- Alternative 2 - Existing Physical Plan

  Complete the development of the resort based on current County land use policy "Minor Resort" designation under the General Plan and related zoning without modifying the existing resort infrastructure and amenities.

- o Alternative 3 - Mauka Hotel/Coastal Private Open Space

  Reserve the coastal lands makai of the existing improved roadway for private open space and locate the hotel development mauka of the Belt Highway. Obtain the required GP Amendment to permit resort designation mauka of the highway and complete the development of the resort based on current County land use policy "Minor Resort" designation under the General Plan and related zoning.

- o Alternative 4 - Private Club/Estates

  Develop an exclusive, very low density high priced recreational club oriented around the existing recreational amenities (golf and tennis).

- o Alternative 5 - "No Action"

  Retain the resort in its present configuration with no additional development. Take necessary measures to reduce/eliminate annual operating losses and carrying costs.

All of the alternatives have been found lacking in their abilities to meet the objectives of (1) establishing a high quality, medium density, destination resort that would be economically viable and competitive with other resorts in Hawaii or on the island of Hawaii; (2) continuing to provide employment opportunities within the community; and (3) improving the overall economic and social well-being of the community and region. In assessing each of the alternatives and the proposed project, it has been determined that the proposed action provides the desired benefits to both the community and developer while minimizing environmental costs and risks.

8. SUMMARY OF UNRESOLVED ISSUES

The applicant is aware of concerns regarding the proposed project, as expressed by some of the residents in the project area. The applicant is continuing to work with the area residents to alleviate their concerns and reach agreement regarding the development with the residents. Known unresolved issues and concerns regarding the proposed project are described in Chapter IX.

9. SUMMARY OF COMPATIBILITY OF LAND USE POLICIES AND PLANS

The proposed project lands are predominantly classified as Urban. With adoption of the General Plan amendment and rezoning requested, the entire project would be consistent with state and county land use plans and policies.

10. NECESSARY APPROVALS AND PERMITS

The existing land use authorities, designations and related permits or approvals required are listed in Table I-1.

TABLE I-1

Land Use Description/Approvals

Authority/Land Use Designation	Area Affected	Approval Required	Status*
COUNTY OF HAWAII			
General Plan o Open (LUPAG)	40' Coastal Setback and Golf Course	None	AF
o Low Density Urban (LUPAG)	Mauka Resort Area	General Plan Amend. w/ Environmental Impact Statement (EIS)	AF
o Medium Density Urban (LUPAG) and Resort (LUPAG)	Makai Resort Area	None	N/A
Zoning (Various Zones)	Makai Resort Area	Change of Zone	AF
Zoning (Various Zones)	Mauka Resort Area	Change of Zone	ATBF
Special Management Area (SMA)	Makai of Hawaii Belt Hwy.	SMA Permit	ATBF
Subdivision Approval	Entire Site	Subdivision (Preliminary & Final)	ATBF
Grubbing, Grading Excavation and Stockpiling Permit	Roadways and Development Sites	Grading Permit	ATBF
Well Permit	Source Location	Well Permit	Permit
Sign Permit	Various Locations	Sign Permit	ATBF

Table I-1

Land Use Description/Approvals
(continued)

Authority/Land Use Designation	Area Affected	Approval Required	Status*
STATE OF HAWAII			
State Land Use o Urban District	Entire Site	None	N/A
Department of Land And Natural Resources o Conservation: Resource Subzone	Coastal Fringe	Conservation District Use Application/Permit	ATBF
o Historic Sites (Chapter 6E Review)	Various Sites	Review/Approval	AF
Department of Transportation o Navigable Water	Nearshore Water	If Modified, Review/ Approval Required	N/A
Department of Health o Private Wastewater Treatment	Treatment Plant Expansion	Certification/Permit	ATBF
Department of Planning and Economic Development o CZM Federal Consistency Review	Coastal Ponds/ Shoreline Area	If Modified, Review Required	N/A
FEDERAL GOVERNMENT			
Army Corps Of Engineers (COE)	Connection of Pond No. 1 and Dry Mauka Pond	If Modified, COE Permit Required	ATBF
U.S. Fish & Wildlife Service	Coastal Area	Section 7 Consultation (Endangered Species)	ATBF

*Status

AF = Application Filed.
ATBF = Application To Be Filed.
N/A = Not Applicable.
Permit = Permit Received

11. ORGANIZATIONS AND INDIVIDUALS WHO ASSISTED IN THE PREPARATION OF THE EIS

This Environmental Impact Statement was prepared for C. Brewer Properties, Inc. by PBR HAWAII with input provided by the planning team and subconsultants. The following organizations and persons were involved:

PLANNING TEAM

Name/Affiliation	Title	Education	Area of Expertise
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M. J. Tilker	Chairman/President	BA Economics, MS Finance	Land Development Business
B. G. Moynahan	Sr. Vice President	BA Psychology, MBA	Land Development Business
E. Mott-Smith	Project Planner	BSME, MBA	Land Development Business
R. L. Herberg	Special Consultant	BA Accounting, MBA	Land Development Business
PBR HAWAII			
Wm. F. Brandt	President	BA Landscape Arch.	Planning, Project Management
T. S. Witten	Vice President	BA Landscape Arch.	Project Management, Land Planning, Landscape Architecture
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M. Grady	Cartographer	BS Environ. Studies	Cartography
C. Kimura	Cartographer	BS Geography	Cartography
W. Nagasako	Editor	MA Education	Editing
L. Warning	Proofreader	BS Landscape Arch.	Proofreader
G. Wang	Word Processor		Word Processing
D. Takiguchi	Word Processor		Word Processing
L. Teruya	Word Processor		Word Processing
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J. N. Watanabe	Partner	Juris Doctor	Land Use Regulatory Process
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THE HKS COLLABORATIVE			
A. Krivatsy, AICP	President	Architecture/Urban Design	Urban Planning, Architecture

PLANNING TEAM (Continued)

Name/Affiliation	Title	Education	Area of Expertise
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M. L. K. Rosendahl	Vice President	BA, SOPA	Archaeology
A. Haun	Sr. Archaeologist	PhD	Archaeology
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GK AND ASSOCIATES			
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Chapter II: Description of the Proposed Project

CHAPTER II

DESCRIPTION OF THE PROPOSED PROJECT

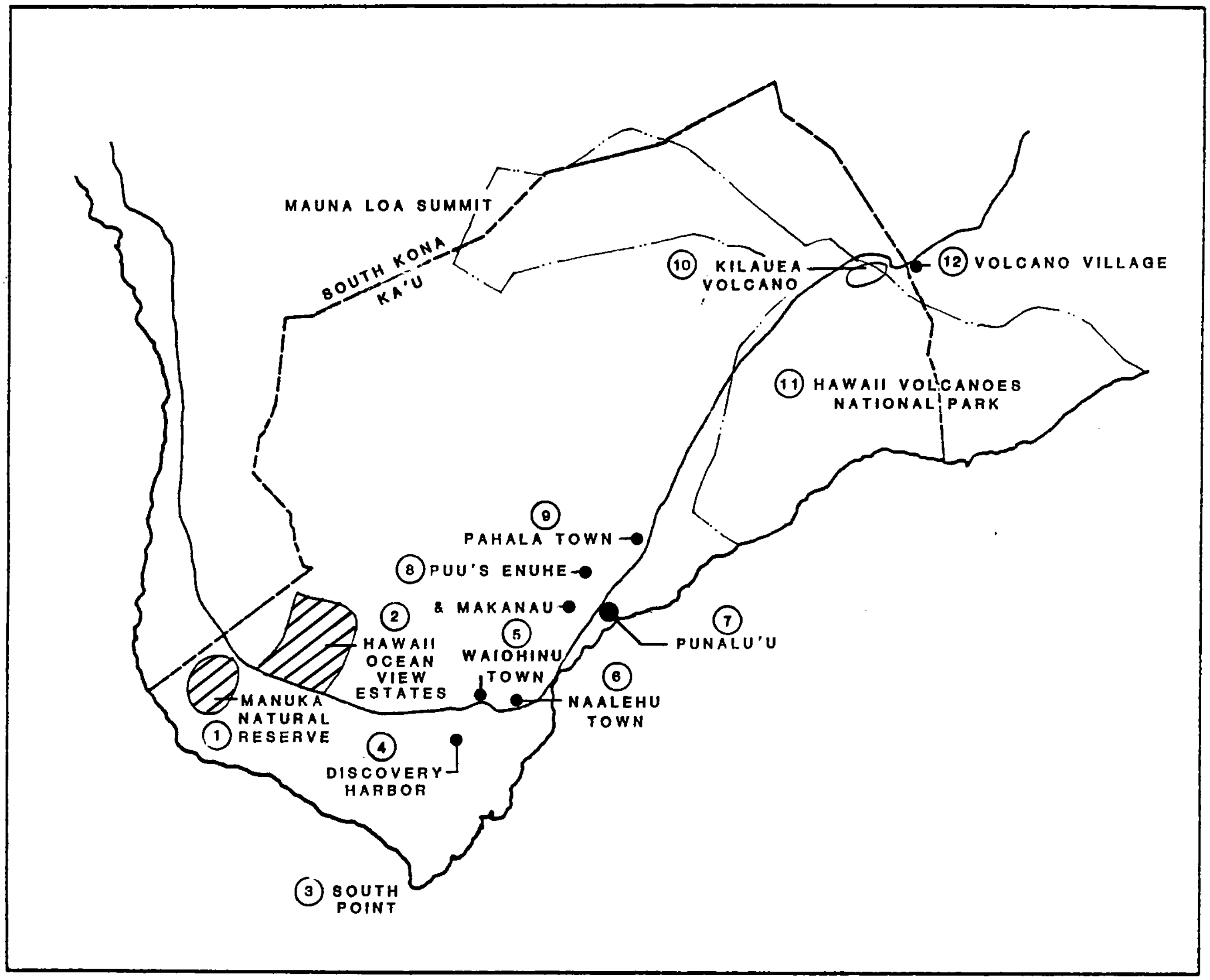
1. REGIONAL SETTING

Punalu'u Resort is located in Ka'u District on the island of Hawaii (Figure II-1). Ka'u District stretches from Hawaii Volcanoes National Park with the spectacular Kilauea Volcano to the 13,680-foot peak of Mauna Loa to the shoreline, including South Point, and on to South Kona District on the west side of the island (Figure II-2). Ka'u District is larger than the island of Oahu, but has a population of about 4,475 persons (1985 estimate). The District is primarily a rural agricultural area with sugar cane, macadamia nuts, cattle raising and fishing accounting for most of the primary employment. Punalu'u Resort currently directly employs 60-65 persons, including those employed at the Black Sand Restaurant, in a variety of positions and is the only resort destination currently operating in Ka'u.

Ka'u is rich in Hawaiian history and archaeological sites that evidence the large Hawaiian population that once farmed and fished there. Ka'u is thought by some to have been the original landing place of the first Polynesian settlers in the Hawaiian Islands. The coastal areas in particular have large numbers of ancient house sites, villages, heiau, paved trails and other remains of the early Hawaiian inhabitants. Artifacts from archaeological investigations at South Point have carbon dated to the year 124 A.D. Heiaus, outside the project boundaries, flank the project site, and one, Kane'ele'ele, is among the largest on the island.

The Hawaiians settled in Ka'u about 2,000 years ago and some of their descendants are living in Ka'u today. The increased awareness and interest in Hawaiian culture that is being experienced today, along with the historical and archaeological features of the project site, provide visitors and residents an enriching opportunity when visiting the Resort. It is the developer's intention to preserve and incorporate significant archaeological and cultural resources into the proposed Resort improvements for the benefit of visitors to the Resort as well as residents of the State (see Chapter IV, Section 3 and Appendix A).

Pahala and Na'alehu, the two towns closest to the Resort, are both "sugar" towns where many of the residents work for the Ka'u Agribusiness Company, owned by C. Brewer & Company,



LEGEND

(PLACES OF INTEREST)

1 MANUKA NATURAL RESERVE	7 PUNALU'U
2 HAWAII OCEAN VIEW ESTATES	8 PUU'S ENUHE & MAKANAU
3 SOUTH POINT	9 PAHALA TOWN
4 DISCOVERY HARBOR	10 KILAUEA VOLCANO
5 WAIOHINU TOWN	11 HAWAII VOLCANOES NATL. PARK
6 NAALEHU TOWN	12 VOLCANO VILLAGE

KA'U DISTRICT

Punalu'u Resort

KA'U, ISLAND OF HAWAII

MILES (APPROX.) 0 3.5 7

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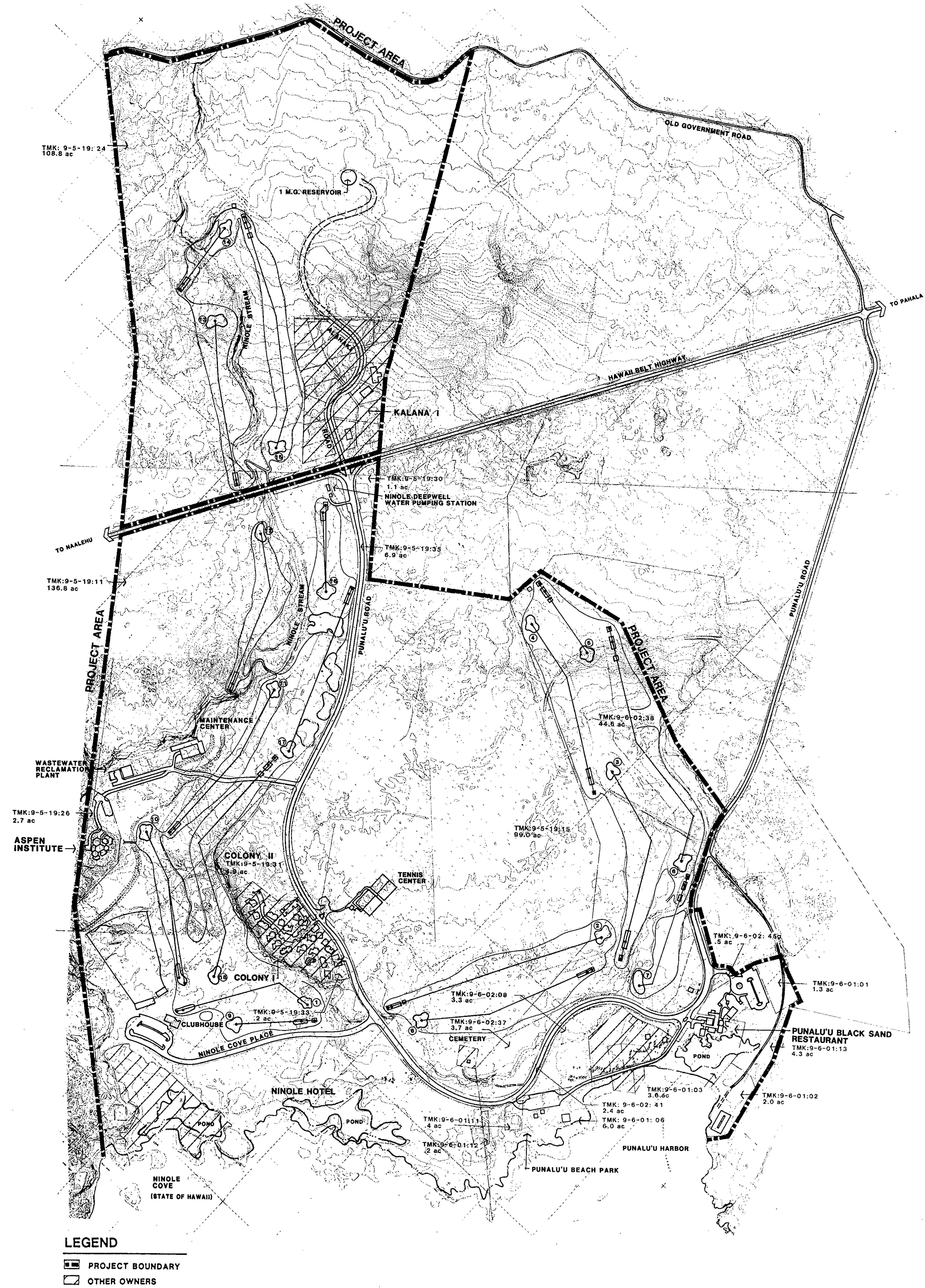
FIGURE II-2



LEGEND

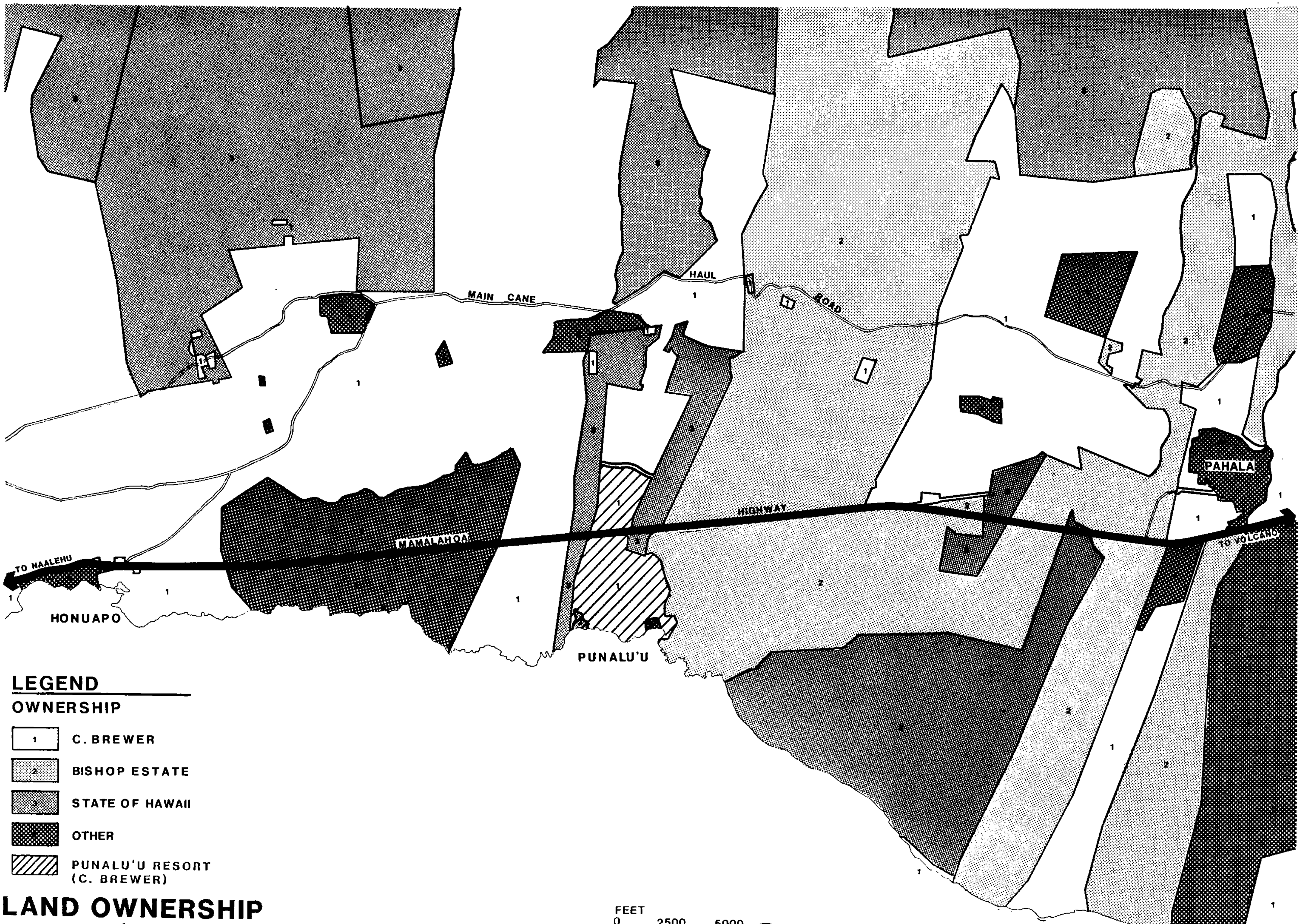
PROJECT BOUNDARY
OTHER OWNERS

EXISTING DEVELOPMENT

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE II-3



LAND OWNERSHIP

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE II-4

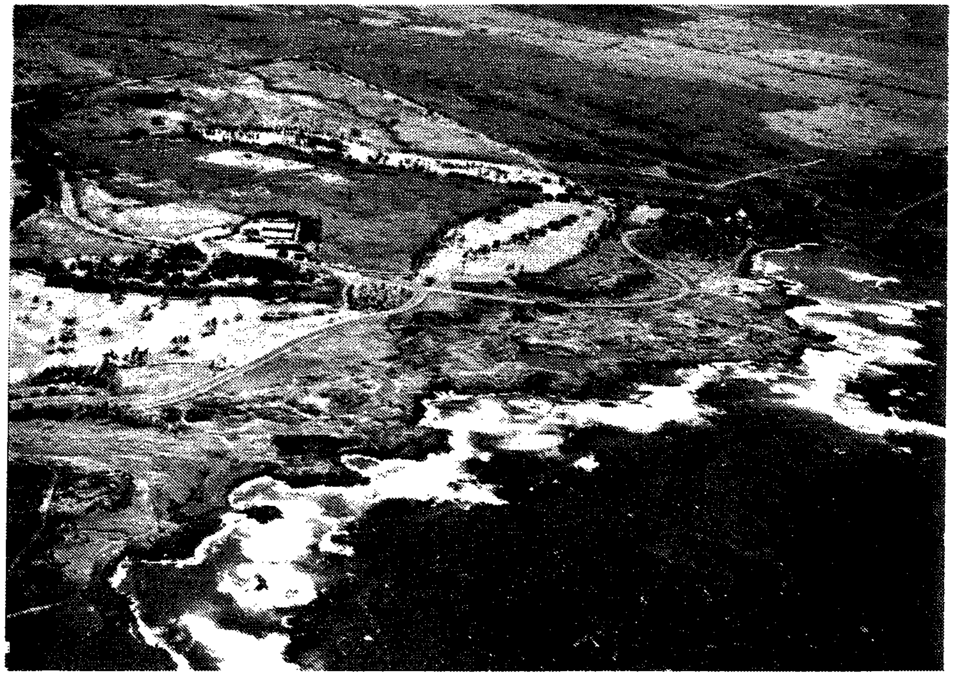
ginal Resort have included the Aspen Institute for Humanistic Studies, four tennis courts and a convenience store, Ka'u Center of History and Culture, the 19-lot Kalana I single family residential subdivision and improvements to the golf clubhouse.

In addition, a substantial portion of the Resort infrastructure and facilities have already been developed, including underground Public Utilities Commission regulated water transmission and distribution lines, sewer system with self-contained reclamation and secondary treatment plant, underground power, telephone and cable TV lines, drainage system and internal roadways. The replacement value of in-place facilities and amenities is approximately $39 million. The facilities and amenities provide the essential fundamental base upon which the Resort Master Plan and proposed project are founded and provide significant economic, cultural, social and recreational resources for the community. These features would be improved and added to as a part of the proposed project. Figure II-5 A through E show the major features of the existing Punalu'u Resort and locations of proposed new facilities.

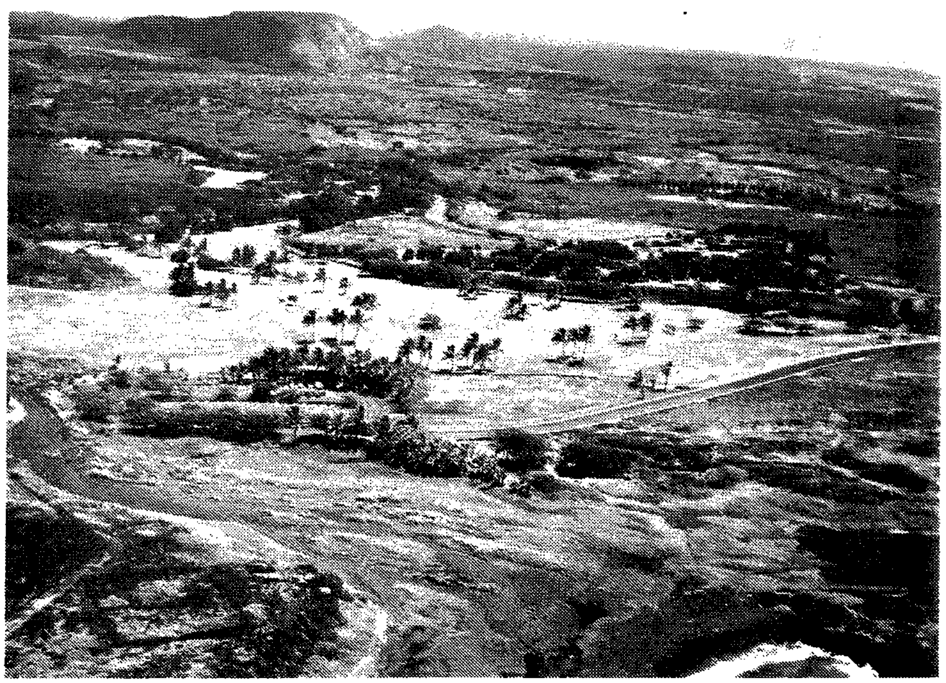
The State Land Use (SLU) Urban designated area (Figure II-6) has a total of approximately 585 acres (less than one-tenth of one per cent of the entire Ka'u region). This includes approximately 424 acres of CBP fee property and 161 acres of Bishop Estate and other lands. The State Land Use (SLU) Conservation district has a total of approximately 18 acres including nine acres of CBP fee property and nine acres of State of Hawaii and other lands located along the shoreline. Pahala, Na'alehu, and Waiohinu are the only other urban designated areas in Ka'u and total approximately 800± acres.

The existing and proposed County General Plans are shown on Figures II-7 and II-8 respectively. As shown, the area for which the GP amendment is being requested is presently designated Low Density.

Existing County zoning designations (Figure II-9) in the Resort total approximately 433 acres and include approximately 4.7 acres Village-Commercial (CV-10), 27.9 acres Resort-Hotel (V-1.5), 19.4 acres Multiple Family Residential (RM-2.0), 17 acres Single Family Residential (RS-20 and RS-7.5), 118.1 acres Agricultural (A-20a), and 245.4 acres Open (O). Refer to Table II-1 for summary of existing zoning at Punalu'u Resort. Ultimate proposed County zoning is shown on Figure II-10.



(A) COASTAL AREA OF PUNALU'U RESORT



(B) NINOLE COVE (FILLED WITH SEDIMENTS), GOLF CLUBHOUSE AND COLONY I

AERIAL PHOTOGRAPHS OF EXISTING PUNALU'U RESORT

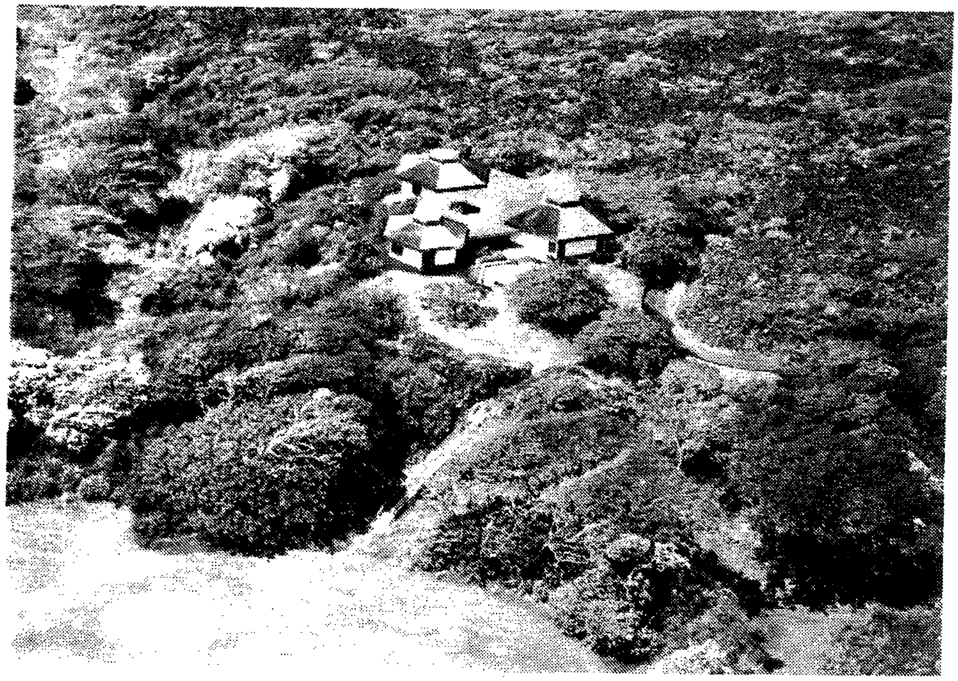
SEPT. 1986

Punalu'u Resort

KA'U, ISLAND OF HAWAII

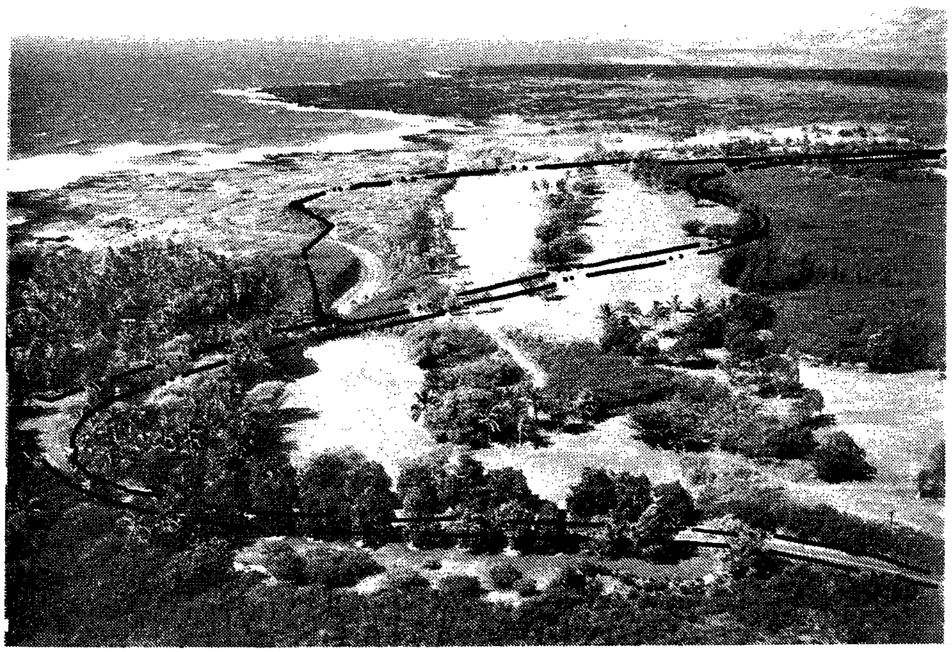
pbr

FIGURE II-5

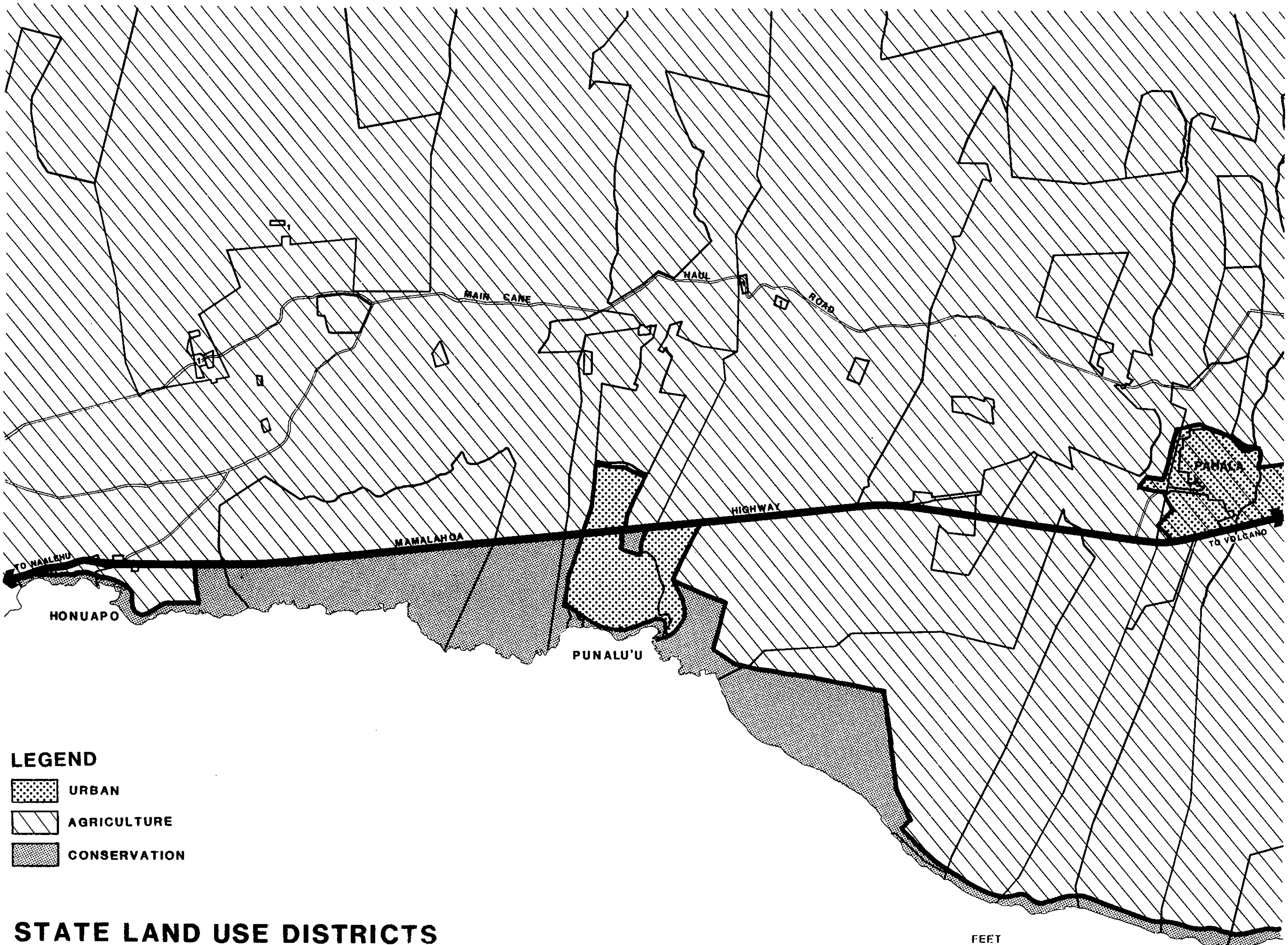


(C) ASPEN INSTITUTE

(D) PUNALU'U BLACK SAND BEACH AND EXISTING RESTAURANT COMPLEX



(E) SITE OF PUNALU'U VILLAGE AND HOTEL

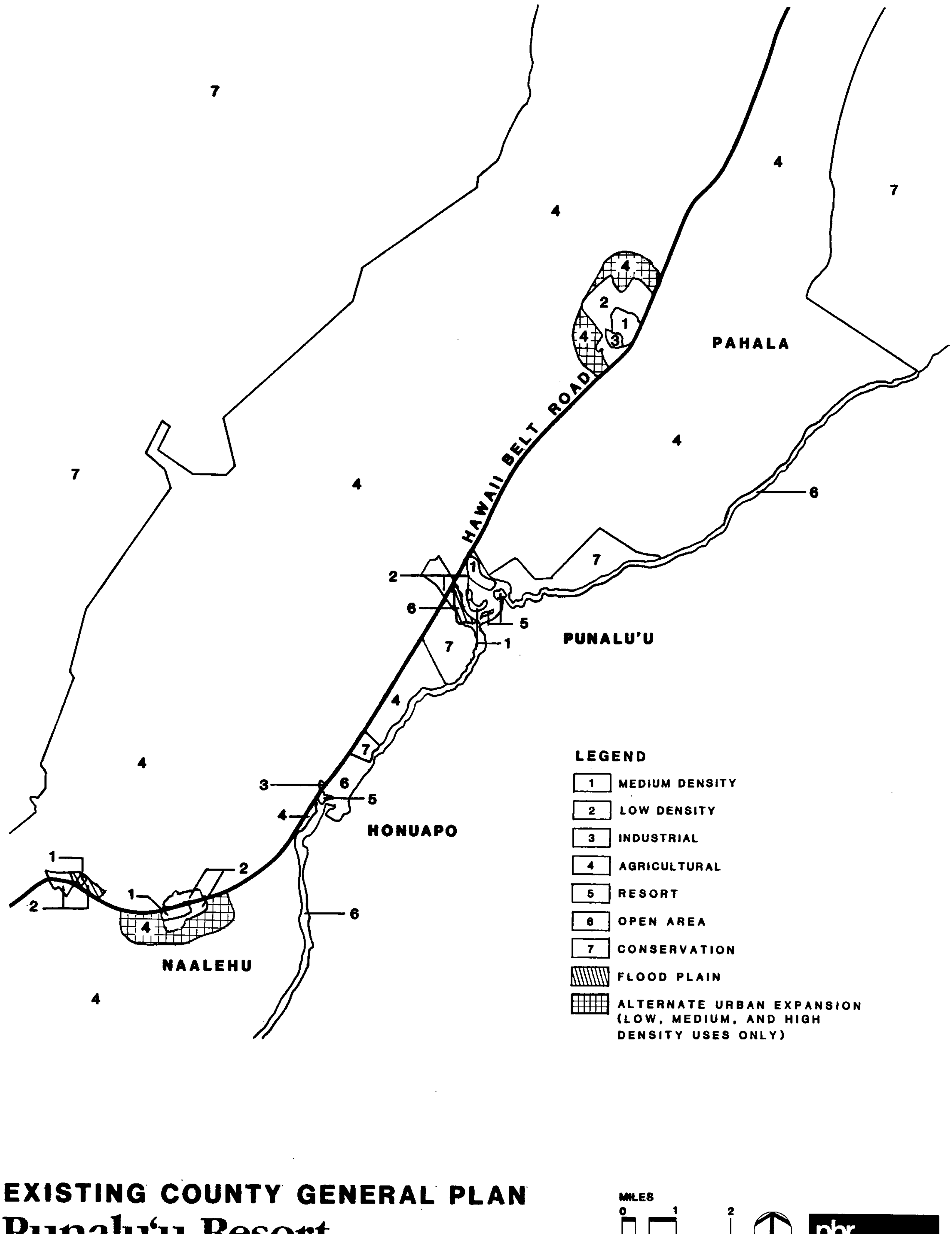


STATE LAND USE DISTRICTS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE II-6

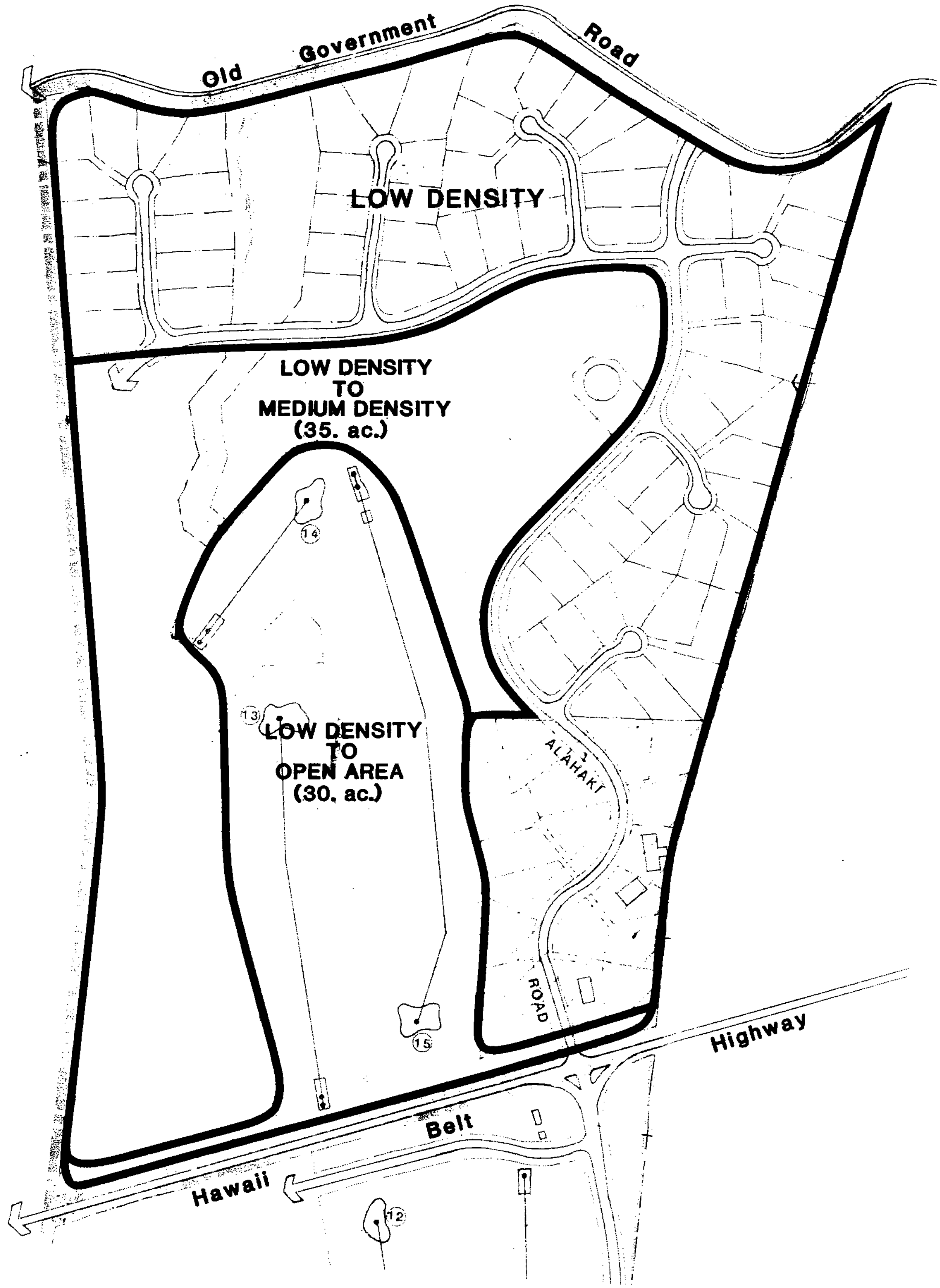


EXISTING COUNTY GENERAL PLAN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE II-7



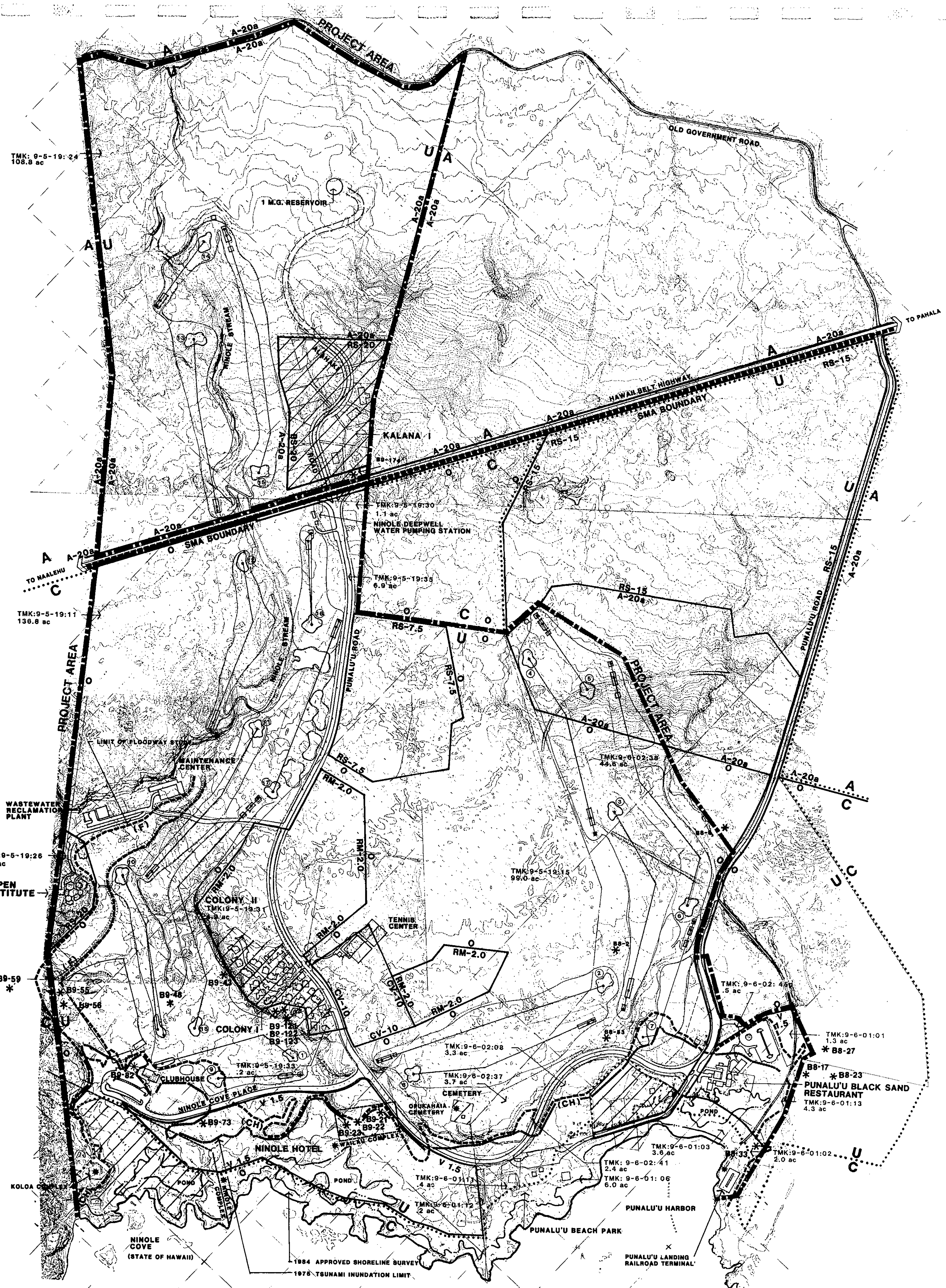
PROPOSED COUNTY
GENERAL PLAN AMENDMENT

Punalu'u Resort

KA'U, ISLAND OF HAWAII

pbr

FIGURE II-8



COUNTY ZONING

VILLAGE COMMERCIAL	CV-10
HOTEL/RESORT	V-1.5
SINGLE FAMILY	RS-7.5
SINGLE FAMILY	RS-20
MULTIPLE-FAMILY	RM-2.0
AGRICULTURE	A-20a
OPEN	O

STATE LAND USE (TO BE CONFIRMED)

URBAN	U
CONSERVATION	C
AGRICULTURE	A

FLOOD HAZARD

FLOODWAY	(F)
COASTAL HIGH HAZARD	(CH)

ARCHAEOLOGICAL SITES

- BISHOP MUSEUM INVENTORY
- STATE HISTORIC INVENTORY

COASTAL ZONE MANAGEMENT

- SPECIAL MANAGEMENT AREA (SMA)

NORTH SCALE 200 0 200 600 FEET

pbr

EXISTING COUNTY ZONING AND REGULATORY MAP
Punalu'u Resort
KA'U, ISLAND OF HAWAII

FIGURE II-2

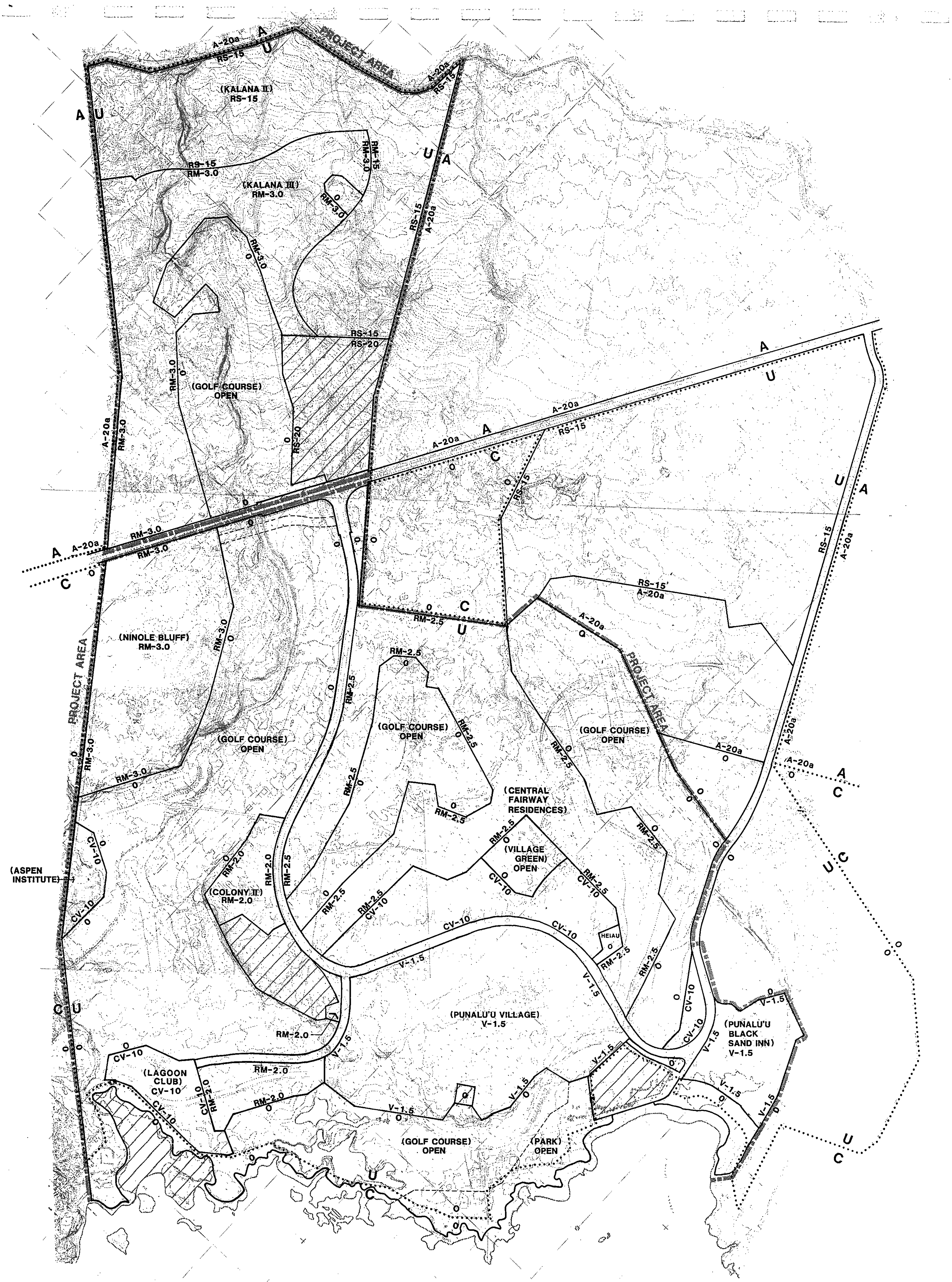
TABLE II-1

Punalu'u Resort

EXISTING ZONING / PROPOSED ZONING SUMMARY

County Zoning	Existing Zoning (Acs.)	Future Proposed Zoning (Acs.)	Net Change (Acs.)
Village Commercial (CV-10)	4.7	22.8	+18.1
Hotel Resort (V-1.5)	27.9	43.2	+15.3
Multiple Family (RM-2.0)	19.4	10.5	-8.9
Multiple Family (RM-2.5)	0	47.9	+47.9
Multiple Family (RM-3.0)	0	64.2	+64.2
Single Family (RS-7.5)	14.3	0	-14.3
Single Family (RS-15)	0	44.6	+44.6
Single Family (RS-20)	2.7	0	-2.7
Agriculture	118.1	0	-118.1
Open and Roads	245.4	199.3	-46.1
TOTAL ACRES +/-	432.5	432.5	0
DEVELOPABLE ACRES +/-:	69.0	233.2	+164.2

NOTE: Acreages are approximate only. Variations in resultant zoned parcels are to be expected in final parcel description and map. Refer to Figure II-9 and II-10.



LEGEND

▭	PROJECT BOUNDARY
▨	OTHER OWNERS

PROPOSED COUNTY ZONING

VILLAGE COMMERCIAL	CV-10	
HOTEL/RESORT	V-1.0	
HOTEL/RESORT	V-1.5	
SINGLE FAMILY	RS-15	
SINGLE FAMILY	RS-20	
MULTIPLE FAMILY	RM-2.5	
MULTIPLE FAMILY	RM-3.0	
OPEN	O	
EXISTING/NO CHANGE		

NORTH SCALE 200 0 200 600 FEET

PROPOSED COUNTY ZONING
Punalu'u Resort
KA'U, ISLAND OF HAWAII

pbr

FIGURE II-10

The current land uses adjacent to the resort are either barren lava flows or low utility grazing lands. Located in the general area are an extensive C. Brewer sugar plantation and macadamia nut orchards along with cattle ranching operations and other small diversified agricultural activities. The two neighboring communities of Pahala and Na'alehu are the primary residential communities that house the agricultural and resort work force supporting these operations. Other residential communities in the area include Volcano Village, Waiohinu (including Mark Twain Estates and Discovery Harbor), and Hawaiian Ocean View Estates.

Ninole Cove, a State-owned parcel, and the County's park facilities at Punalu'u Beach Park are existing coastal recreational resources. Public shoreline access to Ninole Cove is provided over CBP property with parking provided within the golf clubhouse parking lot. It is the developer's intention to dedicate Punalu'u Beach Park in fee to the County following completion of improvements to the park. The County would be responsible for all park maintenance. To date, the County has developed the park with a pavilion, picnic shelters, a comfort station, and parking lot. Primary public access is provided via the privately owned portion of Punalu'u Road (Alanui Road) that traverses through the center of the Resort and via the County portion of Punalu'u Road that enters the east side of the Resort and the remnants of an unimproved old government right-of-way along the Punalu'u Black Sand Beach presently serving as a secondary access road.

Other owners located within or adjacent to the project limits of Punalu'u Resort include Colony I, Kalana I, the Ninole Cove State parcel, the Hawaiian Evangelical Association cemetery, and six parcels with two existing houses at Punalu'u Black Sand Beach. The six parcels are owned by four owners; Helen B. Dahlberg (3 parcels); Elizabeth K.K. Bangay; Cecil S. and Margret L. Carmichael; and Arthur U. Ulrich. It is noted that one of the Dahlberg parcels and the Ulrich parcel are on the makai side of the county beach road and mostly under water.

State lands abut the resort on the southwest while both State and Bishop Estate lands abut the northeastern boundary. These lands are utilized by SeaMountain Hawaii Ranch Corporation as pasture under a State Revocable Permit (S-5491) and a lease with Bishop Estate (No. 20397) encompassing the area bounding the Bishop Estate portion of the resort. Additionally, C. Brewer lands abut the northwestern boundary at the upper mauka reaches of the project site.

Table II-2 summarizes the total acres of each existing Tax Map Key parcel (TMK) by each zoning designation. There will be no proposed zoning change to 10 TMK parcels. Refer to Figure II-9: Existing County Zoning and Regulatory Map, and Figure II-10: Proposed County Zoning.

3. DEVELOPMENT CONCEPT

3.1 C. BREWER'S REGIONAL DEVELOPMENT PLAN

C. Brewer owns approximately 35,000 acres in the Ka'u district stretching from the Volcano National Park boundary to South Point, and holds State and private leases on an additional 30,000 acres. Ka'u Agribusiness, a subsidiary of C. Brewer, operates a 15,900 acre sugar plantation and farms and manages an additional 4,500 acres of macadamia nuts. 2,582 acres of C. Brewer fee property is in the Conservation district and another 19,500 acres are either vacant or currently underutilized. Punalu'u, a planned destination resort, is the major non-agricultural activity in the Ka'u district and has been in operation for several years.

Between sugar, macadamia nut, and resort activities, C. Brewer is the largest single employer in Ka'u. Some of the key issues facing Ka'u in the next decade include:

1. Stabilization of agricultural employment through crop diversification and increased operating efficiencies.

2. Increasing levels of non-agricultural economic activity to provide stable employment to local residents.

3. Providing for adequate water systems through source development and delivery system expansion.

4. Increasing the utilization of existing underutilized land resources.

Related to the key issues facing the Ka'u District, C. Brewer's regional land use plans are summarized as follows and represent the company's five major initiatives to achieve the stated objectives through the future planning and utilization of their land resources in Ka'u.

1. <u>Large Scale Agricultural Development</u>

Objective: Enhance large scale agricultural activity through the integration and expansion of macadamia nut cultivation by Ka'u Agribusiness.

TABLE II-2

Punalu'u Resort

EXISTING ZONING: SUMMARY BY TMK
(C. Brewer Fee Parcels Only)

COUNTY ZONING

PARCEL TMK	CV-10	V1.5	RM-2.0	RS-7.5	RS-20	A-20a	OPEN	TOTAL ACRES
9-5-19:11		20.9					115.6	136.5
9-5-19:15	4.7		12.5	14.3			67.5	99.0
9-5-19:24						108.8		108.8
9-5-19:26					2.7			2.7
9-5-19:30							1.1	1.1
9-5-19:31			4.9					4.9
9-5-19:33			.2					.2
9-5-19:35			1.8				5.1	6.9
9-6-01:01		1.3						1.3
9-6-01:02		.1					1.9	2.0
9-6-01:03		1.3					2.3	3.6
9-6-01:06							6.2	6.2
9-6-01:11							.4	.4
9-6-01:12							.2	.2
9-6-01:13		4.3						4.3
9-6-02:08							3.3	3.3
9-6-02:37							3.7	3.7
9-6-02:38						9.3	35.3	44.6
9-6-02:41							2.4	2.4
9-6-02:45							.4	.4
TOTAL ACRES +/-	4.7	27.9	19.4	14.3	2.7	118.1	245.4	432.5

Note: Acreages may vary depending on final land survey.

Since 1961, Ka'u Agribusiness has planted nearly 3,600 acres of macadamia nuts of which approximately 1,100 acres were on Bishop Estate land. Brewer's commitment to increasing the survivability of sugar in Ka'u is also apparent in a recent multi-million dollar investment in the Ka'u Mill to improve general plant efficiency. Committed to a viable agricultural base in Ka'u, C. Brewer continues to work towards that end.

Maximum production and improved milling efficiency is essential if C. Brewer's longstanding commitment to the sugar industry is to be sustained. With improved mill operations completed, Ka'u Agribusiness has set a target of 60,000 tons in production as the optimum annual capacity. Present capacity is near that level today and no major changes are expected.

Based on 25 years of experience in the macadamia nut industry and extensive analysis of the current and projected world markets, C. Brewer has made a major commitment to increasing macadamia nut production and developing a broader market base both nationally and internationally. For example, C. Brewer budgeted some $5.5 million in 1985 to market Mauna Loa brand macadamia nuts and it's associated products through an expanded national and international network and is confident that such efforts will show substantial benefits in the long run and will assist in the stabilization of agricultural activity in areas where sugar cannot be grown profitably.

2. <u>Resort Development</u>

Objective: Continue development of the Punalu'u Resort through the implementation of a revised Master Plan and renewed marketing efforts.

Since its opening in 1974, Punalu'u Resort has experienced some difficulty in establishing a place for itself in the resort marketplace. A tsunami in 1975 had a significant impact on the initial resort development plans. Some of the master planned land uses along the coast became obsolete and a period of re-assessment followed. About that same time national economic conditions began to decline, leaving Punalu'u without a strong position in the marketplace.

In 1978-80, Brewer initiated a new planning effort to analyze and eventually redesign the land use configurations at Punalu'u. Among the first steps was a lengthy land acquisition process with Bishop Estate which resulted in some important consolidation of key properties by 1984. Since then, C. Brewer has completed a new Resort Master Plan that better recognizes the natural hazards of the area and the environmental and historic features of the area. The recognition and accommodation of these factors will require reconfiguration of existing infrastructure, rezoning of some parcels and obtaining zoning for other parcels in order to improve the overall viability of the project.

Implementing the revised resort design is a major objective for C. Brewer's Big Island operations. Over the next 5-10 years, C. Brewer intends to focus its efforts on implementing the resort plan and to market the resort on both a national and international level. Based on consultant prepared market assessments, C. Brewer is convinced that Punalu'u has a significant role to play in the state and island wide resort industry (see Section 3.4 below).

The success of the Punalu'u Resort is an important corporate goal. It is also critical to the overall economy of the Ka'u district both as a major source of non-agricultural employment and as a center for both primary and secondary economic activity. Current projections suggest that over the next 10-15 years Punalu'u could provide a variety of job opportunities, both within and outside of the resort operations, thus making it a bright prospect on the district's economic horizon.

3. <u>Diversified Agriculture Development</u>

Objective: Provide for increased utilization of currently underutilized agricultural lands.

A substantial portion of C. Brewer's Ka'u lands are currently unneeded or unsuitable for corporate scale agriculture. The market fundamentals involved in the scale of C. Brewer's current operations and the production schedules for optimum efficiency have left much land without an economically viable corporate use.

Approximately 5,000 acres of these lands lie mauka of the Belt Highway between Punalu'u and Honuapo. For planning purposes these lands are referred to as SeaMountain Farms. The area is serviced by existing agricultural roads and is currently utilized for pasture. Assessment of these lands suggests that there are agricultural opportunities attached to these lands that cannot be realized by corporate scale agriculture. Part of the SeaMountain Farm's opportunity may lie in its potential for small to moderate size agricultural activity under diversified uses and ownership.

SeaMountain Farms is an underutilized resource and C. Brewer is exploring development alternatives in a manner that is compatible with the Ka'u community as a whole.

4. <u>Community Development</u>

Objective: Provide for an appropriate mix of housing opportunities to support the future growth and development in the region.

The towns of Pahala and Na'alehu provide the primary urban centers around which the region of Ka'u functions. Together they house nearly 80 percent of the district's population and both have experienced only moderate population growth in the last ten years. This lack of growth is due to the slow pace of economic growth in the region and has resulted in a limited inventory of new housing units.

C. Brewer recently completed two housing projects in Pahala, one at Pahala Unit X with the County Office of Housing and Community Development (OHCD) and an expansion program for the elderly housing project, also with OHCD, for a total of 40 new units (36 single family and 8 elderly). In addition, property north of Paauau Stream is planned for future residential development and is so designated on the County General Plan.

In Na'alehu, most of the future residential expansion area provided for in the County General Plan is located south of the existing town toward what was once proposed as a bypass highway. These lands, although easily developable, do not provide a wide enough range of environment and other residential characteristics that make them desirable to a broad range of potential residents.

Lands mauka of Na'alehu, overlooking the town and the pasture lands of South Point, provide a more desirable location for urban and/or rural expansion than the flat exposed lands makai of town. Both areas have value for future housing and the resulting mix of residential alternatives will have a positive effect on the housing market in general.

Over the next 10 years C. Brewer is considering several housing developments in both Na'alehu and Pahala to meet the needs of employees in both the agricultural and resort industries. In short, the primary community development strategy in Ka'u will be to provide opportunities for growth in a character that is consistent with an existing urban and rural mix and that seeks to intensify the agricultural uses of lands that might not otherwise be put to use under existing corporate agricultural efforts.

5. <u>Hawaii Space Port</u>

Objective: Cause the construction of a space port in the vicinity of Kahilipali Point (near South Point) through the donation of 500 acres of land to any public and/or private agency or group that would utilize these lands for that and related space service uses.

The South Point area has advantages geophysical characteristics which provide for both equatorial and polar orbit access to space. C. Brewer has offered to provide up to 500 acres from its lands in the South Point area to an entity which will cause a Space Launch facility to be developed there.

[Note: Since announcing its intentions regarding a space launch facility in Ka'u, the state has taken on the role of promoting the facility and has conducted feasibility and preliminary site selection studies. The analyses included in this EIS include the establishment of the space launch facility where appropriate and sufficient information is available to allow analyses to be made.]

3.2 PUNALU'U RESORT PROJECT OBJECTIVES

Within the context of C. Brewer's regional development plan described above, C. Brewer Properties' Punalu'u Resort objectives are: (1) to develop a high quality, medium density resort community at Punalu'u which is economically viable; (2) to continue to provide a substantial amount of employment opportunities within the community; and (3) to improve the overall economic and social well-being of the community to the advantage of the region as well as the developer. Punalu'u would be a human scale, pedestrian oriented, low rise integrated resort community.

Further, it is the developer's intent to preserve and protect significant cultural, social, recreational and ecological features of the Resort area. As such, the Resort community would include significant on-site cultural and historical features that would be described and explained to visitors and residents through a self-guided, interpretive tour utilizing appropriately placed displays and signs. The ecological importance of the beach areas, coastal ponds and offshore areas, as habitats for several species of endangered or threatened birds and turtles, also would be described and explained through the use of appropriately placed displays and signs (see Appendices A, H and I).

The resort community would be a significant component of the visitor industry in East Hawaii and provide needed stability to East Hawaii's economy. East Hawaii's economy presently is dependent on agricultural operations including sugar, macadamia nut, ranching and fishing and service operations in Hilo and outlying communities.

To achieve the project objectives, it is necessary to amend the Hawaii County General Plan at this time, and in the future to change the zoning, and obtain a Special Management Area (SMA) permits to relocate Punalu'u Road and relocate golf holes to allow the development of Punalu'u Village and associated Village Hotel as the central focus of the resort development and the Punalu'u Black Sand Inn.

The Master Plan for Punalu'u improves land use efficiency and consequently the Resort's potential for long term economic viability. The Plan also increases the quality of the resort experience by unifying the resort and providing a cohesive "sense of place" at a human/village scale.

3.3 DESCRIPTION OF PROPOSED RESORT DEVELOPMENT

The proposed Resort development is described in comparison to the existing facilities development in the following paragraphs. As noted previously, a substantial portion of the Resort infrastructure and facilities are in place. The proposed development project would add to those facilities and modify infrastructure components to support the proposed project.

3.3.1 Existing Resort Development

As noted previously, Punalu'u Resort presently includes an 18-hole championship golf course and driving range; a golf clubhouse and associated golf cart storage area and a parking lot that also serves visitors to the Ninole Cove side of the Resort; the 76-unit Colony I condominiums; Black Sand Restaurant and parking lot that serve visitors to the Resort as well as residents of the area; the Aspen Institute of Humanistic Studies that provides meeting facilities for Big Island as well as off-island groups; four tennis courts and a convenience store that serve the Resort and visitors to the beach park; The Ka'u Center of History and Culture with an interpretive display of the Punalu'u area in prehistoric times as well as artifacts found during archaeological surveys of the area; the 19-lot Kalana I single family residential subdivision mauka of the Belt Highway; a secondary sewage treatment plant and associated underground wastewater collection system that serves the entire Resort with the exception of the beach pavilion and golf clubhouse; Public Utilities Commission regulated underground potable water distribution system, electric, telephone and cable TV systems; and the county Punalu'u Beach Park complete with pavilion, showers, restrooms and adjacent parking lot. Additionally, there is a Resort maintenance center, an internal private roadway system serving the various Resort facilities and the Hawaiian Evangelical Association Cemetery, including a chapel and shrine. Refer to Figure II-3.

3.3.2 Resort Master Plan

The Resort Master Plan is shown on Figure II-11. As shown on Figure II-9, current zoning for the Resort would allow development to proceed in several areas. The rezoning that will be proposed in the future and rearrangement of the facilities would provide a more effective land use plan and would allow the

VC — VILLAGE CENTER/MIXED USE	SF — SINGLE FAMILY RESIDENTIAL
HOTEL SITES/MIXED USE	MF — MULTI-FAMILY RESIDENTIAL
SC — SERVICE CENTER/MIXED USE	PEDESTRIAN NETWORK
GOLF CART PATHS	

RESORT MASTER PLAN

Punalu'u Resort

NORTH SCALE 200 0 200 600 FEET

pbr

FIGURE II-11

developers to develop the human scale, pedestrian-oriented, low-rise integrated resort community to maximize the economic, social, cultural, recreational and ecological protection opportunities of the area to the benefit of the community and developer.

As depicted in Figure II-11, the coastal development of the resort includes the development of the Village Hotel, Punalu'u Village, modifications to the existing golf clubhouse, Punalu'u Black Sand Inn, golf course holes, Punalu'u Beach Park improvements, and related infrastructure modifications.

As proposed, the development areas of the Resort would utilize approximately 50 percent of remaining lands to be developed (433 acres) with the remaining areas maintained as open space (golf course, parks and roadways). Assuming 25 percent building coverage in the single family residential areas, and a 50 percent building coverage on the resort hotel, multi-family residential and commercial areas, the Resort development at completion will utilize less than 25 percent of the entire Resort area for buildings. Approximately 30 acres of the 433 acres will be improved as landscaped open space.

The proposed master plan (Figure II-11) components and their relationship to each other are described in the following paragraphs.

3.3.2.1 Realignment of Punalu'u Road (Alanui Road)

Punalu'u Road (Alanui Road) presently intersects with the Hawaii Belt Highway and loops through the Resort and connects with the County Punalu'u Road. The main resort entrance intersection is signed and landscaped and provides the visitor with the first impression of the beauty of the Punalu'u. The road winds makai downslope alongside golf course fairways and greens towards the Colony I condominiums, golf clubhouse, beach park, Black Sand Restaurant and the Ka'u Center of History and Culture. The proposed project includes the relocation of approximately 6,800 lineal feet of Punalu'u Road and Ninole Cove Place which intersects with Punalu'u Road and leads to the golf clubhouse and parking lot. Punalu'u Road would be relocated mauka approximately 800 feet behind the top of the central bluff above the beach park to allow development of the Village Hotel and Punalu'u Village, a mixed use resort/condominium, commercial and recreational area described below. Vehicular and pedestrian access to the expanded beach park would be maintained, and the beach parking lot expanded. The cemetery would remain with access improved via Punalu'u Road and Punalu'u Village promenade. Realignment of Punalu'u Road would allow golf holes No. 8 and No. 9 to be relocated below the bluff.

Realignment of the roadway would also include relocating the underground utilities that are in the roadway right-of-way, the installation of a tsunami/storm wave warning system and the installation of street lights along the makai side of the road. The street lights would be back shielded to reduce the level of light seen from and directed on the beach areas. Also, pedestrian walkways and golf cart paths would exit off of the realigned roadway to allow access to Punalu'u Village.

3.3.2.2 Golf Course Modifications/Relocation

Realignment of Punalu'u Road would allow golf holes No. 8 and No. 9 to be relocated below the bluff to take advantage of the coastal fringe of the Resort and to increase the beauty and the difficulty and challenge of the course. The relocated 8th and 9th golf holes would incorporate coastal pond No. 1 and the dry mauka pond which, for safety and wildlife habitat protection purposes, would be buffered by landscaping. Similarly, the 8th and 9th hole fairways would be lined by landscaping to set them off from the adjacent beach park and shoreline areas and provide a safe buffer zone.

Relocation of the 8th and 9th golf holes and realignment of Punalu'u Road would also entail lengthening golf hole No. 1 and the relocation of the 2nd, 3rd and 4th golf holes. The 2nd golf hole would be relocated to the west and run parallel to the east side of Punalu'u Road. The 3rd golf hole would also be relocated westerly, with the tee area immediately off of the 2nd hole green. In addition, the 3rd golf hole would be shortened to a par 3 hole. The 4th golf hole would be realigned slightly, but essentially remain in its present location.

Relocating the 8th and 9th golf holes to the coastal area and the 2nd and 3rd golf holes to the westerly and northerly portions of the Resort opens the central area to allow for development of Punalu'u Village and multi-family residential units along the golf course, expansion of the tennis center, development of a grassed playfield, and preservation of a heiau (Lanipao). The golf course modifications also increase the playability and challenge of the course.

3.3.2.3 Public Access

Public access to Punalu'u Resort would essentially remain unchanged (see Chapter IV, Section 5.1.3). Punalu'u Road (Alanui Road) would continue to be the primary entry/exit point for both visitors and residents of the Resort and the general public that would be using the beach park and other public areas. Access to the beach park would be modified and the parking lot would be expanded as would the beach park. Access to the Ninole

Cove area would also remain essentially the same as it is with parking provided in the golf clubhouse parking lot. Access would be provided to the existing jeep trail that leads across Ninole Stream to the State lands. Pending State Board of Land and Natural Resources approval, a vehicular access road to the shoreline area on the east side of the Ninole Cove area would be provided along with a parking area to allow fishermen, picnickers and others the opportunity to drive directly to the shoreline. Vehicular access beyond the roadway and parking area would be restricted to protect the beach plants, coastal pond organisms, birds and the endangered Hawksbill turtle which is known to nest in the sand areas along the front of the Resort and for continued use of the shoreline by people.

Access to Punalu'u Beach Park and parking lot would be relocated mauka of the private lands adjacent to the park. The expansion of the beach park parking lot from its present 35 parking stalls to 50 parking stalls would accommodate the expected increase in park users without significantly increasing walking distance to the park facilities.

Vehicular access to the Hawaiian Evangelical Association cemetery would be provided through Punalu'u Village while pedestrian access would be through the Punalu'u Village or a pathway from the beach park that would parallel the relocated 8th golf hole.

Vehicular access to the boat launch ramp would be essentially the same as it is at present, with the exception that a more direct access route will be provided through the Punalu'u Black Sand Restaurant/Inn parking area.

Additional public access information relative to easement agreements, old Government Road and old Government Trail is provided in Chapter IV, Section 5.1.3.

3.3.2.4 Public Shoreline Park

Punalu'u Beach Park, a county beach park that would be dedicated in fee to the County by CBP, would be reconfigured, expanded and improved to accommodate expected increased usage by both residents of the Big Island as well as visitors to the Resort. New grass areas, with appropriate landscaping, would be established as would specific overnight and day camping areas. The present pavilion and restrooms would be retained and a new covered pavilion constructed. Additionally, displays and interpretive signs regarding the archaeological, historical and ecological importance of the Punalu'u shoreline areas would be erected at appropriate locations in the park. With access to the shoreline areas limited to pedestrians, a series of shoreline and beach trails would be established to direct public access to those areas that are outside of ecologically sensitive wildlife habitats and would provide lateral shoreline access along the entire shoreline. Shoreline fishing and food gathering practices would not be restricted.

Access to the interior portions of Punalu'u Village and the multi-family residences would be via pedestrian and/or golf cart paths. Vehicles, with the exception of commercial establishment service and emergency vehicles and those traveling to the cemetery, would be restricted.

3.3.2.5 Punalu'u Village

Setback 400 to 800 feet from the shoreline and set atop the coastal bluff, the Punalu'u Village would be planned to be the focal point of the Resort and consist of 240 to 400 hotel/condominium accommodation units on the approximately 20 acres of the village site. Designed as multi-family residential units, some of the units would be operated as hotel suites for resort visitors while others may be owner occupied. As viewed from the coastal area (Figure II-12) the architecture of the Village would be a contemporary version of Hawaiian plantation town architecture. There would be other visitor accommodations at the Resort, but the main point of arrival would be the Village itself. The Village would be comprised of clusters of one to four-story building structures that define a pedestrian promenade through the commercial area of the village. Automobile arrival points and parking areas would be provided at each end of the promenade.

In the center of the Village promenade there would be a village square, framed on the makai end by the cemetery and chapel and on the mauka end by an elaborate water feature, as characterized in Figure II-12, that would provide swimming areas, water play areas and sunning areas. The promenade, water areas and greenspace would form an additional visual and pedestrian link between the loop road (Punalu'u Road) and the village square. The buildings along the mall and water play areas would be of mixed commercial and residential/visitor accommodation uses, with the commercial shops, various dining places and visitor service facilities on the ground floor and the residential units/visitor accommodations stepped above, much in the fashion of Mediterranean hill towns. The mixed uses along the promenade and water play areas would give the Village a sense of scale and village character. The water play and associated sunbathing areas would be designed to be the primary "beach" and water contact areas for the Resort, thereby reducing pressure on the coastal areas and county beach park facilities.

VIEW OF WATER PLAY AREA LOOKING MAUKA

CHARACTER SKETCH OF PUNALU'U VILLAGE

Punalu'u Resort

KA'U, ISLAND OF HAWAII

THOMAS WELLS & ASSOCIATES/ARCHITECTS pbr

FIGURE II-12

3.3.2.6 Village Hotel

The Village Hotel would be planned to be a 350 to 425 room hotel adjacent to and integrated with Punalu'u Village on the approximately 36 acre village site. Entry to the hotel would be on the north with an entry drive from Punalu'u Road with the primary view area being towards Ninole Cove and the coastal golf holes and ponds and the open ocean. Setback a minimum of 450 feet from the shoreline and on the bluff overlooking the ocean, the hotel would be designed to maintain some view corridors of the mauka views from the shoreline and would be heavily landscaped to soften its visual impact. The hotel would include dining and lounge areas, commercial shops, swimming pool and snack bar area, meeting facilities and standard hotel service facilities. Parking would be provided in a stepped, heavily landscaped parking structure mauka of the hotel. The hotel would be above the tsunami and high wave inundation elevation and design precautions would be taken to minimize seismic hazards. Total land area to be occupied by the hotel would be approximately 16 acres. All structures will be below the 45-foot height limit measured from the average final grade. The buildings will be designed to minimize the view obstruction from the mauka resort areas and along the shoreline.

3.3.2.7 Punalu'u Black Sand Inn

Punalu'u Black Sand Inn, to include the existing Black Sand Restaurant, would be designed to be a 150 to 210 room inn type hotel on the approximately 11 acre site. Entry to the inn would be on the mauka side and the primary view plane would be over the existing Punalu'u lagoon, black sand beach and ocean. Setback approximately 150 to 210 feet from the shoreline, the inn would incorporate the existing restaurant and have a swimming pool and snack bar area. Meeting rooms and commercial shops would also be provided in the complex. Parking for the inn would be provided on-site where the existing restaurant parking lot exists and would be heavily landscaped. Total existing zoned land area to be occupied by the inn and existing restaurant would be approximately seven acres. The existing restaurant and kitchen facilities would remain at the existing +15-foot elevation with all new structures elevated to the +22-foot base flood elevation. All structures would be below the 45-foot height limit measured from the average final grade. Extensive water features and lush tropical landscaping would provide a tranquil setting for the inn as characterized in Figure II-13.

3.3.2.8 Multifamily Residential Sites/Condominiums

Multifamily residential/condominium units would be located in the Colony II, Ninole Bluffs, Kalana, Central Fairway, Punalu'u Village areas and westerly of the Village Hotel and include a total of approximately 123 acres. The majority of the units would be located in the Central area. The total number of units would range from approximately 1240 to 1870. It is expected that some of the units would be owner occupied while others would be used as second homes or placed in a Resort rental pool. The units would be clustered, low rise structures, with appropriate landscaping and other amenities complimenting the rest of the Resort. Cart paths and pedestrian trails would provide connections between the various sites and facilities of the Resort.

3.3.2.9 Single Family Residential Sites/Development

Additional single family residential sites would be located in the Kalana area mauka of the Kalana I subdivision. A total of approximately 45 acres (70 to 80 lots) would be developed. The lots would be served by underground sewer, water, telephone and cable TV systems and include paved streets. The single family residences would be developed and maintained by individual owners, in accordance with Resort design covenants and restrictions. The minimum allowable lot size would be 15,000 square feet. It is expected that the majority of the residences would be owner occupied, with others used as second homes or as long-term rentals.

3.3.2.10 Support Facilities

The Resort support facilities that would be included with the commercial, residential and recreational facilities development include modifications to the existing golf clubhouse to develop an expanded clubhouse; Lagoon Club, Punalu'u Village service center, a health spa and an enlarged tennis center along with the other commercial and recreational amenities of the Resort. The Lagoon Club would be a dining and lounge club that would include a swimming pool and deck, locker and exercise rooms. The Lagoon Club would also include meeting rooms and would be available for shows and stage presentations. The existing golf course and driving range, as with the Lagoon Club would be open to the public. Punalu'u Village service center would provide commercial services to the Resort including supplies and convenience services such as a service station, laundry center and village market. The tennis center would feature 12 championship tennis courts and a support clubhouse and pool which would also be open to the public. The health spa would be developed to provide those guests that are at the Resort

VIEW FROM EDGE OF POND LOOKING MAUKA AT EXISTING RESTAURANT AND FUTURE INN

CHARACTER SKETCH OF PUNALU'U BLACK SAND INN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

ARCHITECTS HAWAII LTD. pbr

FIGURE II-10

for retreat purposes, a place to exercise and improve their overall health and well being. The spa would also compliment the golf course and tennis facilities and provide additional recreational activities that are generally not presently available at other resorts in Hawaii. Other Resort support facilities that are planned include a performing arts center, hula and luau areas and an art gallery.

3.3.2.11 Other Resort Amenities

Other Resort amenities to be included in the development include the numerous archaeological and historical sites that will be integrated within the overall Resort along with interpretive displays and signs depicting the sites, their history and importance. Similarly, displays and signs regarding the ecological importance of the Punalu'u area will be placed at appropriate locations near the shoreline to inform visitors and residents about the wildlife and plants that are found at the Resort and the need to protect and preserve those elements of the Resort. The shoreline and ocean areas of the Resort would offer residents and guests additional recreational opportunities, and, as noted previously, the county park would feature picnicking, sunbathing and camping areas.

3.3.2.12 Proposed Land Use

At completion of the remaining undeveloped Resort property, under county zoning designations, there will be a total of approximately 27 acres of land devoted to resort hotel use, approximately 20 acres devoted to hotel/condominium use; 23 acres of land devoted to service and commercial activities; 45 acres devoted to single family residential use; 123 acres devoted to multi-family residential use; and 195 acres of open space (including golf course, parks and roadways). At present, there are about 27.9 acres zoned resort hotel, 4.7 acres zoned commercial, 17 acres zoned single-family, 19.4 acres zoned multi-family, 118.1 acres zoned agriculture and 245.4 acres zoned open space. Refer to Table II-2.

The entire proposed project area is presently classified as Urban under the state land use designation. No changes are proposed to this designation.

3.3.2.13 Need For General Plan Amendment

A petition for an amendment to the Hawaii County General Plan to redesignate approximately 65 acres from Low Density to Medium Density (45 acres) and Open Area (20 acres) on the mauka portion of the Resort. The real property for which the amendment is sought is situated at Punalu'u, Ka'u, County of Hawaii, State of Hawaii, Tax Map Key 9-5-19:24 portion. The present General Plan Land Use Pattern Allocation Guide (LUPAG) designation for this property is Low Density (Figure II-7).

The total land area of the parcel is approximately 108 acres. However, the proposed amendment only encompasses approximately 65 acres of the parcel; 40 acres to be changed from Low Density to Medium Density and 25 acres to be changed from Low Density to Open Area. This amendment to the General Plan's Land Use Pattern Allocation Map will allow for the future zoning of the mauka area to allow for a mixture of single-family residential lots and multi-family residential units around the existing golf course as shown on Figure II-8.

The reasons supporting the proposed amendment are discussed in terms of the twelve elements of the General Plan.

(1) Economic Element: One of the "Courses of Action" for the Ka'u District states:

> "Resort development in Ka'u shall be kept in balance with the social and physical environment of the area. Provisions for orderly development housing, and pollution controls shall be implemented." (General Plan, p.15.)

Environmental studies have been conducted within the project site. Based on the Resort master plan, the design of the project would mitigate potential significant impacts. Necessary support facilities such as water, wastewater, drainage, and roads have been included in the project plans. This EIS has been prepared to allow the public to review and provide input on the potential environmental impacts that might result from the proposed project. Provisions for orderly development, housing and pollution controls would be included in the implementation plans for the resort.

(2) Environmental Quality: Pertinent language in the General Plan that is applicable to private development proposals is contained under "Standards":

> "Clean air, pure water, freedom from excessive and unnecessary noise, and the natural and aesthetic qualities of the environment shall be without abridgment the right of the people of the County. Pollutants shall be prevented, abated, and controlled at levels which will protect and preserve the public health and well-being, and for the prevention of irritation to the senses, interference with visibility, and damage to vegetation, animals, and property. The existing environmental quality of the island shall be maintained and if feasible, improved." (General Plan, p. 17.)

(3) Flood Control and Drainage: The General Plan discussion for the Ka'u District (General Plan, p. 23) recognizes that flooding due to storm runoff is a problem. The necessary setbacks and structural floodproofing would be incorporated into the site plan and building designs.

(4) Historic Sites: The General Plan lists several historic sites in the Ka'u District that may be significant (General Plan, p. 27). None of these listed sites are located within the project site.

There have been archaeological reconnaissance surveys conducted within the project site (see Appendix A). Sites determined to be significant and requiring preservation would be integrated into the site plan in accordance with the consulting archaeologists recommendations as stated in Appendix A.

(5) Housing: The "Courses of Action" for the Ka'u District states:

- Aid and encourage the development of a wide variety of housing for this area to attain a diversity of housing mix.

- Encourage the sugar companies to continue their assistance in providing employees with suitable housing before phasing out the rental housing market.

- Since many of the lands in and around the existing communities are owned by the sugar companies, they should be encouraged to make lands available for the private market. (General Plan, p. 39.)

The residential component of the proposed project consists of single family and multi-family residential units. Additionally, C. Brewer owns other lands in the area that are suitable to be developed for housing.

(6) Natural Beauty: The General Plan lists scenic landmarks in the Ka'u District (General Plan, p. 43). Included within the list are Ninole Cove and Springs and Punalu'u Black Sand Beach both of which are makai of the subject area. Therefore, the design of the project would include appropriate setbacks and pollution control measures to protect the water quality of these examples of natural beauty in the Ka'u district.

(7) Natural Resources and Shorelines: The General Plan includes "Standards" for the protection and conservation of natural resources (General Plan, p. 44-45). The proposed project conforms with these standards. Native plants and wildlife would be protected by integrating the use of native dry land plant species into the landscape.

(8) and (9) Public Facilities and Utilities: The Developer would construct all necessary facilities for sewage, water, drainage, roads, electrical, and telephone. The existing sewage and water facilities are maintained privately. Educational and health care facilities in Ka'u would be relied upon.

(10) Recreation: The pertinent "Courses of Action" in the General Plan for the Ka'u district include the following:

- Encourage the establishment of the Punalu'u-Ninole Springs region as a recreation area. (General Plan, p. 68.)

Recreational facilities within the Punalu'u Resort including the Punalu'u-Ninole Springs would be available for visitor or resident use include the existing golf course and tennis center.

(11) Transportation: All proposed roads would be constructed to County standards, as modified for Resort purposes, to ensure safe and efficient circulation.

(12) Land Use: The purpose of this petition is to seek the necessary amendments to the LUPAG map to redesignate a portion of the "Minor Resort" at Punalu'u so that the General Plan for the mauka portion of the resort would be in conformance with the proposed master plan. The amendment is consistent with the Land Use element goals (General Plan, p. 77) as follows:

- The proposed project will not cause significant social, cultural, or physical impacts;

- No prime agricultural lands are affected;

- No forest, water, natural, or scientific reserve will be affected.

According to the standards in the "Resort" section (General Plan, p. 95), the Punalu'u Resort is classified as a "Minor Resort Area" and the subject area requiring a General Plan amendment is a portion of this resort.

3.3.2.14 Need For Change of Zoning

The future requests for rezoning at Punalu'u Resort will facilitate the completion of the Resort in a form most beneficial to the community and the developer. A sagging economy and poor market conditions together with the 1975 tsunami caused a re-evaluation and redesign of the Resort. The new Resort Master Plan required the acquisition of 64.7 acres of Bishop Estate lands in order to implement the new plan, thereby causing further delays in completion of the Resort. For these reasons the project has not met anticipated levels of development.

The following six points are the primary reasons for future change of zone requests:

(1) The proposed zoning will reflect the demonstrated need for a more diverse range of land uses which will help to create an economically and socially viable Resort.

(2) It will be essential to reconfigure the present zoning designations (Figure II-9) in order to implement the new Resort Master Plan which is more sensitive to the natural features of the site and environmental conditions of the area. Punalu'u Road and five golf holes require relocation to provide for an improved resort design and land use efficiency.

(3) Certain presently zoned parcels are not considered usable because they do not conform to the new Resort Master Plan and thus would encumber any future opportunities to achieve a successful destination resort.

(4) To bring recently acquired Bishop Estate parcels into conformance with the new Resort Master Plan.

(5) Based on the existing infrastructure, the scale and cohesive nature of planned development, the entire Resort is planned to be zoned in accordance with the master plan to provide the necessary flexibility to facilitate the timely completion of the development.

(6) The potential economic growth and employment generated from the proposed project will contribute significantly to the economic vitality and well-being of the Ka'u District and the County.

The proposed future change of zoning requests, as depicted in Figure II-10, will be consistent with all pertinent goals, policies, standards and courses of action of the County General Plan and related rules, regulations and requirements as outlined by appropriate state and county agencies.

3.3.2.15 Need For Special Management Area Permit (SMA)

A Special Management Area (SMA) Use Permit Petition will be filed with the County of Hawaii Planning Department-Planning Commission for further development of Punalu'u Resort. Although an Environmental Impact Statement (EIS) is not statutorily required for a SMA Permit, this EIS has been prepared, in part, to support that petition as well as other necessary permits that may be required. Additional informational documents, including additional environmental impact information, will be prepared and submitted as required and requested by approving agencies at the time the SMA permit application(s) are prepared and submitted. The proposed Resort development involves site improvements to facilitate the completion of the approximately 433-acre Resort. The proposed project is described in detail in other chapters and sections of this EIS. The major portion (approximately 325 acres) of the Punalu'u Resort lies on the makai side of the Hawaii Belt Highway and is within the Special Management Area as designated by the County of Hawaii.

The proposed project will include improvements within the SMA including the modification of the existing Resort infrastructure (Figure II-14) to provide for the reallocation of density to conform to the natural features of Punalu'u. The project will also improve existing conditions of the shoreline while protecting and preserving other important natural resources which are an integral part of the project area.

3.3.2.16 Need For Conservation District Use Permit (CDUP)

A Conservation District Use Permit (CDUP) for the proposed project will be required to (1) allow improvements to be made to the county beach park, (2) allow the establishment of trails and pathways in environmentally sensitive areas along the shoreline, (3) allow the clearing and restabilization of shoreline portions of Punalu'u Lagoon that are within the Conservation District and, (4) to allow development of a vehicular access roadway and parking area on the easterly side of Ninole Cove to provide fishermen, picnickers and others the opportunity to drive directly to the shoreline. A Conservation District Use Permit Application (CDUA), supported in part by this EIS, will be filed with the State of Hawaii Board of Land and Natural Resources upon completion of on-going engineering design studies. These studies, along with this EIS, will describe the proposed work and the environmental protection measures that will be taken to minimize potential adverse environmental impacts.

Concurrent with filing of the CDUA, a U.S. Army Corps of Engineers Permit Application, in compliance with Section 10 of the Rivers and Harbors Act of 3 March 1899, will be filed with the U.S. Army Engineer District, Honolulu, for the proposed work that will reconnect coastal Pond No. 1 and the dry mauka pond. This work is limited to the removal of the man-made earthen barrier presently separating the two "ponds" and a general clean up where silting and undesirable plant growth have occurred. The permit application will also be supported by this EIS and any

LEGEND:

EXISTING	NEW	
6"W	6"W	WATER LINE & SIZE
12"S	12"S	GRAVITY SEWER LINE & SIZE
6"FM	6"FM	SEWER FORCE MAIN & DIRECTION
24"D	24"D	DRAIN LINE & SIZE
E&T	E&T	ELECTRIC & TELEPHONE

MASTER INFRASTRUCTURE PLAN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

NORTH 200 0 200 600

pbr

FIGURE II-14

supplements thereto as required. At this time, based on preliminary discussions with Corps of Engineer personnel, it is believed that the reconnection work would fall under the specifications and limitations of General Permit PODCO-O GP 82-1. However, a final ruling on the type of permit required will be made upon filing of the permit application and a review of that application by appropriate federal agencies.

3.4 NEED FOR THE PROJECT: MARKET ASSESSMENT

3.4.1 Introduction

This section assesses market demand for the developments proposed at Punalu'u Resort. The subsections below summarize trends in the visitor industry, statewide and on the island of Hawaii, and present the market analyses for the hotel, multi-family condominium and single-family projects proposed.

3.4.2 Visitor Industry Trends

Visitors are the largest source of income to the State of Hawaii, contributing over $4.9 billion to the state economy in 1985. The Hawaii Visitors Bureau (HVB) estimates and reports visitors to the state, separating visitors in terms of travel direction. Westbound visitors are defined as those arriving from North America and traveling to Hawaii and other destinations in the Pacific and Asian areas. Eastbound visitors are defined as those visitors traveling from Asia (primarily Japan) and the Pacific to Hawaii.

3.4.2.1 Statewide Visitor Arrival Trends

Total overnight visitors to the State of Hawaii have grown at 19.4 percent compounded annually from 1960 to 1970, 8.5 percent from 1970 to 1980 and at 6.1 percent per annum since 1980, as shown in Table II-3. Visitor arrivals growth slowed in 1980 and 1981, following a national slowdown in economic growth, a United Airlines strike and rapidly escalating fuel and air travel costs. Declining visitor arrivals in these years were most evident among westbound visitors, as also shown in the table. Annual growth in visitor arrivals since 1981 have ranged from a low of 0.3 percent in 1985, due to another United Airlines strike, to a high of 14.8 percent in 1986, totaling 5.6 million overnight visitor arrivals. 1987 appears to be showing little growth over 1986.

TABLE II-3

Overnight Visitors to the State of Hawaii

1960 to July 1987

Year	Westbound Number	Westbound Annual percentage growth	Eastbound Number	Eastbound Annual percentage growth	Total	Average annual percentage growth
1960	250,795	- %	45,722	-%	296,517	- %
1965(1)	567,218	17.7	119,710	22.3	686,928	18.6
1970	1,326,135	18.5	420,835	28.6	1,746,970	20.5
1975	2,207,417	12.1	621,688	15.4	2,829,105	13.0
1976	2,551,601	15.6	668,550	7.5	3,220,151	13.8
1977	2,763,312	8.3	670,355	.3	3,433,667	6.6
1978	3,030,999	9.7	639,310	4.6	3,670,309	6.9
1979	3,139,455	3.6	821,076	28.4	3,960,531	7.9
1980	3,046,132	(3.0)	888,372	4.4	3,934,504	(0.7)
1981	2,974,791	(2.3)	959,832	8.0	3,934,623	- (2)
1982	3,278,519	10.2	964,400	.5	4,242,919	7.8
1983	3,395,880	3.6	972,000	0.8	4,367,880	2.9
1984	3,721,380	9.6	1,134,200	16.7	4,855,580	11.9
1985	3,708,610	(0.3)	1,175,500	3.6	4,884,110	.3
1986	4,257,200	14.8	1,349,320	13.7	5,606,520	14.8
1987 (January to July)	2,473,200	(3.6)(3)	878,190	15.2(3)	3,351,390	.7
Compound annual percentage increase:						
1960 to 1970		18.1		24.9		19.4
1970 to 1980		8.7		7.8		8.5
1980 to 1986		5.7		7.2		6.1

N/A Not applicable.
(1) Visitor statistics collection system was revised in 1964.
(2) Not significant.
(3) Represents change from same period in previous year.

Source: Hawaii Visitors Bureau, annual and monthly reports.

3.4.2.2 Neighbor Island Visitor Arrival Trends

Prior to the development of resorts on the neighbor islands, visitors to Hawaii primarily stayed in Waikiki. With the development of resort destination areas on the neighbor islands, increased marketing efforts, the provision of "common" air fares and direct flights to the neighbor islands from the U.S. mainland, travel to the neighbor islands has grown dramatically.

Island Market Shares: In 1970, 94 percent of westbound travelers visited Oahu, but this figure has since declined to about 71 percent, as shown in Table II-4. Making up this difference, westbound visitors to Maui County have increased most rapidly, from 34 percent of statewide westbound visitors in 1970, to 46 percent in 1987, as also shown in the table. Maui has achieved this growth primarily through the successful development and marketing of destination resort areas and public policy supportive of the industry. By contrast, the island of Hawaii has lost market share over this period, from 36 percent of westbound visitors to the state in 1970, to about 20 percent in 1987 as also shown in the table. This decline, however, has occurred because Hilo was formerly a common point of landing for westbound carriers entering the state, as well as because of the increasing competitiveness of the other neighbor island destinations.

Length of Stay: With the increasing visitor attractions and facilities on the neighbor islands, average lengths of stay have also increased considerably. This is again, most noticeable on Maui, the first island to develop and market full amenity destination resort areas.

Between 1970 and 1986, average length of stay on Maui increased by 3.3 days, as shown on Table II-5. Kauai also showed a considerable increase, from 2.7 days in 1970, to 5.3 days in 1986, as also shown in the table. In contrast, lengths of stay on the islands of Oahu and Maui, which have lagged in the development and marketing of destination resorts, have increased only modestly over the period with the more aggressive pursuit of visitor industry development. The island of Hawaii may also be expected to realize significantly increased lengths of stay in future years.

Island of Hawaii: Westbound arrivals to the island of Hawaii increased at an average 5.5 percent per annum between 1970 and 1980, but declined by an average .6 percent per annum between 1980 and 1986 due to the significant loss of visitors in 1985 resulting from the United Airlines strike, as shown in Table II-6. As in the rest of the state, arrivals in the first months of 1987 were showing slight improvement over 1986. Hawaii

County's slow visitor growth has been due to its relatively slower facility development, historically greater dependence on agriculture and less prominent market image among westbound travelers compared to the other neighbor islands.

TABLE II-4

Percentage of Westbound Visitors
Visiting the Major Hawaiian Islands

1970 to May 1987

Year	Oahu	Hawaii	Maui(1)	Kauai
1970	94.0%	35.6%	33.8%	30.9%
1975	85.6	34.9	42.2	28.7
1976	85.0	32.0	43.5	27.4
1977	83.1	30.4	45.5	26.8
1978	82.3	30.0	46.3	27.6
1979	81.0	27.4	45.2	26.3
1980	78.7	25.0	45.2	25.7
1981	80.6	22.6	45.2	24.6
1982	79.0	20.7	49.1	23.2
1983	76.3	21.0	50.1	21.1
1984	78.0	20.4	49.7	21.7
1985	76.3	18.8	49.4	22.4
1986	73.8	18.5	47.0	23.8
1987 (January to May)	71.3	19.9	45.7	24.4

(1) Includes the island of Molokai.

Sources: Hawaii Visitors Bureau, Annual Research Report, annual and monthly. Figures reported represent percentage of the state's visitors who intended to visit each island; most tourists visit more than one island during their stay in Hawaii.

TABLE II-5

Average Intended Length of Stay of Westbound Overnight and Longer Visitors by Island

1970 to 1986

(Days)

Year	Oahu	Hawaii	Maui	Kauai
1970	6.03	2.94	2.97	2.68
1975	5.97	3.08	3.42	2.85
1976	5.99	3.04	3.50	2.85
1977	5.88	3.13	3.62	2.97
1978	5.83	3.25	3.77	3.08
1979	5.85	3.39	4.01	3.27
1980	5.78	3.46	4.08	3.40
1981	5.91	3.56	4.13	3.48
1982	5.77	3.62	4.26	3.51
1983	6.96	4.52	5.61	4.22
1984	7.49	3.64	6.47	4.91
1985	7.24	4.21	6.36	5.03
1986	7.25	4.58	6.26	5.34
Increase from 1970 to 1986	1.22	1.64	3.29	2.66

Source: Hawaii Visitors Bureau, Research Department, July 1987.

TABLE II-6

Westbound Visitor Arrivals
to the Island of Hawaii

1970 to July 1987

Year	Percent of State westbound visitors	Visitor arrivals	Percentage increase (decrease)
1970	35.5%	445,401	- %
1975	34.9	769,779	3.6
1976	32.0	816,514	6.1
1977	30.4	839,008	2.8
1978	30.0	908,983	8.2
1979	27.4	860,940	(5.3)
1980	25.0	761,103	(11.6)
1981	22.6	672,683	(11.6)
1982	20.7	678,170	.8
1983	21.0	712,380	5.0
1984	20.4	760,940	6.8
1985	18.8	697,380	(8.4)
1986	18.5	786,940	12.8
1987 (January to July)	19.2	474,830	.2 (1)
Compound annual percentage increase:			
1970 to 1980			5.5
1980 to 1986			.6

(1) Compared to comparable period in 1985.

Source: Includes westbound overnight and longer visitors to and beyond Hawaii who indicate an intention to visit the island. Hawaii Visitors Bureau, Research Report, annual and monthly.

3.4.2.3 Visitor Characteristics

The HVB surveys characteristics of westbound visitors to the island of Hawaii. Although no survey of eastbound visitors has been made, inferences can be made based on the profile of the typical Japanese visitor to the state.

Westbound Visitors: As compared to other state visitors, island of Hawaii westbound visitors are relatively older and are more likely to be retired, as shown in Table II-7. Visitors traveling to the island also tend to stay longer in the state and are more likely to travel as part of an organized tour group. The average length of stay on the island itself is 4.2 days.

Westbound visitors to the island of Hawaii typically reside in the continental United States. The largest segment of visitors are residents of the West Coast states and Alaska which represent 32 percent of all visitors to the island. The residency of island of Hawaii visitors is similar to visitors to the state as a whole, as also shown in Table II-7.

Eastbound Visitors: Eastbound visitors are estimated to have represented less than 10 percent of visitors to the island of Hawaii in 1984. Although little specific information on these visitors is available, data on statewide Japanese visitors, also presented in Table II-7, is useful in analyzing this market. Compared to westbound visitors, Japanese visitors are significantly younger and are almost always (68.6) percent part of a tour group. Most importantly, because of their relatively short average length of stay in the islands (6 days), most Japanese visit the neighbor islands on day tours only and do not stay overnight.

3.4.2.4 Projected Visitors to the Island of Hawaii

Projections for visitors to the State of Hawaii through the year 2005 reflect continuing increases in both west- and eastbound visitors and are based on historical data and projections prepared by the Hawaii State Department of Planning and Economic Development (DPED). According to the DPED, the State could expect to receive about 6.1 million visitors by 1990 and nearly 8.2 million by 2005.

TABLE II-7

State and Island of
Hawaii Visitor Characteristics

	Island of Hawaii westbound visitors 1985	Visitors to the State of Hawaii	
		Westbound visitors 1986	Japanese visitors 1987
Median age	45.9	39.7	30.8
Occupation (percentage distribution):			
Professional and technical	36.4%	37.5%	26.9%
Business, managerial official	23.4	25.3	22.7
Clerical, office, sales	7.8	9.3	26.7
Retired	21.5	13.8	4.0
Other	10.9	14.1	19.7
Total	100.0%	100.0%	100.0%
Intended days of stay in:			
State of Hawaii	10.2	10.1	6
Island of Hawaii	4.2	-	Less than 1 day(1)
Pleasure trip (percent of total)	80.5%	82.2%	81.3%
Average party size	1.88	1.85	2.3
Repeat visitors (percent of total)	50.1%	47.2%	40.6%
Organized tour group (percent of total)	22.3%	18.0%	68.6%
Stay in hotel	59.3%	57.7%	91.6%
Stay in condominium	14.6%	21.2%	6.4%
Residence:			
United States:			
West Coast, including Alaska	31.8%	38.1%	N/A
Mountain	7.5	7.1	N/A
Central states	29.2	25.8	N/A
New England	3.8	3.5	N/A
Atlantic	19.5	17.1	N/A
Total United States	91.8	91.6	N/A
Canada	7.0	6.3	N/A
Other foreign	1.2	2.1	N/A
Total	100.0%	100.0%	N/A

N/A Not applicable.
(1) Neighbor islands are commonly visited in a one-day tour.

Source: Hawaii Visitors Bureau, Supplement to the 1985 HVB Research Report, A Study of Westbound Visitors to the Island of Hawaii; 1986 Annual Research Report; and Study of Japanese Winter to Hawaii, 1987.

Westbound Travelers: An increasing proportion of state westbound visitors are projected to visit the island of Hawaii. The anticipated increase is expected to result from increased visitor facilities development as well as the aging of the visitor plant on Oahu. As shown in Table II-8, the percentage of the state's westbound visitors traveling to the island of Hawaii is projected to reach 30 percent by 2005, reapproaching the levels experienced in the mid-60s and early 70s. This would result in a compound annual increase in westbound visitors to the island of 4.7 percent from 1987 to 2005.

Eastbound and Total Travelers: The proportion of eastbound visitors traveling to the island of Hawaii is also expected to increase, but to increase more gradually than for westbound visitors. Due to this increasing market share and the anticipated increase in the total number of eastbound visitors to the state, the number of eastbound visitors to the island could increase at approximately 5.3 percent annually from 1987 to 2005.

Growth Factors: These increases could be driven by the following factors on the island of Hawaii:

- The more rapid development of visitor facilities and amenities
- The diversification of visitor market segments served
- Improved air service to the island
- Increased and more effective marketing of the island
- Increasing disposable incomes in the areas in which visitors reside

Thus, in total, island of Hawaii tourism is expected to increase at about 4.8 percent annually, to a total of nearly two million visitors per year by 2005. Of this number, westbound visitor arrivals from the United States and Canada could continue to account for up to 90 percent of all visitors to the island of Hawaii.

3.4.2.5 State of Hawaii Resorts

Characteristics of major Hawaii resorts are reviewed to provide a prospective as to the market position of Punalu'u Resort in comparison to other Hawaii resorts. Table II-9 presents characteristics of the major destination resorts in Hawaii in terms of site area, site characteristics, existing development, visitor facility, room rates and prices, market appeal and visitor profile.

TABLE II-8

Historical and Projected Visitor
Arrivals to the State and Island of Hawaii

1970 to 2005

	Westbound			Eastbound(1)			Total visitors	
	State	Percent of state	Island of Hawaii	State	Percent of state	Island of Hawaii	State	Island of Hawaii
Historical:								
1970	1,326,135	33.6%	445,401	420,836	N/A	N/A	1,746,971	N/A
1975	2,207,417	34.9	769,779	621,688	N/A	N/A	2,829,105	N/A
1980	3,046,132	25.0	761,103	888,372	5.2%(2)	46,200	3,934,504	807,303
1983	3,395,880	21.0	739,050	972,000	4.6 (2)	44,700	4,367,880	783,750
1984	3,721,380	20.5	760,940	1,134,200	5.0 (2)	56,700	4,855,580	817,640
1985	3,708,610	18.8	697,380	1,175,500	5.0 (2)	58,800	4,884,110	756,180
1986	4,257,200	18.5	786,940	1,349,320	5.0 (2)	67,466	5,606,520	854,406
Projected:								
1987(3)	4,103,039	18.5	787,743	1,554,396	5.0	77,719	5,657,435	865,462
1990	4,461,000(4)	23.0	1,026,000(5)	1,622,300(6)	6.0	97,300	6,083,300	1,123,300
1995	5,171,700(4)	27.0	1,396,400(5)	1,880,500(6)	7.0	131,600	7,052,200	1,528,000
2000	5,709,900(4)	30.0	1,713,000(5)	2,076,300(6)	8.0	174,600	7,786,200	1,887,600
2005	6,001,100(4)	30.0	1,800,300(5)	2,182,300(6)	9.0	196,400	8,183,400	1,996,700
Projected compound annual percentage increase - 1987 to 2005	2.1%		4.7%	1.9%		5.3%	2.1%	4.8%

N/A Not available.

(1) Eastbound visitors not estimated prior to 1980.

(2) Estimated based on surveys of Japanese visitors to Hawaii county as reported by the Hawaii Visitors Bureau, Annual Research Report, 1980 and 1983.

(3) Projected based on the first seven months of 1987.

(4) Non-Japanese visitors as projected by the Department of Planning and Economic Development, State of Hawaii, less those estimated to be traveling eastbound.

(5) Compared to the mid-range "Series B" projections prepared by the County of Hawaii for the Hawaii County General Plan, the westbound arrivals projected here are slightly lower through 1990, but nearly identical thereafter.

(6) Japanese visitors as projected by the Department of Planning and Economic Development, State of Hawaii, plus 33% non-Japanese estimated to be traveling westbound.

Sources: Hawaii Visitors Bureau, Annual Research Report, 1985; ibid, Survey of Westbound Visitors to the Island of Hawaii, 1983; Department of Planning and Economic Development, State of Hawaii, Hawaii Population and Economic Projection and Simulation Model: Updated State and County Forecasts, 1984; and County of Hawaii, Hawaii County General Plan: Text (preliminary draft dated May 1986), 1986.

TABLE II-9

Characteristics of Major Destination Resorts in Hawaii

	Island of Hawaii resorts			
	Keauhou	Waikoloa Beach	Mauna Kea	Mauna Lani
Site area (acres)	890	500	1,100	614
Distance from interisland airport	12 miles (Keahole)	17 miles (Keahole)	26 miles (Keahole)	20 miles (Keahole)
Special site characteristics	Protected bay Several heiaus Burial grounds Ancient settlement areas	Protected bay 2 fish ponds Petroglyphs Burial caves Ancient trail	Isolated beaches Several heiaus Historic building	6 major fish ponds Numerous archaeological sites and artifacts Ancient trail
Existing development:				
Hotel rooms	1,302	548	310	351
Condominium units	832	66	23	136
Single-family lots	109	-	55	-
Total units	2,243	614	388	487
Amenities:				
Beach	Rocky, poor swimming, public beach nearby	White sand	White sand	Sandy, rocky bottom
Shoreline (linear feet)	13,000	7,000	14,100	14,200
Percent usable for swimming	0%	32%	32%	10%
Commercial space in shopping centers	72,088	-	-	-
Golf course holes	36	18	18	18
Tennis courts	18	6	9	10
On-site activities	Fishing, hunting, snorkeling, scuba diving	Deep-sea fishing, scuba diving, catamaran cruises, sailing, windsurfing	Deep-sea fishing, scuba diving, catamaran cruises, horseback riding, hunting	Jogging course, hiking, scuba diving, horseback riding
Hotel developments:				
Hotel class	Tourist/first-class	Luxury/first-class	Luxury	Luxury
1987 average hotel room rates(1):				
Single	\$50 - \$115	\$55 - \$110	\$300 - \$360	\$ 195
Double/triple	65 - 130	55 - 110	340 - 380	220 - 295
Typical condominium unit sales prices (1986)(2)	\$95,000 - \$179,000	\$200,000 - \$560,000	\$750,000 - \$1,300,000	\$550,000 - \$620,000
Market appeal	Activity-oriented resort which benefits from proximity to the Kailua-Kona resort area and area visitor attractions.	Golf-oriented single hotel property expected to significantly broaden its market appeal following completion of a 1,244-room Hyatt in 1988.	World-class destination resort which enjoys a wide reputation and loyal visitor base.	Quality hotel, condominium and golf course development incorporated in a unique natural setting including black lava fields and ancient fish ponds.
Typical visitor profile	Oriented to both GIT and FIT visitors from middle to upper income groups.	Resort-oriented mainly to GIT visitors and convention groups. Planned development to cater to the very upscale world-class market. Average room rates for the planned hotels range from between \$200 to \$1,000 per day.	Caters to travelers who are generally mature, very affluent and return annually.	Marketed to affluent individual visitors.

TABLE II-9

Characteristics of Major Destination Resorts in Hawaii, Continued

	Maui resorts			Kauai -	Molokai -	Punalu'u
	Kaanapali	Wailea	Kapalua	Princeville	Kalua Koi	(as currently operated)
Site area (acres)	1,169	1,450	750	1,713	1,530	599
Distance from interisland airport	28 miles (Kahului)	15 miles (Kahului)	32 miles (Kahului)	28 miles (Lihue)	11 miles (Hoolehua)	57 miles (Hilo)
Special site characteristics	Long stretch of sand beach Rock promontory	Arcuate beaches	Isolated beaches Old fishing village Historic sites	Coastal plateau with cliffs	Rock promontory Island beaches, heiaus	Lagoons and black sand beach
Existing development:						
Hotel rooms	3,756	950	194	300	292	-
Condominium units	1,330	656	528	900	78	76
Single-family lots	210	190	100	673	N/A	19
Total units	5,296	1,796	822	1,873	N/A	95
Amenities:						
Beach	White sand	White sand; excellent swimming conditions	Three sandy bars	Sandy ocean cliff; some beaches below; rough waters	White sand	Black sand and pebble; generally unsuitable for swimming
Shoreline (linear feet)	10,400	7,900	9,500	14,300	12,700	-
Percent usable for swimming	94%	N/A	39%	N/A	31%	-
Commercial space in shopping centers	79,000	40,000	22,000	66,153	-	-
Golf course holes	36	36	36	27	18	18
Tennis courts	30	14	10	-	-	4
On-site activities	Sailing, catamaran cruises, surfing	Scuba diving, excursion boats	All water sports	Fishing, horseback riding, rodeos, hiking, boating		Meeting facilities
Hotel developments:						
Hotel class	Luxury/first-class/tourist	First-class/luxury	Luxury/first-class	First-class	Tourist/first-class	Tourist class
1987 average hotel room rates(1):						
Single	\$64 - \$300	\$145 - \$175	\$175 - \$300	\$160 - \$250	\$80 - \$160	\$75 - \$ 90
Double/triple	85 - 300	165 - 195	175 - 300	160 - 250	80 - 160	85 - 100
Typical condominium unit sales prices (1986)(2)	\$150,000 - \$290,000	\$185,000 - \$1,000,000	\$180,000 - \$400,000	\$100,000 - \$300,000	N/A	N/A
Market appeal	Oriented towards hotels. An integrated resort with many attractions.	Mixture of hotel and condominium units at a wide range of prices. Strong recreational appeal due to prominent golf and tennis facilities.	Oriented to condominium unit development naturally integrated into a sloping terrain.	Oriented to condominiums and single-family lot sales, with only one hotel Resort has a rural appeal with few nighttime activities.	Appeals to visitors who prefer undiscovered destinations and golf, fishing or hunting activities.	Currently golf-oriented resort in Ka'u. Relatively isolated from other visitor activities and attractions.
Typical visitor profile	About evenly divided between GIT and FIT visitors. Primarily younger, travelers from west coast and Canada.	Wide variety of visitors including both GIT and FIT guests. Family and older visitor appeal.	Geared entirely to affluent individual visitors who return annually.	Oriented to upper and middle income travelers and second homeowners including both GIT and FIT travelers. Greater primary home ownership than elsewhere.	Oriented to Hawaii and mainland FIT visitors and package tours.	Primarily older couples from northwest and west coast states.

N/A Not available.

(1) Undiscounted room rates for major hotels or condominiums as published by the Pacific Area Travel Association, Pacific Hotel Directory and Travel Guide, June 1984.

(2) Hawaii Real Estate Investor, Multiple Listing Service and discussions with developers or realtors of the respective resorts.

Source: Compiled by Peat Marwick Main & Co. based on the Hawaii Resort Developers' Conference, Economics of Resort Development, 1983, other published sources and interviews with resort personnel.

Facilities and Amenities: As shown in the table, developments completed to date range from about 400 units or lots at the smallest (Mauna Kea, the relatively new Mauna Lani Resort and Molokai's Kalua Koi resort) to nearly 5,300 units at Kaanapali Resort. Amenities generally include golf, tennis and extensive water sports.

Three of the four resorts on the island of Hawaii cater to the luxury or first-class hotel market (Mauna Kea, Mauna Lani and Waikoloa), while Keauhou Resort caters to the tourist and first-class market. Resorts on Maui, Kauai and Molokai generally cater to a broader range of guests from economy class to the luxury market.

Market Appeal: The appeal of the resorts differs markedly between resorts. The majority benefit from locational characteristics and recreational, commercial and dining/entertainment facilities offered within the resort. Resorts which cater to the luxury traveler market typically host visitors who are older Free Independent Traveler (FIT) guests, who return year after year, while those catering to the first-class or tourist market have a broader range of age groups including Group Inclusive Tour (GIT) and package groups.

Currently none of the selected Hawaii resorts feature special programs beyond traditional activities to attract visitors to the resort and instead rely on traditional recreational amenities such as swimming, golf, tennis and commercial facilities. None of the selected resorts currently offer health or lifestyle educational programs although a few are conducting preliminary planning regarding possible health spa programs.

3.4.3 Hotel Market Analysis

This section presents the market analysis for hotel development at Punalu'u Resort. The sections below describe island of Hawaii existing and proposed visitor accommodations, average occupancy rates and projected demand for additional units and summarize the market potential for Punalu'u Resort.

3.4.3.1 Existing and Planned Hawaii Island Accommodations

Existing Development: In February 1987 the island of Hawaii had a total of 7,328 visitor units, including hotel rooms and resort condominium units. Hotel rooms represent about 71 percent of the total island's visitor plant inventory and condominium units in visitor rental pools the remaining 29 percent. Currently there are 5,226 hotel rooms and 2,102 condominium units in visitor rental pools on the island of Hawaii, as shown in Table II-10.

TABLE II-10

Distribution of Existing Visitor Accommodations
on the Island of Hawaii

February 1987

	Hotel rooms		Condominium units		Total	
	Number	Percent	Number	Percent	Number	Percent
Hilo/Honokaa	1,188	22.7%	147	7.0%	1,335	18.2%
Ka'u	13	.3	34	1.6	47	.7
Kohala	1,253	24.0	169	8.0	1,422	19.4
Kona	2,734	52.3	1,752	83.4	4,486	61.2
Volcano	38	.7	-	-	38	.5
Total units	5,226	100.0%	2,102	100.0%	7,328	100.0%
Percent of total units		71.3%		28.7%		100.0%

Source: Hawaii Visitors Bureau, Visitor Plant Inventory, 1987.

Quality master planned development has occurred in several resort areas on the Kona and Kohala coast of the island, including:

- Mauna Kea Resort
- Mauna Lani Resort
- Waikoloa Beach and Village Resorts
- Kona Village Resort
- Keauhou Resort

In addition, there is a large concentration of units in the Kailua-Kona area. A majority of the island's visitor accommodations are located in the Kona area. Including the Kohala district's 19 percent, together the Kona and Kohala area represent 81 percent of the island of Hawaii's accommodations inventory. Hilo, the island's original visitor destination area which grew quickly after statehood, now accounts for only about 18 percent of the visitor room inventory.

During the last three years, the number of hotel units on the island of Hawaii has increased only slightly. This has been due to the closing or conversion of several hotels into commercial or residential condominium units in the Hilo area as a result of low occupancy levels and slow new growth.

Planned Development: Currently planned hotel developments on the island represent about 3,000 units representing five hotels as shown in the table below:

Projected Inventory of Hotel Rooms
on the Island of Hawaii

Project name	Location	Number of rooms	Expected quality	Estimated date of completion
Hyatt Regency Waikoloa	Waikoloa Beach	1,244	Luxury	1988
Ritz-Carlton Mauna Lani	Mauna Lani	450	Luxury	1990
Unnamed hotel	South Kohala Resort	350	Luxury	1992
Unnamed Princess Resorts hotel	Kaupulehu Resort	600	Luxury	1992
Sheraton Royal Waikoloa addition	Waikoloa Beach	400	First-class	1991

Sources: Compiled by Peat Marwick Main & Co. based on interviews with resort developers and information published by the Hawaii Visitors Bureau, Visitor Plant Inventory, February 1987.

All of the new luxury hotels will be operated by well-known luxury hotel management companies. These include the Hyatt, Ritz-Carlton, Westin, Princess and Sheraton hotel chains. Thus the island's luxury hotel inventory and the level of service at luxury hotels on the Big Island is expected to be significantly upgraded in the near future.

3.4.3.2 Historical Occupancy Rates

Historically, island of Hawaii hotel and resort condominium occupancy levels have been lower than the state's. Through 1986, Hawaii island annual occupancies have ranged from 44 percent to 63 percent, while the state's have ranged between 68 percent to 82 percent, as shown in Table II-11. During the first six months of 1987, hotels and resort condominiums on the percent achieved their highest occupancy levels since 1975, averaging 67.2 percent, as also shown in the table.

TABLE II-11

Average Annual Occupancy Rates
for Hotels and Resort Condominiums

1975 to June 1987

	1975	1980	1981	1982	1983	1984	1985	1986	1987(1)
Island of Hawaii	59.9%	52.7%	48.3%	44.0%	44.7%	55.6%	57.6%	62.8%	67.2%
Kailua-Kona	59.3	55.7	48.9	46.9	47.0	54.9	57.5	64.6	69.7
Hilo	57.3	39.7	39.5	37.7	39.2	58.2	57.8	54.6	59.0
State of Hawaii	71.9	67.8	68.2	70.4	69.7	76.0	76.1	81.7	83.1

N/A Not available.
(1) Represents average through June 1987.

Sources: Hawaii Visitors Bureau, Annual Research Report and Supplemental Report, annual and periodical; and Pannell, Kerr, Forster, Trends in the Hotel Industry, annual.

3.4.3.3 Hotel Unit Demand Assessment

This section estimates hotel room requirements for the island in order to indicate the level of support for future hotel development at Punalu'u.

Projected Daily Occupied Rooms: Total room demand for the island is based on the projected numbers of east- and west-bound visitors, as shown previously in Table II-8, and assumptions regarding the average length of stay and the average party size as provided by the HVB. In addition, room demand from State of Hawaii residents is estimated to increase at about 5 percent over current estimated levels, reflecting population growth projected for the state and an increasing attractiveness of the island as a visitor destination.

The total average daily room demand on the island could be expected to increase from the estimated 4,850 rooms per day in 1987, to a nearly 14,000 rooms per day by the year 2005, as shown in Table II-12. This increase would be the result of two factors:

- o Increase in the number of visitors to the island of Hawaii, both east- and westbound

- o Increase in the average length of stay for both categories

Westbound visitors are expected to drive the greatest portion of the increase in demand, with visitors increasing at an annual rate of about 4.7 percent, while the projected average length of stay increases from about 4.2 nights in 1987 to 5.5 nights in 2005.

The projected westbound visitor average of 5.5 nights, or 6.5 days of stay is comparable to that currently experienced on the island of Maui, as shown previously in Table II-5. Thus, the analysis suggests that by 2005, Hawaii island will have developed and preserved visitor facilities, amenities and other attractions that are comparable in diversity and quality to those currently offered on Maui. The projected length of stay would also represent an increase of 1.3 nights over 18 years. By comparison, average intended length of stay for westbound visitors increased 3.4 nights (or days) on Maui island and 2.4 nights (or days) on Kauai in the 15 years between 1970 and 1985.

Projected Hotel Unit Requirements: The number of hotel units required is based on the projected daily room demand, the assumed share of visitors using hotels and condominiums and the desired occupancy levels of hotels and resort condominiums.

As shown in Table II-13, daily visitor room demand is estimated to be served 73 percent by hotels and 27 percent by condominium units in 1990, following the development of nearly 3,000 additional hotel units on the island as currently planned. In subsequent years, condominiums are expected to serve a greater share of the total accommodations demand as more and more visitors are repeat and longer-staying visitors.

Assuming desired islandwide occupancy levels ranging from 70 percent to 80 percent, required hotel units on the island would range from 6,000 to 6,900 units in 1990, to 11,400 to 13,000 units in 2005, as also shown in Table II-13. These projected levels of room demand also assume a 10 percent to 20 percent improvement over current and historical average hotel occupancies for units throughout the island over the next two decades. At the current occupancy level of about 60 percent, the island could support about 8,000 hotel units by 1990, as also shown in the exhibit.

TABLE II-12

Historical and Projected Daily Occupied Visitor Rooms

1985 to 2005

	Historical		Projected				
	1985	1986	1987	1990	1995	2000	2005
Westbound:							
Visitor arrivals	697,380	786,940	787,743	1,026,000	1,396,400	1,713,000	1,800,300
Commercial accommodations demand(1)	627,600	708,200	709,000	923,400	1,256,800	1,541,700	1,620,300
Average stay, nights	4.3	4.0	4.2	4.5	4.9	5.2	5.5
Visitor nights	2,669,975	2,832,980	2,977,670	4,155,300	6,158,300	8,016,800	8,911,700
Average party size(2)	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Daily occupied rooms	3,850	4,090	4,290	5,990	8,880	11,560	12,850
Eastbound:							
Visitor arrivals	58,800	64,500	77,719	97,300	131,600	174,600	196,400
Average stay, nights	1.5	1.5	1.5	1.6	1.7	1.8	1.9
Visitor nights(3)	88,200	96,750	116,600	155,700	223,700	314,300	373,200
Average party size(4)	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Daily occupied rooms	140	160	190	250	360	510	600
Total daily room demand:							
Visitors to Hawaii	3,990	4,250	4,480	6,240	9,240	12,070	13,450
Hawaii residents(5)	340	350	370	380	420	460	510
Total	4,330	4,600	4,850	6,620	9,660	12,530	13,960

(1) About 10% of all visitors projected to stay with friends, relatives, or in other noncommercial accommodations. Hawaii Visitors Bureau, A Study of Westbound Visitors to the Island of Hawaii, 1983.

(2) Historical figure estimated based on Hawaii Visitors Bureau, A Study of Westbound Visitors to the Island of Hawaii, 1983.

(3) All eastbound visitors assumed to stay in commercial hotel or condominium accommodations.

(4) Historical figure based on Hawaii Visitors Bureau Annual Research Report, 1983, Japanese visitor profile.

(5) Projected to increase over estimated 1984 levels at a compounded rate of 5% per year, numbers rounded.

Source: Peat Marwick Main & Co.

TABLE II-13

Projected Requirements for Hotel Units
on the Island of Hawaii

1990 to 2005

	1990	1995	2000	2005
Daily room demand(1)	6,600	9,700	12,500	14,000
Estimated hotel share	73%	70%	68%	65%
Occupied hotel rooms	4,820	6,790	8,500	9,100
Hotel rooms required:				
80% occupancy	6,000	8,500	10,600	11,400
70% occupancy	6,900	9,700	12,100	13,000
60% occupancy(2)	8,000	11,300	14,200	15,200

(1) Average daily demand for visitor accommodations, including hotel and condominium units, rounded.

(2) Shown to indicate potential future demand if 1985-1986 levels of occupancy were continued; does not necessarily suggest desired future conditions.

3.4.3.4 Market Assessment for Punalu'u Resort

Anticipated Short Run Hotel Occupancy: Accounting for the 5,226 existing and the nearly 3,000 planned hotel units identified previously, the island could experience average hotel occupancies somewhat less than the desirable in the short run. This is indicated by the lack of demand for additional hotel units on the island in 1990 as shown in Table II-14.

Future Demand: With the expected continued increases in demand for hotel accommodations, the island could require 3,200 to 4,800 additional units by the year 2005, in addition to supporting the 5,226 existing and nearly 3,000 planned units at 70 percent to 80 percent rates of occupancy.

TABLE II-14

Projected Market Support
for Hotel Development at Punalu'u Resort

1990 to 2005

	1990	1995	2000	2005
Island of Hawaii demand:				
At average 80% occupancy:				
Required units(1)	6,000	8,500	10,600	11,400
Net additional unit requirements(2)	-	300	2,400	3,200
At average 70% occupancy:				
Required units(1)	6,900	9,700	12,100	13,000
Net additional unit requirements(2)	-	1,500	3,900	4,800
At current occupancy levels(3):				
Required units(1)	8,000	11,300	14,200	15,200
Net additional units(2)	-	3,100	6,000	7,000
Punalu'u Resort market demand:				
Share of net unit requirements	15%	17%	19%	20%
Supportable units by islandwide average occupancy:				
80% occupancy	-	-	400	600
70% occupancy	-	200	700	1,000
60% occupancy	-	500	1,100	1,400

N/A Not applicable.

(1) As shown in Table II-13.

(2) Accounting for support of the existing 5,226 and the expected approximately 3,000 additional hotel units planned for development on the island at 70% to 80% occupancy, as noted.

(3) Based on 1985-1986 islandwide occupancy of about 60%.

Supportable Units at Punalu'u Resort: By achieving a 15 percent to 20 percent share of the future additional unit requirements on the island that are not already planned for, Punalu'u Resort could support 600 to 1,000 hotel units by 2005, assuming hotel properties on the island are able to achieve an average occupancy rate of 70 percent to 80 percent as also shown in the table. Thus overall, Punalu'u's inventory could increase to about 8 percent to 10 percent of the supportable hotel units on the island by 2005.

Considering the Resort's need to expand and reorient its market image and to create value and momentum for subsequent phases of growth, it is recommended that Punalu'u have completed 550 to 650 hotel units within the next five to ten years. These units are considered appropriate for development at Punalu'u over the period due to:

- The Resort's separateness from the Kohala and Kona markets, where most other hotel development is planned.
- The Resort's potential to create and attract new visitor market segments to the island due to its unique location and planned market orientation.
- The likelihood that the island may not support average occupancies in the 70 percent to 80 range in the short run, due to the many planned developments in the Kona and Kohala areas and the relatively lower quality of existing developments in the Kailua-Kona area.
- The desirability of establishing a critical mass of units at the Resort in order to:
  - Support appropriate hotel sizes for efficient management practices.
  - Attract nationally recognized hotel operators with national and international reservations linkages.
  - Foster market recognition of the Resort and of the Ka'u region.
  - Offer a variety of accommodation types at the Resort, since there are no hotel developments elsewhere in the region.

3.4.4 Resort Condominium Market Analysis

3.4.4.1 Market Review

Inventory of Resort Condominiums: The island of Hawaii presently includes about 51 condominium projects located in resort areas. These projects represent over 4,200 units, the majority of which are located in the Kona area, as shown in Table II-15. According to the HVB, about 50 percent of these units are kept in transient visitor rental pools, as also shown in the table.

TABLE II-15

Resort Condominium Inventory
for the Island of Hawaii

February 1987

	Properties	Unit count: Total(1)	Unit count: Visitor rental pool(2)	Percent units in rental pool
Hilo	1	147	147	100%
Ka'u	1	76	34	45
Kohala	6	450	169	38
Kona	43	3,570	1,752	49
Total	51	4,243	2,102	50%

(1) Estimated based on Monitor, Hawaii, Inc., 1984, other published sources and interviews with developers.

(2) As of February 1987, Hawaii Visitors Bureau, Visitor Plant Inventory, 1987.

Two projects totaling 148 units are planned for development in West Hawaii.

In addition, however, there is significant existing zoned capacity for condominium development at Waikoloa, Mauna Lani and Keauhou Resorts, and there are numerous proposed resorts currently seeking County and/or State approvals for further development.

Sales Trends: Annual sales of condominiums are based on sales information provided by Hawaii TMK Service and Multiple Listing Service (MLS) for condominiums in the Kohala and Kona areas. As less than 5 percent of the resort condominiums on Hawaii are located outside of these two districts, condominium sales in these areas are representative of the island of Hawaii resort condominium market.

Annual condominium sales have fluctuated dramatically since 1975 between 200 to 600 units, an average of about 300 units per year over the period, as shown in Table II-16. Using a three-year moving average to smooth the fluctuations, between 163 and 476 units were sold annually. Condominium unit sales have slowed in recent years due to the:

- Lack of new inventory development on the island, except in a few high-end projects such as at Mauna Kea, and Mauna Lani and Waikoloa resorts

- Relatively slow visitor and real estate markets throughout the state until 1986

- Relatively high interest rates until 1986

- Uncertainty over the effects of Federal tax law changes on real estate investment deductions and amortization periods

The most limiting factor to new condominium sales absorption on the island has been the lack of new inventory, except in the luxury market. Because of the ongoing and expected improvements in the visitor arrivals to the island and the recent drop in mortgage interest rates, new condominium development in the region is expected to be met with improved rates of unit sales absorption. In the resort condominium market, potential effects of the changes in federal tax law are most likely to be experienced at those projects targeted at investor-buyers who seek tax shelters.

TABLE II-16

Condominium Sales in Kona and Kohala

1975 to 1987

Year	Annual sales	Three-year moving average
1975	84	-
1976	199	-
1977	218	167
1978	220	163
1979	626	212
1980	349	398
1981	453	476
1982	250	351
1983	196	300
1984	292	246
1985	215	234
1986	351	286
1987(1)	386	317
Average	295	-

(1) Annualized estimate based on 193 sales reported as of July 1987.

Sources: Hawaii TMK Service and Multiple Listing Service computer runs.

Sales Prices: Estimated average prices of condominium units in the Kona and Kohala regions in 1986 ranged from about $49,000 to $145,000 and $109,000 to $529,000, respectively, as shown in Table II-17. Average unit prices in the Kohala region have increased significantly since the development of super luxury properties at Mauna Kea and Mauna Lani resorts in 1983 and 1984. Average prices in the South Kohala district in 1986 are somewhat lower than those observed in 1985 due to the market entry of the relatively lower priced shores at Waikoloa project.

TABLE II-17

Average Sales Prices of Condominium Units
in Kona and Kohala by Number of Bedrooms

1982 to July 1987

	1982	1983	1984	1985	1986	1987
Kona:						
Studio	$ 70,362	51,200	55,833	51,167	49,333	-
One-bedroom unit	104,781	78,541	82,684	60,523	64,049	75,802
Two-bedroom unit	147,750	159,402	133,556	122,341	118,156	128,239
Three- or more bedroom unit	-	211,600	178,000	328,250	145,250	117,500
Average	$ 134,244	125,400	115,940	106,157	93,055	102,310
Kohala:						
One-bedroom unit	-	94,000	189,333	112,000	109,000	-
Two-bedroom unit	-	120,425	54,416	253,208	528,754	440,958
Three- or more bedroom unit	-	-	175,000	-	-	301,000
Average	$ -	113,218	106,950	217,906	486,778	405,969

Source: Compiled by Peat Marwick Main & Co. based on Hawaii TMK Service and Multiple Listing Service computer runs.

Buyer Profile: According to developers of the new condominium projects, purchasers of resort condominiums on the island of Hawaii typically are from the West Coast, primarily California, Washington, Oregon, Nevada and Colorado. Unlike on Maui, Canadians have not represented a major market for condominiums on the island of Hawaii.

Major characteristics of condominium purchasers are compared to single-family lot purchases in Table II-18. There are two primary differences between single-family lot and condominium buyers:

- First is the immediacy of the need or use of the property. Condominium buyers are able to take "turnkey" possession of their units for use as vacation homes or rental units as soon as the purchases are closed. In contrast, lots are generally purchased for anticipated use as a vacation or retirement home at a future date.

TABLE II-18

Comparative Characteristics of
Condominium Purchasers and Resort Lot Purchasers

	Condominium purchasers	Lot purchasers
Primary purchase motivation	• Purchased to use as often as possible as vacation homes or for speculative investment.	• Purchased to be improved at a later date, to be used as vacation or future retirement homes. Some purchased by investors or home contractors for possible appreciation or resale.
Intended use	• Immediate use. Occupied one or two times a year for about two to three weeks, occasionally occupied as long as six months. • Majority of low- and medium-priced units are rented while not owner occupied.	• Future use. Homes not completed for about three years or more from date of purchase. Homes used once or twice a year for two to six months. More likely to be occupied full time than condominiums. • About 20% to 25% of homes are rented while not in use; less likely to be rented than condominium units.
Primary purchase considerations	• Potential cash flow from rental income is a key consideration to enable buyers to cover mortgage payments. • In addition to payments and interest deductions, depreciation of rental units is a prime investment consideration.	• Lots purchased if current prices are attractive, likely to escalate in near future or if sites are scarce and not likely to be available in the future. • Purchases are made with anticipation of rising income and ability to support future home completion. • Rental income as well as tax benefits of depreciation are not applicable to vacant land; not considered in purchase decision.
Key considerations in selection of a condominium/single-family lot	• Enjoy security, freedom and peace of mind of condominium ownership made possible by project maintenance and security. • Want convenience of "turnkey" ownership. Knows exactly what they are buying. • Are reticent to undertake the trouble involved in designing and constructing homes or do not have the sophistication, time and control.	• Enjoy privacy. • Accustomed to single-family living. • Want homes more customized and personal than those being offered by condominiums. • Avoidance of maintenance fees of condominiums; especially important if planning to retire on fixed incomes. • Not ready to undertake financial outlay of a finished home or condominium.
Typical buyer profile:		
Occupation	Wide range, depending on the quality of the development, from professionals, real estate developers and entrepreneurs to senior executives.	Similar to condominium buyers; dependent on quality and pricing of subdivision development.
Age	35 to 55 years. Wide range depending on quality of the development.	45 to 55 years. Generally older and more often retired than are condominium buyers.
Income	Generally slightly higher incomes than single-family lot buyers of comparable quality developments due to mortgage notes and maintenance fees.	Generally lower incomes than those of condominium buyers at comparable quality developments.
Other characteristics	Few lot owners subsequently purchase condominiums.	May have owned condominiums or other single-family lots at the resort and are "trading up."

Source: Developers or realtors of selected Hawaii resorts.

For lots, the initial investment and freedom from maintenance fees permit lower investment than the purchase of a comparable quality condominium unit. Thus, resort lot buyers currently appear to have slightly lower incomes than do condominium purchasers. Lots are purchased with the expectation that their incomes will rise in future years to finance home completion.

As a result of this typically nonimmediate need for residential use of single-family lots, lots are purchased by potential buyers if current prices appear to be relatively more attractive if purchased immediately, rather than in the future, or if the homesite is unique and not likely to be available in the future.

- The second major difference is the lifestyle preferences of the two resort owners. Condominium buyers enjoy the security, convenience and peace of mind afforded by central maintenance and security of the project. They enjoy being able to lock up their units while they are away without having to hire a house sitter or gardener. On the other hand, single-family homeowners have grown accustomed to the privacy and ability to do as they choose in a single-family home.

3.4.4.2 Punalu'u Resort Condominium Market Assessment

Factors in Market Demand: The demand for resort condominium units at Punalu'u will be supported in part by the general increase in visitor arrivals to the island since significant and increasing shares of visitors seek accommodations in condominiums rather than in hotel units. This trend is increasingly observed in Hawaii as more visitors are repeat visitors to the islands who are familiar with the destination areas of the islands. Such visitors often prefer the additional privacy and convenience of more complete household and kitchen amenities and the greater space that condominium units offer in comparison to hotel units.

In addition, the market support for condominium development at Punalu'u is indicated by the following trends and market factors:

- The Resort's relatively remote location could be advantageous, offering a relaxing and supportive atmosphere in a health or lifestyle-oriented destination.

- This market orientation would enable the Resort to expand the visitor base to the state by capturing a segment of the visitor market which is not currently served in Hawaii.

- The attraction of visitors to Punalu'u Resort would expose potential condominium buyers to the Resort as well as creating demand for use of these units as visitor accommodations.

Target Markets: Condominium purchasers are expected to be repeat visitors to the Resort who plan to vacation in Hawaii annually, staying anywhere from two weeks to three months per year. Such purchasers may also purchase their units with others, informally "time-sharing" with friends. In addition, many unit owners would be expected to place their units in a rental pool for most or parts of the year.

The availability of golf, tennis and health spa facilities, as planned at Punalu'u, are also important features as they would enhance the Resort's recreational and personal development opportunities. Such facilities and the pride of ownership in a Hawaiian resort could be essential elements in the decision to purchase units at the Resort.

Sales Prices and Unit Characteristics: Purchasers who are attracted to condominium ownership in a rural resort are expected to seek relatively moderately priced and less luxuriously furnished units than offered at other resorts in Hawaii. Simple, rustic, possibly open air units without excessive unit and project amenities are expected to be attractive to prospective condominium unit purchasers at Punalu'u.

Thus, sales prices and unit sizes of condominium units at Punalu'u are suggested as follows:

Proposed Condominium Unit Sales Prices and Sizes at Punalu'u Resort

Units	Estimated unit prices (1986 prices)	Estimated unit size (square feet)
One-bedroom	$125,000 to 200,000	700 to 900
Two-bedroom	150,000 to 250,000	800 to 1,300
Three-bedroom	200,000 to 300,000	1,000 to 1,500

Projected Sales Absorption: Since 1975, using a three year moving average, annual condominium sales on the island have amounted to about 300 units, as discussed previously. By the 1988 to 1990 period, about the time of the first potential project completions at Punalu'u, this market could be expected to have expanded about 30 percent, to representing about 400 units sold per year. Such an increase appears reasonable given the expected strengthening of the general economy, stabilization of interest rates and increased visitor arrivals to and facility development on the island of Hawaii. Over the next 15 years, from 1991 to 2005, potential average annual condominium sales are projected to increase at a decelerating rate, reaching about 650 per year as more and more visitors and especially repeat visitors are attracted to the island. Such growth in the market for condominium real property would be modest compared to that observed on the islands of Maui and Kauai during their periods of significant visitor industry development during the early and mid 1970's. Data on condominium unit sales absorption is not available for Maui and Kauai. However, according to Bank of Hawaii, new construction authorizations for private multi-family developments were 282 percent and 348 percent higher in the 1971 to 1975 period than in the 1966 to 1970 period on the islands of Maui and Kauai, respectively. Thus condominium sales on the island could be as shown in the table below:

Projected Condominium Sales
for the Island of Hawaii

	Units sold		
	Average annual	Percent Increase(1)	Total
1989 to 1990	400	30%	800
1991 to 1995	500	25%	2,500
1996 to 2000	600	20%	3,000
2001 to 2005	650	8%	3,250
Total			9,550

(1) Compared to projected average annual sales in preceding five-year period. Projected 1989 to 1990 sales is compared to overall three-year moving average of about 270 new unit sales per year since 1978, as shown in Table II-16.

Based on the recommended pricing, unit characteristics and orientation of the Resort, Punalu'u is estimated to capture a 10 percent to 15 percent share of the annual condominium sales on the island of Hawaii. This assumption is based on the relative market shares of other comparable resorts in Hawaii at comparable periods in their development. Recent condominium sales among the island's major existing resorts are estimated to be distributed approximately as shown below.

Keauhou	60%
Waikoloa Village	14
Mauna Kea	7
Mauna Lani	19
Total	100%

Thus, from 1989 to 2005, between 955 and 1,910 units are projected to be sold at the resort, as shown in Table II-19.

About 1,240 to 1,868 condominium units are proposed under the current request. Thus, assuming a 20 percent market share of the island's projected new condominium sales, all units could be sold by about the year 2006. Assuming a 10 percent market share, the units could take about 16 additional years to be fully absorbed. Changes in and uncertainty over federal tax law, however, could slow the absorption of new condominium unit sales at Punalu'u as elsewhere throughout the country. That segment of the market that has primarily sought tax shelters is expected to be most affected. Investor-buyers, including tax shelter seekers, are estimated to have represented 15 percent to 20 percent of the condominium market on the island of Hawaii in recent years. Thus, absorption of the units proposed for development at Punalu'u could take longer than noted above.

TABLE II-19

Projected Annual Condominium Unit Sales at Punalu'u Resort

1989 to 2005

Years	Total island of Hawaii condominium sales(1)	Estimated Punalu'u market share(2)	
		10%	20%
1989 to 1990	800	80	160
1991 to 1995	2,500	250	500
1996 to 2000	3,000	300	600
2001 to 2005	3,250	325	650
Total, rounded	9,550	955	1,910
Average annual sales, rounded - 1989 to 2005	560	55	110

(1) See discussion in text.
(2) Sales of new condominium units on the islands.

3.4.5 Resort Single-Family Lot Market Analysis

Resorts with single-family lot developments were selected for comparison to Punalu'u based on the following criteria:

- Long history of residential lot sales and development
- Communities distant from major employment centers
- Rural resort orientation

Based on these criteria, the resorts most comparable to Punalu'u were Waikoloa Village Resort on the island of Hawaii and Princeville Resort on Kauai. In addition, lot sales on the island of Hawaii at Mauna Kea and at Keauhou are examined.

3.4.5.1 Annual Lot Sales

Annual lot sales at the four selected resorts with single-family lot developments are shown in Table II-20. Waikoloa Village and Princeville Resorts, which include significant single-family lot development relative to hotel and condominium development, have averaged 30 to 47 lot sales per year. These averages are strongly influenced by the boom in real estate sales which occurred in 1978 and 1979.

Since 1980 new lot sales at both of these resorts have declined as no new subdivisions were developed and the real estate industry slowed. Thus the slow sales are attributed to inventories and slower absorption of the remaining and typically less desirable lots.

The Fairways at Mauna Kea North have encountered buyer resistance due to the very large lot sizes (22,000 square feet and larger) and the high lot prices in comparison to other single-family developments. Only eight lots were known to have sold as of July 1987.

The Keauhou Estates I subdivision in Keauhou Resort began sales in summer 1984. The first sales closed in 1985 and 1987 sales are expected to reach nearly 60 lots. The project is expected to take an additional two or more years until this first phase is completely sold out.

TABLE II-20

Annual New Sales of Residential Lots
at Selected Hawaii Resorts

1978 to July 1987

	First year offered for sale	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987(1)	Total	Average annual lot sales(2)
Waikoloa Village	1978 to 1980	16	185	36	26	28	26	11	-	-	-	328	47
Princeville	1978 to 1984	149	40	11	11	1	5	21	6	27	N/A	271	30
Mauna Kea - Fairways at Mauna Kea North	1982	-	-	-	-	1	4	2	1	-	N/A	8	2
Keauhou Estates I	1984	-	-	-	-	-	-	-	-	27	58	85	43
Total		165	225	47	37	30	35	34	7	54	58	692	

N/A Not available.
(1) Annualized estimate based on sales experience through July 1987.
(2) During periods with inventory available.

Sources: Hawaii TMK Service and discussions with developers of the respective subdivisions or their representatives.

3.4.5.2 Sales Prices and Lot Sizes

Sales prices for resort lots vary significantly by market orientation of the resort and by lot type and view orientation. Single-family lots at the relatively rural Waikoloa Village and Princeville Resorts are currently selling for $35,000 to $105,000, or $3.40 to $5.70 per square foot for 10,000- to 20,000-square foot lots, as shown in Table II-21.

Sales prices at the Mauna Kea Fairways are significantly higher and targeted to the very upscale buyer market. Lots at Mauna Kea range from $395,000 to $595,000, depending on the view orientation. This represents $10.00 to $23.00 per square foot even for 24,000- to 30,000-square foot lots.

Keauhou Estates I is also a relatively exclusive residential development featuring security systems and controlled access. Prices there currently range between $94,000 and $225,000 ($6.10 to $13.64 per square foot).

3.4.5.3 Buyer Profiles

Almost all of the purchasers of lots at the selected resorts have vacationed at the hotel or condominium facilities of the resorts before. The purchasers are typically repeat visitors who purchase lots for future use as a vacation or retirement home.

Occupation and income vary significantly by the quality or price of the development. Purchasers of the lower priced lots at Waikoloa Village and Princeville include professionals, small business owners, mainland and local contractors and retirees.

As with condominium buyers, the majority of the purchasers of these developments were from California and other West Coast states. At Princeville, local Kauai or Oahu purchasers represented 20 percent to 55 percent of all buyers of the individual subdivisions due to the relatively lower lot prices and discounts offered to resort employees.

3.4.5.4 Punalu'u Resort Market Assessment

<u>Buyer Profile</u>: A major market for single-family lots at Punalu'u is expected to come from West Coast visitors who want to vacation and possibly retire at the Resort. The tranquil lifestyle of this rural area and the proposed recreational and health-oriented facilities of Punalu'u are expected to be major attractions to a single-family retirement or vacation lifestyle.

TABLE II-21

Sales Prices and Sizes of Lots at Selected Resort Subdivisions

1986 to 1987

Resort subdivision	Location and view orientation	Typical lot size (square feet)	Typical sales price	Price per square foot
Keauhou Resort - Keauhou Estates(1):				
Interior lots(some view obstruction)	Hillside/ocean view	16,500	$ 94,000 to 120,000	$ 6.10 to 10.00
Interior lots(180° view)	Hillside/ocean view	16,500	150,000 to 165,000	8.00 to 10.20
Fairway	Fairway	16,500	190,000 to 225,000	9.40 to 13.64
Waikoloa Resort - Waikoloa Village(lot resales)	Not available	11,000 to 13,000	35,000 to 45,000	3.40 to 4.20
Princeville Resort(1):				
Increment II, Unit I and II	Interior	10,000 to 13,000	55,000 to 60,000	4.50 to 5.40
Sunset Drive	Fairway/interior	15,500 to 20,000	87,000 to 105,000	4.80 to 5.70
Mauna Kea Resort - Fairways at Mauna Kea North	Interior	24,000 to 30,000	395,000 to 495,000	10.00 to 21.00
	Fairway	24,000 to 30,000	495,000 to 595,000	17.00 to 23.00

(1) Discount for cash or multiple purchases may also apply.

Buyers will typically be between the ages of 45 to 55; many will be approaching retirement and may have to depend on fixed incomes. These purchasers are expected to be repeat guests who are currently quite active and who already participate regularly in exercise and physical fitness activities.

In addition, lots at Punalu'u could be attractive to full-time residents who are employed in the Ka'u region based on the expected growth in economic activity and the existing pent-up demand for housing in the region.

Sales Prices and Lot Sizes: Lots at Punalu'u are proposed to be relatively large, ranging from 12,000 to 19,000 square feet. The minimum allowable lot size would be 10,000 square feet. They are expected to be attractive to prospective purchasers due to the "rural feeling" and open space which they would provide. Many would also afford views over the Resort and of the ocean. Projected sales prices are based on the target markets for single-family lot buyers and prices realized at comparable other projects in the islands and are proposed as follows:

Proposed Lot Prices and Sizes
at Punalu'u Resort

(1986 dollars)

	Estimated lot prices		Typical
	Total	Per square foot	lot size (square feet)
Interior lots	$65,000 to 85,000	$4.50 to 5.50	12,000 to 19,000
Golf-front lots	80,000 to 125,000	5.50 to 7.35	12,000 to 17,000

Projected Sales Absorption: Sales absorption of single-family lots at Punalu'u are projected based on sales levels at comparable resort developments, primarily at Waikoloa Village and Princeville. Recent average annual new sales at these developments have been 47 and 31, respectively.

As the majority of the lot purchasers to Punalu'u are expected to be repeat visitors who have visited the Resort previously, lot sales are expected to be relatively limited during the first few years of new development at the Resort. Thus, from 1989 to 1990, about five lots are projected to be sold annually. Thereafter, lot sales are projected to increase to 10 lots per year upon completion of the first hotel and 15 per year when the resort is well established. Thus, all 70 to 80 planned lots are projected to be absorbed by about 1996, as shown in the table below:

Projected Sales Absorption
of Single-Family Lots at Punalu'u Resort

1989 to 2000

	Projected lot sales	
	Annual	Cumulative
1989 to 1990	5	10
1991 to 1995	10	65
1996 to 2000	15	140(1)

(1) The master planned 71 to 78 units could be expected to be fully absorbed by 1996.

Source: Peat, Marwick, Main & Co.

3.4.6 Summary of Development Plan and Market Support

The master planned units and projected market support for the hotel, condominium and single-family developments are summarized in the table below:

Summary of Development Plan and Projected
Market Support for Additional Units at Punalu'u Resort
At Project Completion

	Master planned units		Projected market support by 2005	
	Low	High	Low	High
Hotel units	740	1,035	600	1,000
Condominium units	1,240	1,868	955	1,910
Single-family units	71	78	78	78(1)

(1) Expected to be fully absorbed by about 1996.

3.4.7 Resort Support Facilities and Amenities

Current support facilities and amenities at Punalu'u include an 18-hole golf course, a tennis center and a nearby public beach park. In order to attract and cater to the visitor and resident markets targeted, it is recommended that the resort also develop significant amenities in addition to those provided at individual hotels or condominium projects. These could include:

- A major freshwater swimming area, including pools, waterfalls and other swimming, sunning and play areas.

- Up to 65,000 square feet of commercial shopping center area, including boutiques, diverse eating establishments, convenience shopping, sports supplies and office space.

- A health spa facility offering a full range of spa activities as well as lifestyle and "healing" programs.

- A center for community activities and outdoor performances.

- Nature trails throughout, leading to the archaeological features on the site.

3.5 PROJECT SCHEDULE

The proposed project is expected to be completed over an approximately 15 to 20 year period, as noted in section 3.3. It is estimated that, given present market conditions and the level of tourism that the state is experiencing, all of the hotel and multi-family residential units proposed would be absorbed by the year 2005, assuming a 1988 start date.

Pending the necessary government approvals, the projected schedule to complete the reconfiguration of the golf course and roadways so as to allow the implementation of the Resort Master Plan.

As is the case with any development similar to the proposed project, market conditions at any given time, as well as permitting and other governmental procedures, will determine the specific schedules for each element of the project. As the final design and construction drawings and specifications for each project element are developed, specific schedules for those elements will be developed and provided to the public and appropriate public agencies. It is the intent of the developer to keep the community informed of the actions that will take place as soon as definitive schedules for those actions are available.

PROJECT SCHEDULE

Project Element	Start	Estimated Completion
1. Obtain Necessary regulatory approvals including Change of Zone and Special Management Area Permits.	1988	1989
2. Complete subdivision plans and final design and engineering plans for golf course modifications and infrastructure improvements.	1989	1990
3. Construct new golf course holes No. 2 and 3.	1989	1990
4. Construct new section of Punalu'u Road (Loop Road) and shorten golf hole No. 8.	1990	1990
5. Construct new access road to Punalu'u Beach Park, eliminate makai portion of private Punalu'u Road (Loop Road), construct golf hole No. 8 and No. 9, and improve Punalu'u Beach Park.	1990	1991
6. Construct new Ninole Cove Place (through golf hole No. 9) and lengthen golf hole No. 1.	1991	1992
7. Complete detailed design and construction documents for the Punalu'u Village, Village Hotel and Punalu'u Black Sand Inn.	1989	1991
8. Construct Village Hotel, Punalu'u Village, and Punalu'u Black Sand Inn.	1991	1995
9. Complete design and construction documents for various other resort facilities, obtain regulatory approvals, and complete construction over 10 to 15 year timeframe.	1990	2005

Chapter III: Alternatives to the Proposed Action

CHAPTER III

ALTERNATIVES TO THE PROPOSED ACTION

1. INTRODUCTION

1.1 BACKGROUND

The proposed action is a request to amend the County General Plan (GP) to redesignate approximately 65 acres located mauka of the Hawaii Belt Highway. Approximately 40 acres would be designated for "medium density" from "low density" with the remaining 25 acres designated "open" from "low density". The proposed project is the completion of the development of the entire Resort per the Revised Master Plan. The objective of the action, (GP Amendment) is to allow the proposed project to proceed in conformance with the appropriate land use designation, thereby enabling the proposed project, i.e., completion of the Resort, to accomplish the Resort Master Plan and project objectives as stated in Chapter II, Section 3.2 and below. Under current General Plan designations, CBP intends to apply for appropriate county zoning for the Resort makai of the Belt Highway and make a similar application for the mauka portion upon approval of the requested GP Amendment.

1.2 REGULATORY REQUIREMENTS

In compliance with the provisions of Title 11, Department of Health, Chapter 200, Environmental Impact Statement Rules, Section 11-200-17(f), the "known feasible" alternatives to the Resort Master Plan and proposed project are described in this Chapter. Those alternatives which could "feasibly" attain the objectives of the Resort Master Plan and proposed project are described and evaluated. A rigorous exploration and evaluated of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid or reduce some or all of the adverse environmental impacts, costs and risks area included in order not to prematurely foreclose options which might enhance environmental quality or have less detrimental effects. In each case, the analyses have been sufficiently detailed to allow the comparative evaluation of the environmental benefits, costs and risks of the proposed action and each reasonable alternative.

In conformance with the applicable rules, the alternatives have been evaluated relative to their capability and/or lack of capability to meet the Resort Master Plan and proposed project objectives as stated previously in Chapter II, Section 3.2 and described below in Section 2.1.

1.3 ALTERNATIVES EVALUATED

The alternatives to the Resort Master Plan and proposed project that have been evaluated include the following:

- Alternative 1 - Revised Physical Plan (Preferred Alternative)

  Modify the existing resort infrastructure and amenities (roads and golf course) and complete the development of the resort based on current "Minor Resort" designation under the General Plan and related zoning.

- Alternative 2 - Existing Physical Plan

  Complete the development of the resort based on current County land use policy "Minor Resort" designation under the General Plan and related zoning without modifying the existing resort infrastructure and amenities.

- Alternative 3 - Mauka Hotel/Coastal Private Open Space

  Reserve the coastal lands makai of the existing improved roadways for private open space and locate the hotel development at a location mauka of the Belt Highway. Obtain the required GP Amendment to permit resort designation mauka of the highway and complete the development of the resort based on current County land use policy "Minor Resort" designation under the General Plan and related zoning.

- Alternative 4 - Private Club/Estates

  Develop an exclusive, very low density, high priced, recreational club oriented around the existing recreational amenities (golf and tennis).

- Alternative 5 - "No Action"

  Retain the resort in its present configuration with no additional development. Take necessary measures to reduce/eliminate annual operating losses and carrying costs.

In assessing each of the alternatives to the proposed Punalu'u Resort Master Plan and project, quantifiable objective and qualifiable subjective criteria have been employed to ensure that the comparative benefits, costs and risks associated with each alternative have been analyzed in an equal and consistent manner, thereby reducing the potential for over- or under-rating a specific alternative. The specific factors for each alternative that have been evaluated are described below in Section 2.2.

2. ALTERNATIVES ANALYSIS AND EVALUATION CRITERIA

2.1 PROJECT OBJECTIVES

To weigh the benefits and impacts of alternative plans for the Resort, there is a need to provide a consistent set of evaluation guidelines by which each alternative can be uniformly compared. These guidelines or criteria should be structured around applicable regulatory requirements; sound planning and economics, engineering and business practices and procedures; environmental protection principles, professional judgement and experience; and those demonstrated elements that equate to a "successful resort." This includes the delivery of satisfaction to the visitor necessary to generate occupancy and spending which in turn provides jobs and economic growth and stability to the community. Further, the analyses and evaluations should be comparative and include numerous variations of the basic alternatives identified above.

Per applicable regulatory requirements and in keeping with the above noted principles, the project objectives become the primary guidelines as to whether a suggested alternative plan meets the goals of the developer. As stated previously in Chapter II, the Punalu'u Resort Master Plan objectives are:

(1) A high quality resort development;

(2) A resort development which will be economically successful in terms of long-term operations;

(3) A development that provides a substantial amount of employment opportunities; and,

(4) A development that improves the overall economic and social well being of the community to the advantage of the region as well as the developer.

Applicable regulations require that the alternatives considered be evaluated and investigated relative to their ability and capability to meet the Resort Master Plan and proposed project objectives. The alternatives evaluated herein have been considered within the context of C. Brewer's regional development plan, Punalu'u Resort Master Plan and the project objectives as stated above. Further, during the planning and alternatives evaluation process, the Resort's fundamental planning/design issues and challenges were identified as being:

(1) Provide the greatest feasible visitor satisfaction through:

(a) man-made facilities and amenities which capitalize on and present the natural features of the site in an attractive physical environment.

(b) services and programs to provide a pleasing social environment.

(2) Provide a resort that is acceptable to the targeted visitor market segment and one that can be economically and socially acceptable at a planned level of occupancy.

(4) Provide a resort that incorporates and accommodates existing facilities, uses, site features, environmental and community concerns.

The preceding regulatory requirements, business and planning principles, design issues and challenges are expressed in the development of the evaluation factors listed and described below.

2.2 FACTORS EVALUATED

The factors that have been used to evaluate the various alternatives are listed below. These factors are interrelated, thereby allowing comparative analyses to be performed. Also, as noted previously, the factors evaluated consider the natural, social and economic environments of the Resort, the surrounding community and, in general, the Island and State of Hawaii. No one factor in and of itself is sufficient to determine the viability of any alternative. Rather, all of the factors need to be considered collectively to determine the relative merits of each alternative.

Density: Number of units per acre.
Development Costs: Amenities, facilities and utilities.
Quality of Visitor Experience.
Total Occupancy.
Total Expenditures.
Community Economic Benefits: Jobs.
Natural and Social Environmental Impacts: Shoreline use, etc.
Resort Development Viability.

Also, embodied in the alternatives analysis and evaluations is the concept that each of the items listed below have been considered either directly or indirectly as part of one of the evaluation factors listed above. Similarly, embodied in the alternatives analysis process is the premise that all of the factors and elements have been considered throughout the planning process from inception to completion and the selection of the preferred alternative for Punalu'u.

Physical Environment

- Physiography and Geology
- Hydrology and Drainage
- Natural Hazards
- Visual Impacts
- Noise Impacts

Natural Environment

- Terrestrial Flora Impacts
- Faunal Impacts
- Protected Species Impacts
- Marine Environment Impacts
- Nearshore Impacts
- Coastal Pond Impacts

Social Environment

- Population
- Housing Requirements
- Qualitative Social Impacts
- Quantitative Social Impacts
- Ka'u Community Integration Potential
- Cultural Resources Impacts
- Historical and Archaeological Resources Impacts

Economic Environment

- Marketability
- Public Expenditures
- Tax Revenues
- Income Opportunities
- Employment Opportunities

Public Services

- Police Protection
- Fire Protection
- Schools
- Transportation Facilities
- Health Care Facilities
- Electrical Power and Generation
- Community Services Requirements
- Impacts on Existing and Planned Recreational Facilities

Resort Facilities

- o Facilities Siting
- o Water Supply
- o Facilities Quality
- o Development Costs
- o Wastewater Treatment and Disposal
- o Solid Waste Generation, Collection and Disposal

Institutional Factors

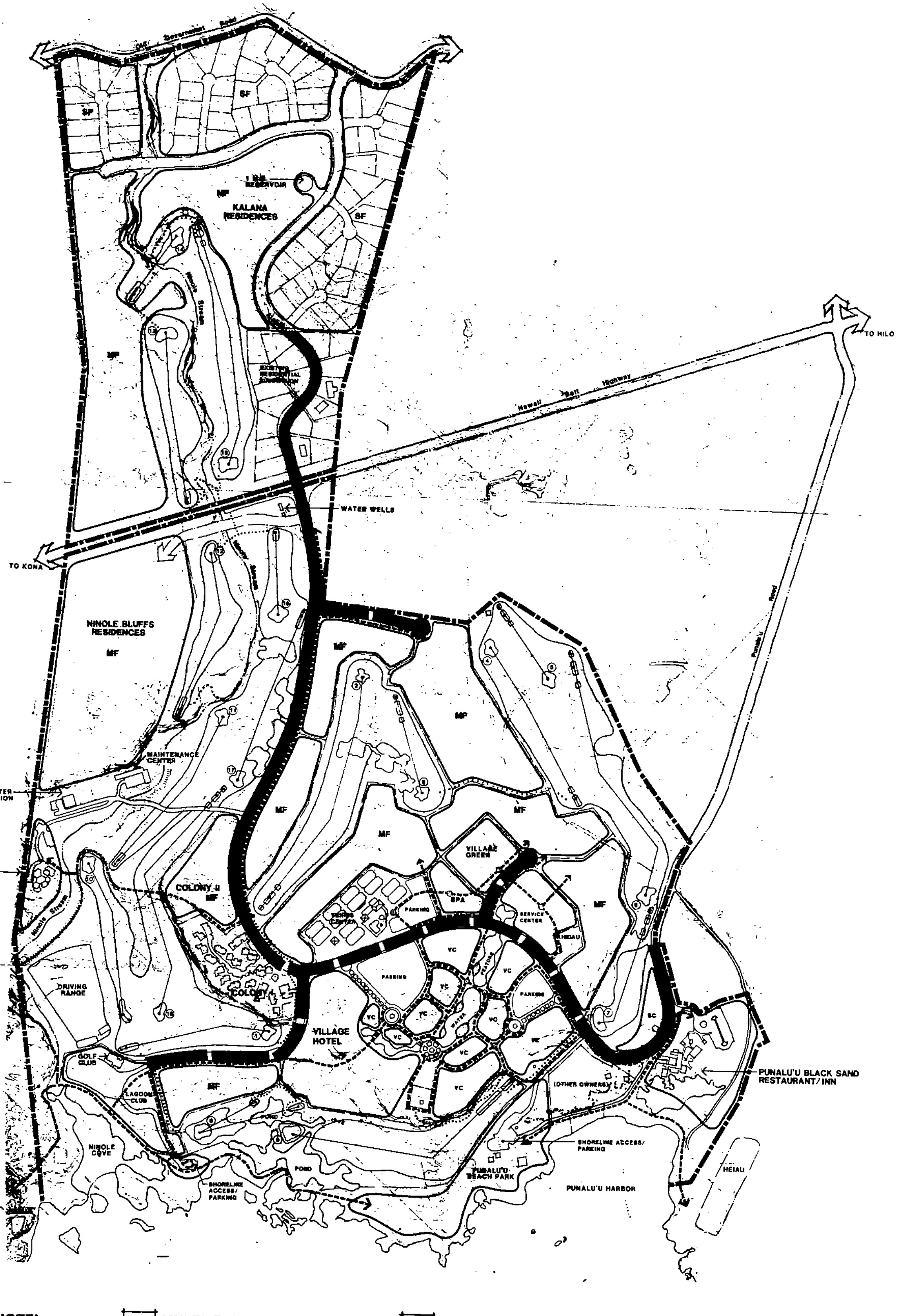
- o Relationship to Land Use Plans, Policies and Controls
- o Relationship Between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity
- o Irreversible and Irretrievable Commitments of Resources

3. DESCRIPTION OF ALTERNATIVES EVALUATED

The alternatives evaluated, as listed and described below, include a wide range of densities, facilities and amenities and differing social, economic and natural environmental impacts. Although there may be other resort configurations, layouts and combinations of facilities and amenities that could be studied, the alternatives analyzed here cover the spectrum of possibilities and allow the analyses performed to be sufficiently detailed and comprehensive for a comparative evaluation of the environmental benefits, costs and risks of the proposed project and each reasonable alternative.

3.1 ALTERNATIVE 1 - REVISED PHYSICAL PLAN (Preferred Alternative - See Figure III-1)

The existing Resort facilities as described in detail in Chapter II, Section 3.3.1 would be retained with some modifications. As previously described in Chapter II, Section 3.3.2 the preferred development plan includes revising the Punalu'u roadways (private) and golf course to provide a land use configuration that responds to the natural site feature and creates a greater opportunity for a successful resort. In order to achieve a "successful resort," it was determined (after evaluation of the existing conditions at Punalu'u) that there is a need for increasing amenity frontage. The changes result in the village on the bluff and the addition of a major water feature and related activity areas, creation of a village ambiance that provides a visitor with a unique experience, and the mix of uses and activities throughout the Resort along with the overall critical mass. Additionally, golf holes 8 and 9 are relocated to the coastal area, thereby retaining the open space character. Golf holes 2 and 3 are relocated to increase the amenity frontage in the central area. Note that the relocation of golf holes 2



LEGEND

V RESORT HOTEL	MF MULTI-FAMILY RESIDENTIAL	P PARK
VC VILLAGE COMMERCIAL	SF SINGLE FAMILY RESIDENTIAL	EXISTING ROAD
V/MF HOTEL CONDOMINIUM	R/O RECREATION/OPEN (PRIVATE)	PROPOSED ROAD

AREA SCALE 2 acres .5 ac 1 ac .5 ac

SCALE IN FEET 200 0 200 600

ALTERNATIVE 1: REVISED PHYSICAL PLAN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

pbr

FIGURE III-1

and 8 permit the location of the village and the water feature on the bluff which capitalizes on the high amenity frontage characteristic of this area.

Alternative 1 has been judged to be the preferred alternative due to (1) the appropriate mix and sizing of guest accommodations and amenities to be provided; (2) the expected high quality visitor experience that would result from the amenities and frontage created; (3) the appropriate density, i.e., number of hotel rooms, hotel/condominium, multi-family and single family residential units, commercial shops and services, and recreational and support facilities; (4) relatively moderate, adverse or favorable, natural and social environmental impacts as compared to other alternatives; (5) expected positive economic, guest occupancy and expenditure impacts.

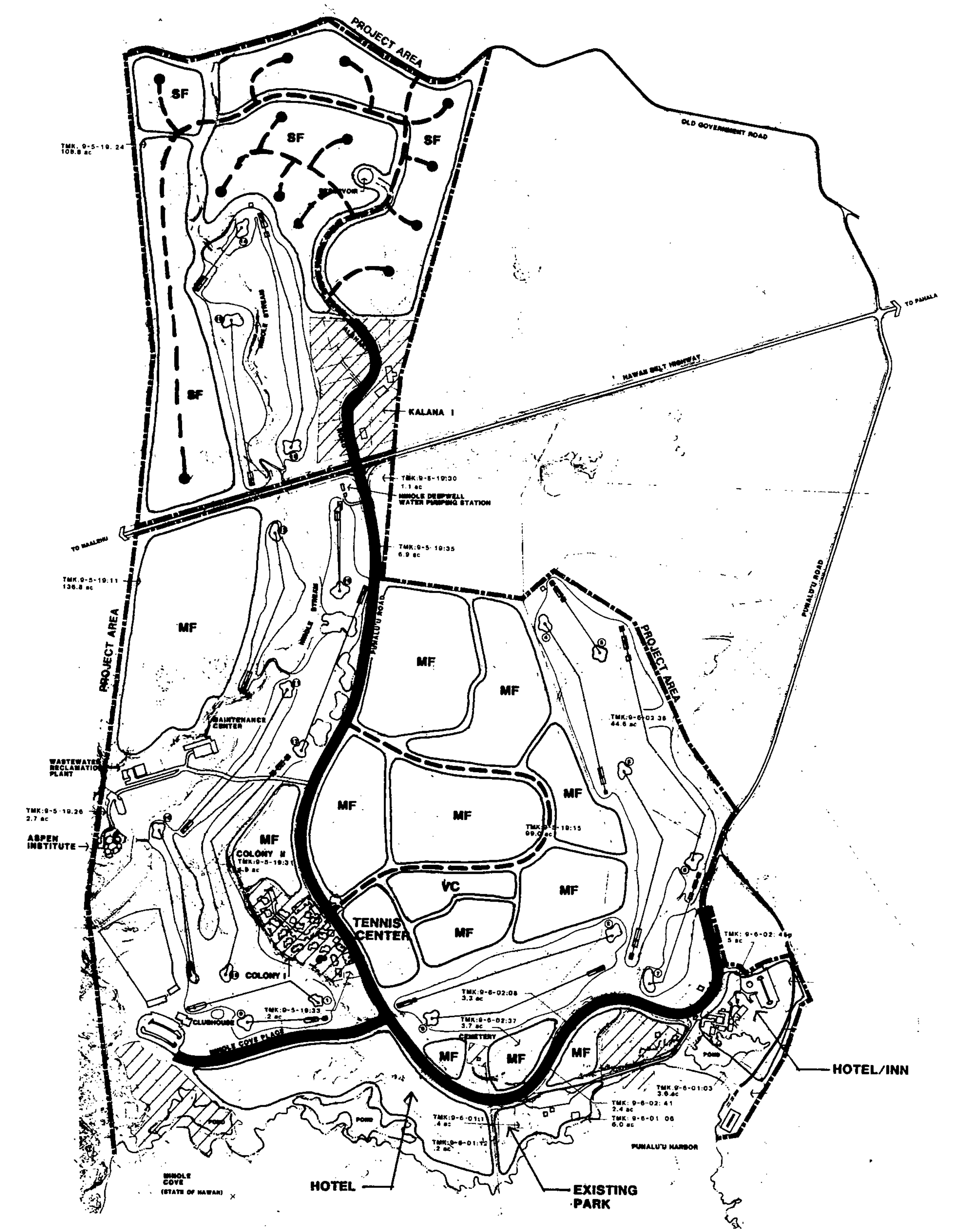
3.2 ALTERNATIVE 2 - EXISTING PHYSICAL PLAN (See Figure III-2)

The existing Resort facilities are described in detail in Chapter II, Section 3.3.1. Briefly, the present Resort includes an 18-hole golf course and driving range; a golf clubhouse and associated golf cart storage area and parking lot; the 76-unit Colony I condominiums, Black Sand Restaurant; Aspen Institute of Humanistic Studies; four tennis courts and convenience store; Ka'u Center of History and Culture; the 19-lot Kalana I single family residence subdivision; Resort associated sewage collection and treatment facilities, potable water distribution system, electrical power and communication systems and internal roadway system; Resort maintenance center; Punalu'u Beach Park and Hawaiian Evangelical Association Cemetery and Chapel.

Existing County zoning designations in the Resort total approximately 433 acres and includes approximately 5.5 acres Village-Commercial (CV-10); 28.3 acres Resort-Hotel (V-1.5); 21.8 acres Multiple Family Residential (RM-2.0); 17.4 acres Single Family Residential (RS-20 and RS-7.5); 118.2 acres Agricultural (A-20a); and 241.5 acres Open (O).

Based upon current County land use policy, Punalu'u Resort would be completed as a "Minor Resort" under its present configuration. As shown on Figure III-2, the existing two zoned hotel sites, Ninole Cove and Punalu'u Black Sand, would be developed and the balance of the project area would include a mix of single family, multi-family and village commercial uses.

As presently zoned and developable, the density of the existing Resort would be slightly lower than that proposed under the Revised Physical Plan. However, there would be a greater impact on the coastal area; facilities would be sited in less than most desirable locations, thereby resulting in a greatly



LEGEND

V RESORT HOTEL	MF MULTI-FAMILY RESIDENTIAL	P PARK
VC VILLAGE COMMERCIAL	SF SINGLE FAMILY RESIDENTIAL	EXISTING ROAD
V/MF HOTEL CONDOMINIUM	R/O RECREATION/OPEN (PRIVATE)	PROPOSED ROAD

ALTERNATIVE 2: EXISTING PHYSICAL PLAN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

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FIGURE III-2

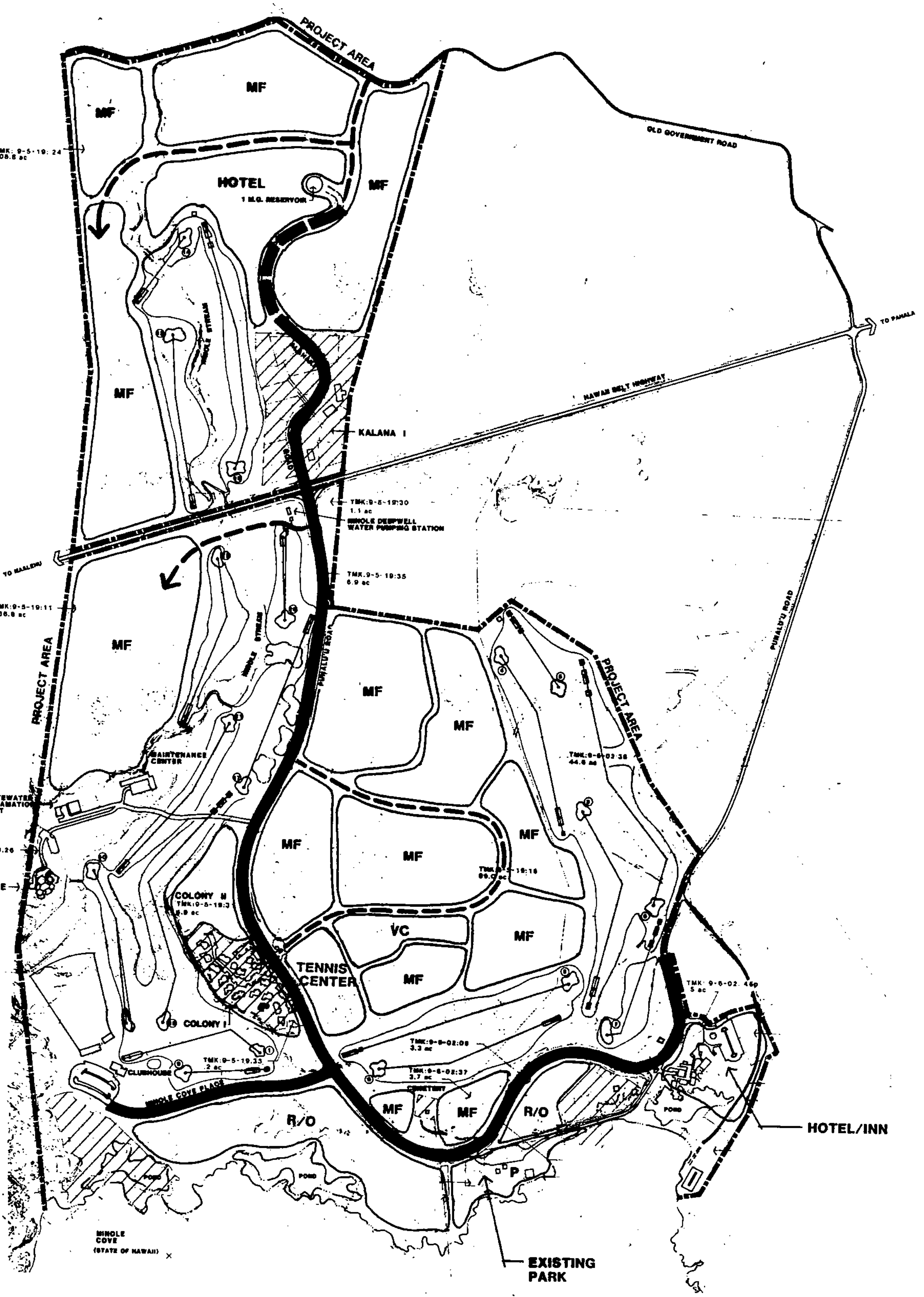
reduced visitor experience quality with consequent serious impacts on operating and development viability; fewer positive economic impacts than the preferred plan; and greater negative social impacts. Based on the evaluations performed, Alternative 2 was judged unacceptable due to the adverse social, economic and environmental impacts noted above.

3.3 ALTERNATIVE 3 - MAUKA HOTEL/COASTAL PRIVATE OPEN SPACE (Figure III-3)

Under Alternative 3, the existing Resort physical facilities as described in Chapter II, Section 3.3.1 would be retained in their present configuration. In addition to the proposed dedication of the existing approximately 6-acre Punalu'u Beach Park to the county, a private recreational/open space area would be created on the shoreline between the Punalu'u Beach Park and the state owned Ninole Cove boundary. Also, a hotel, of the same size as that planned for the Village Center under the preferred plan, would be constructed mauka of the Belt Highway and guests transported to the recreational/open space park area, to take advantage of the shoreline features and environment. The planned Punalu'u Black Sand Hotel/Inn/Restaurant complex would be retained under this alternative and the majority of the other lands would be developed as multi-family residential units. Density under this alternative would be essentially the same as that under the preferred plan in order for the resort to be theoretically economically viable. Locating the hotel mauka of the Belt Highway would require a GP Amendment, redesignating the land from "low density" to "resort".

Alternative 3 initially appears to have a lower environmental impact on the coastal plain makai of the existing roadways, i.e., Punalu'u Road and Ninole Cove Place. However, the only real difference is that no buildings would be constructed on the coastal plain area, not that the potential numbers of shoreline users would be different. It is expected that with this alternative, the numbers of shoreline users would be greater than some of the other alternatives because the "Village Center" would not be constructed, thereby eliminating the major water feature area planned for the Village Center as the primary "water contact" area for guests and residents of the Resort.

Alternative 3 would be approximately the same density as the preferred plan, but visitor experience quality is expected to be much lower due to the lack of view frontage and shoreline proximity of the hotel. This in turn is expected to lead to very low guest occupancy and consequent lower economic and social benefits to the community. Although some potential adverse environmental impacts may be lower, the adverse economic impacts indicate that this alternative would not meet the objectives of the project. Most of all, locating a Hawaiian resort hotel



LEGEND

V RESORT HOTEL	MF MULTI-FAMILY RESIDENTIAL	P PARK
VC VILLAGE COMMERCIAL	SF SINGLE FAMILY RESIDENTIAL	EXISTING ROAD
V/MF HOTEL CONDOMINIUM	R/O RECREATION/OPEN (PRIVATE)	PROPOSED ROAD

ALTERNATIVE 3: MAUKA HOTEL/ COASTAL PRIVATE OPEN SPACE

Punalu'u Resort

KA'U, ISLAND OF HAWAII

AREA SCALE: 2 acres, 1 ac, .5 ac, .5 ac

SCALE IN FEET: 200 0 200 600

pbr

FIGURE III-3

across a highway and more than a mile (about 5,400 feet) from the shoreline has been attempted only once (Makaha on Oahu) without success. Locating the principle visitor accommodations in such a manner is clearly contrary to the demonstrated preference for shoreline proximity as expressed by actual visitor selections. Based on the expected adverse social, economic and environmental impacts of this alternative, the proposed project objectives would not be met.

3.4 ALTERNATIVE 4 - PRIVATE CLUB/ESTATES (Figure III-4)

Under this alternative, the existing Resort facilities as previously described in Chapter II, Section 3.3.1 would be retained unchanged. A lagoon club recreational facility and private park would be developed adjacent to the coastal ponds. The balance of the Resort would be developed as large single family estate lots as shown on Figure III-4.

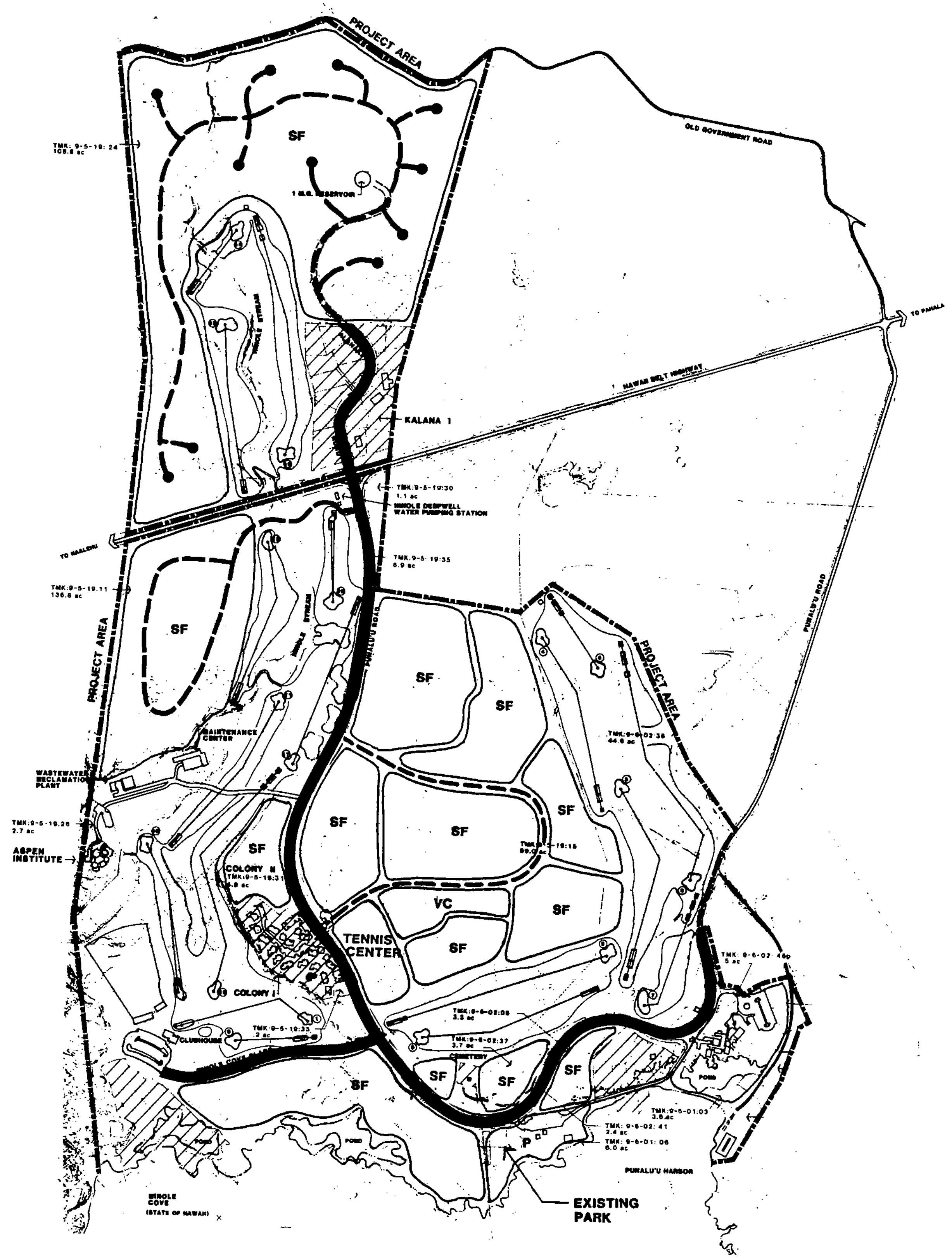
The existing Urban designated lands would be retained and County zoning changed to reflect the low density residential development. No resort hotel or additional multi-family developments would be included in the project.

The "Minor Resort" designation currently identified for the Punalu'u area would not be completed. Instead, at moderate additional infrastructure costs, the Resort would be developed as a private residential community oriented toward the existing site amenities (shoreline, golf and tennis).

Alternative 4 represents the lowest density development plan, and consequently would provide the fewest economic benefits to the community and very few, if any, additional jobs would be created. Single family lots would replace the coastal golf holes of Alternative 1. The potential for shoreline crowding would be reduced because of low density. Although development costs would be relatively moderate, there is no demonstrated market evidence which would support development viability. This alternative would represent a pioneering effort and, as such, would represent a high market and economic risk with unknown returns. Based on the social, economic and environmental factors associated with this alternative, the proposed project objectives would not be met.

3.5 ALTERNATIVE 5 - "NO ACTION"

Under a "no action" scenario, the land owner and resort operator would take measures to minimize annual operating losses. Existing operating facilities, including the golf course and clubhouse, tennis center and Punalu'u Black Sand Restaurant, which are presently uneconomic, would be closed given no future prospects for improved operations.



LEGEND

V RESORT HOTEL	MF MULTI-FAMILY RESIDENTIAL	P PARK
VC VILLAGE COMMERCIAL	SF SINGLE FAMILY RESIDENTIAL	EXISTING ROAD
V/MF HOTEL CONDOMINIUM	R/O RECREATION/OPEN (PRIVATE)	PROPOSED ROAD

AREA SCALE: 2 acres, 1 ac, .5 ac, .5 ac
SCALE IN FEET: 200 0 200 600

ALTERNATIVE 4: PRIVATE CLUB/ESTATES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

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FIGURE III-4

Due to the permanently impaired economic potential associated with this alternative, no additional development could be undertaken at the Resort. The ultimate consequences could include abandonment or sale of the property. This alternative would not meet the project objectives for the developer or the community.

4. EVALUATION RESULTS

4.1 COMPARATIVE EVALUATION

Utilizing the evaluation criteria previously described, a comparative quantitative and qualitative evaluation of the alternatives considered has been completed and is summarized in Table III-1. Based on the projected quantitative and qualitative aspects of the preferred plan (Alternative 1), all alternatives are measured on a relative basis, using selected key "success" criteria.

4.2 RESULTS

Measured against the overall project objectives, Alternative 1 - Revised Physical Plan (Preferred Plan) satisfies the project objectives and provides the best opportunity to create a "successful resort." Through the completion of the resort development, the community's need for economic opportunities could be satisfied as it would be a major contribution to resolving a primary community problem, i.e., a healthy, prosperous and growing community.

TABLE III-1

COMPARATIVE EVALUATION OF ALTERNATIVES

Alternative	Density	Development Cost	Quality of Visitor Experience	Total Occupancy	Total Expenditures	Community Economic Benefit	Potential Adverse Environmental Impacts	Development Viability
1	"Conventional"*	High	Very High	High	High	High	Moderate	High
2	"Conventional"*	Moderate	Low	Low	Low	Low	High	None
3	"Conventional"*	Moderate	Very Low	Very Low	Very Low	Very Low	High	None
4	Very Low	Low	Moderate	Very Low	Very Low	Very Low	Low	None
5	Very Very Low	Very Low	Very Very Low	Very Very Low	Very Very Low	Very Very Low	Very Low	None

* "Conventional" - Typical of other resorts of similar scale and size. In this specific case, ranging around 2,000-3,000 units.

Chapter IV: Description Of The Affected Environment (Existing Conditions), Probable Environmental Consequences (Impacts) And Mitigation Measures

CHAPTER IV

DESCRIPTION OF THE AFFECTED ENVIRONMENT (EXISTING CONDITIONS), PROBABLE ENVIRONMENTAL CONSEQUENCES (IMPACTS) AND MITIGATION MEASURES

Descriptions of the affected environment (existing conditions), identification of probable environmental consequences (impacts) of the proposed project on existing conditions and proposed mitigation measures designed to minimize and/or eliminate adverse impacts are given in the following paragraphs. For ease of review, evaluation and identification, information and analyses of the impacts of the proposed project on the physical, natural and socioeconomic environments; historical and archaeological resources; transportation facilities; and public services and facilities, in that order, are provided in the following paragraphs. The information and analyses provided are based on (1) field and/or office studies conducted specifically for this EIS; (2) comparisons and evaluations by specialty consultants (see Chapter I, Section 11) of the proposed project relative to similar planned or existing resort projects; and (3) the input, advice, guidance and information provided by public agencies, private groups, organizations and residents of the project area during the development and review of the original EIS (October 1986 and January 1987) and the consultation and Draft EIS review period for this EIS.

1. PHYSICAL ENVIRONMENT

1.1 PHYSIOGRAPHY AND GEOLOGY

1.1.1 Existing Conditions

The Ka'u District, south and west of the Ka'u Desert, is a unique landscape containing ancient eroded valleys and highlands that are the remnants of a volcanic structure which apparently had evolved before Mauna Loa and Kilauea. The old valleys were flooded with lavas that effused from the Mauna Loa rift long after the earlier volcanic activity had ended. The combination of an old volcano, subsequent erosion, creation of a soil-saprolite mantle, and covering of that surface with new lavas and pyroclastic deposits has created the geological environment in which a complex set of groundwater resources occur.

The region is underlain by four distinct rock formations and a blanket of ash separating two older basalts from younger ones. The Ninole formation, the oldest, is the remnant of the initial volcanic period. It consists principally of basalt but contains at least one widespread tuff bed up to 15 feet thick. Following deposition it was profoundly eroded and weathered. The general geology of the Punalu'u area and extent of lava flows are shown on Figures IV-1 and IV-2.

The Kahuku formation followed the period of erosion. Lava flooded the landscape, filled valleys and created new surfaces. Numerous ash strata, that perch groundwater, are found within this formation. Many of the high level water tunnels exploit this relationship. At the end of the Kahuku period a thick blanket of ash covered the landscape. The ash is called the Pahala ash because of its thick (up to 55 feet) exposures in the Pahala region.

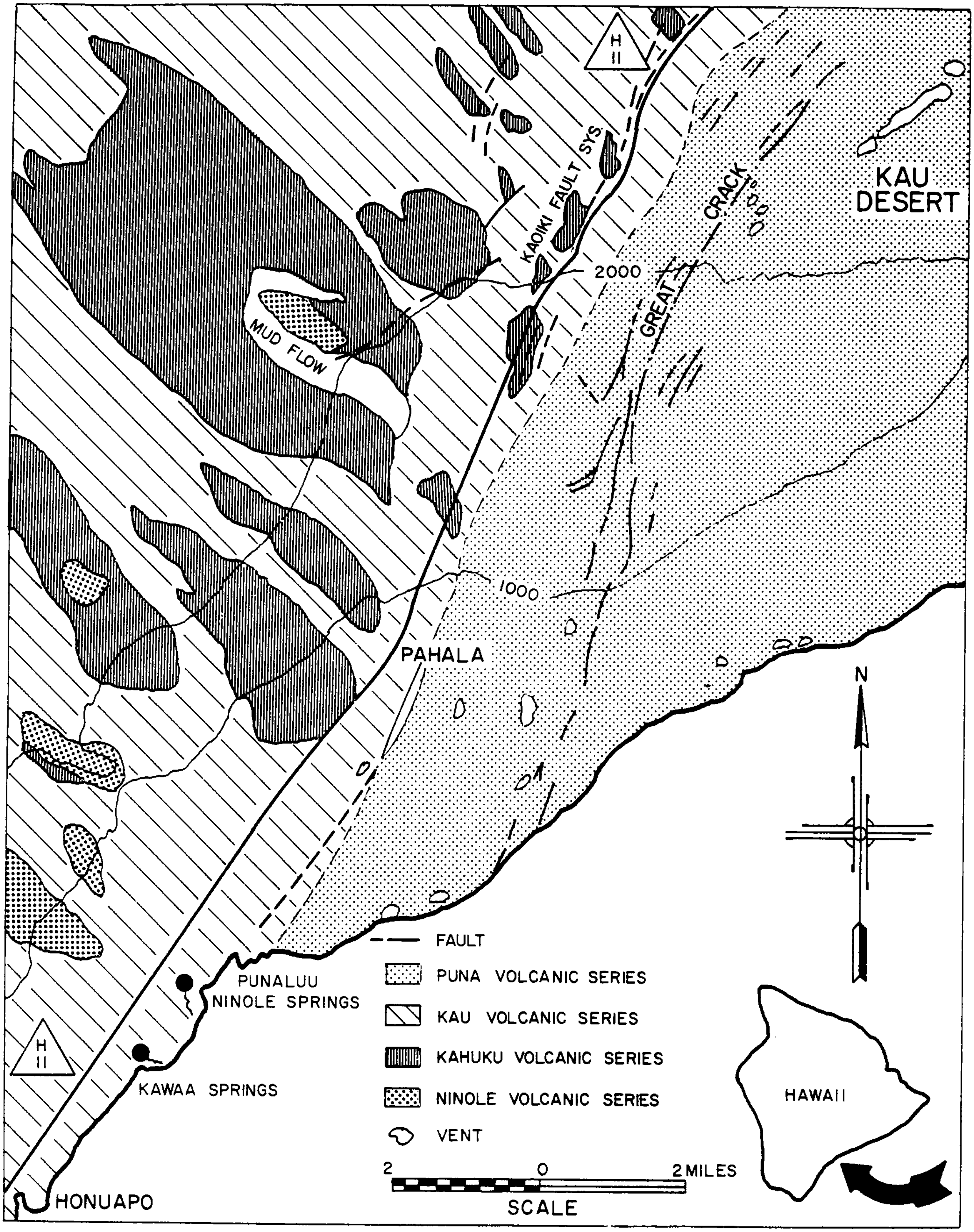
The main period of Pahala ash deposition was quickly followed by the extrusion of lavas from the southwest rift of Mauna Loa. These lavas, called the Ka'u volcanic series, cover areas between outcrops of Ninole and Kahuku formations above the Hawaii Belt Highway (State Highway II) and are the coastal rocks south of the Great Crack (Figure IV-1). The Ka'u series has been divided into the prehistoric and historic formations, but this differentiation has little hydrogeological significance.

The principal basal aquifer along the coast consists of Ka'u series basalt, but some distance inland the Ninole and Kahuku formations could occur at and below sea level. Because of the Pahala Ash blanket on and the ash beds within it, the Kahuku formation serves both as an aquiclude (perching formation) and an aquifer. Inland it is responsible for most shallow high level water and may be the source of intermediate high level water. The Ninole formation probably constitutes some of the shallow and intermediate aquifers, and it may be the formation of the Pahala high level aquifer.

All of the basaltic formations are highly permeable and are excellent aquifers. The least permeable formations are the weathered unconformity between the Ninole and Kahuku series, the ash on and within the Kahuku series, and the tuff layer in the Ninole series. The lithologic section in southern Ka'u is unusually complicated in contrast to the monotonous layering of basalts typical of Oahu and Maui.

1.1.2 Impacts on Physiography and Geology

Impacts on the physiography and geology of the project site could be caused by alterations to the topography of the site to accommodate realigned and/or new internal Resort roadways,



SOURCE: HUSSONG D.M., P.C. COX, 1967, W.R.R.C. TECH. REPORT, NO. 17

REGIONAL GEOLOGY

Punalu'u Resort

KA'U, ISLAND OF HAWAII

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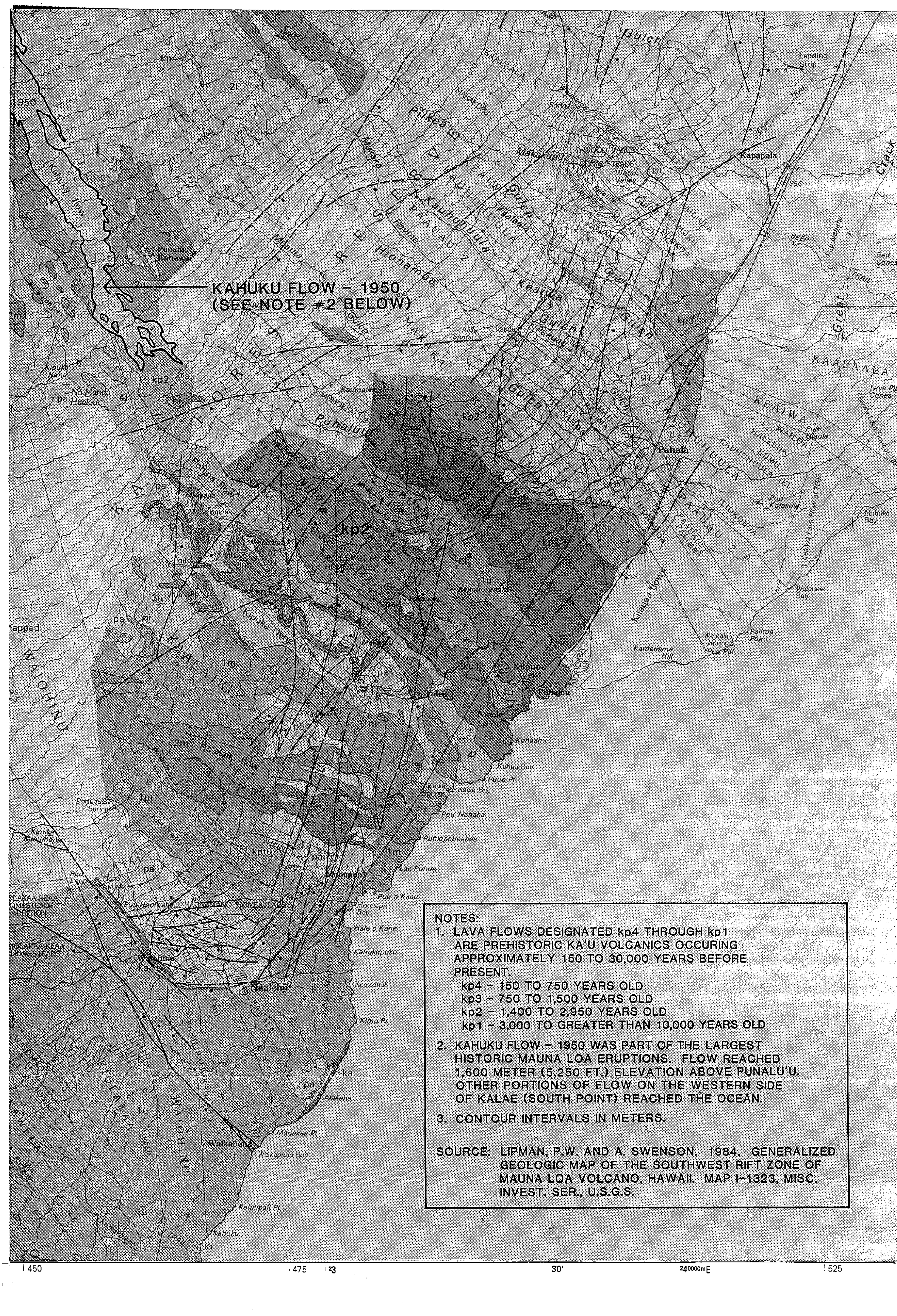
FIGURE IV-1



GENERAL GEOLOGY MAP OF SOUTHWEST RIFT ZONE OF MAUNA LOA VOLCANO

Punalu'u Resort

KA'U, ISLAND OF HAWAII

NORTH SCALE 0 1 MILES

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FIGURE IV–2

hotel/inn/condominium sites and golf course modifications. The alterations planned are relatively insignificant compared to the overall physiographic and geologic character of the site and region. As such, significant impacts resulting from the proposed project are not expected.

1.1.3 Mitigation Measures

Due to the expected lack of significant impacts on the physiography and geology of the project region and site, mitigation measures to minimize adverse impacts are not warranted. As noted in subsections 1.4.2 and 1.4.3 below (Volcanic and Seismic Activity and Subsidence), appropriate engineering, design and construction mitigation measures would be taken to minimize potential adverse impacts to the facilities to be constructed and on the physiography and geology of the project region and site that could be caused by natural hazards.

1.2 SOILS AND AGRICULTURAL POTENTIAL

1.2.1 Existing Conditions

Developed portions of the project site have modified existing soil conditions. Undeveloped portions of the site conform to the USDA Soil Conservation Service classifications listed below. According to the USDA Soil Conservation Service, there are four general soil types within the project site (Figure IV-3). They are:

(1) Lava flows, Aa: Lava flows, Aa (rLV) have been mapped as a miscellaneous land type. This lava has practically no soil covering and is bare of vegetation except for mosses, lichens, ferns and a few small Ohia trees. Aa lava flows are found from near sea level to 13,000 feet and depending on elevation, receive from 10-250 inches of rainfall annually. Aa lava is associated with the pahoehoe lava flows in many soils. Aa lava is rough and broken and a mass of clinkery, hard, glassy, sharp pieces piled in tumbled heaps in areas of high rainfall. It contributes substantially to the underground water supply and is used for watershed.

(2) Lava flows, Pahoehoe: Lava flows, pahoehoe (rLW), have been mapped as a miscellaneous land type. Pahoehoe lava has a billowy, glassy surface that is relatively smooth. In some areas, however, the surface is rough and broken, and there are hummocks and pressure domes.

Pahoehoe lava has no soil covering and is typically bare of vegetation except for mosses and lichens. However, in the areas of higher rainfall scattered Ohia trees, Ohelo berry and Aalii have gained a foothold in cracks and crevices.

This miscellaneous land type is at an elevation from sea level to 13,000 feet. The annual rainfall ranges from 10 inches to more than 140 inches.

Some flat slabs of pahoehoe lava are used as facings on buildings and fireplaces. In areas of higher rainfall, this lava contributes to the ground water supply.

(3) Punalu'u Series: The Punalu'u Series consists of well-drained, thin, organic soils over pahoehoe lava bedrock. These soils are gently sloping to moderately steep. They are on uplands at an elevation ranging from near sea level to 1,000 feet and receives from 60 to 90 inches of rainfall annually. The mean annual soil temperature is between 72 and 74 degrees F. The natural vegetation consists of Koa-haole, Christmas berry, guineagrass, natal redtop, and sand bur. These soils and Kaalualu, Kaimu, Kainaliu, Malama, Pakini, and Waiaha soils are in the same general area.

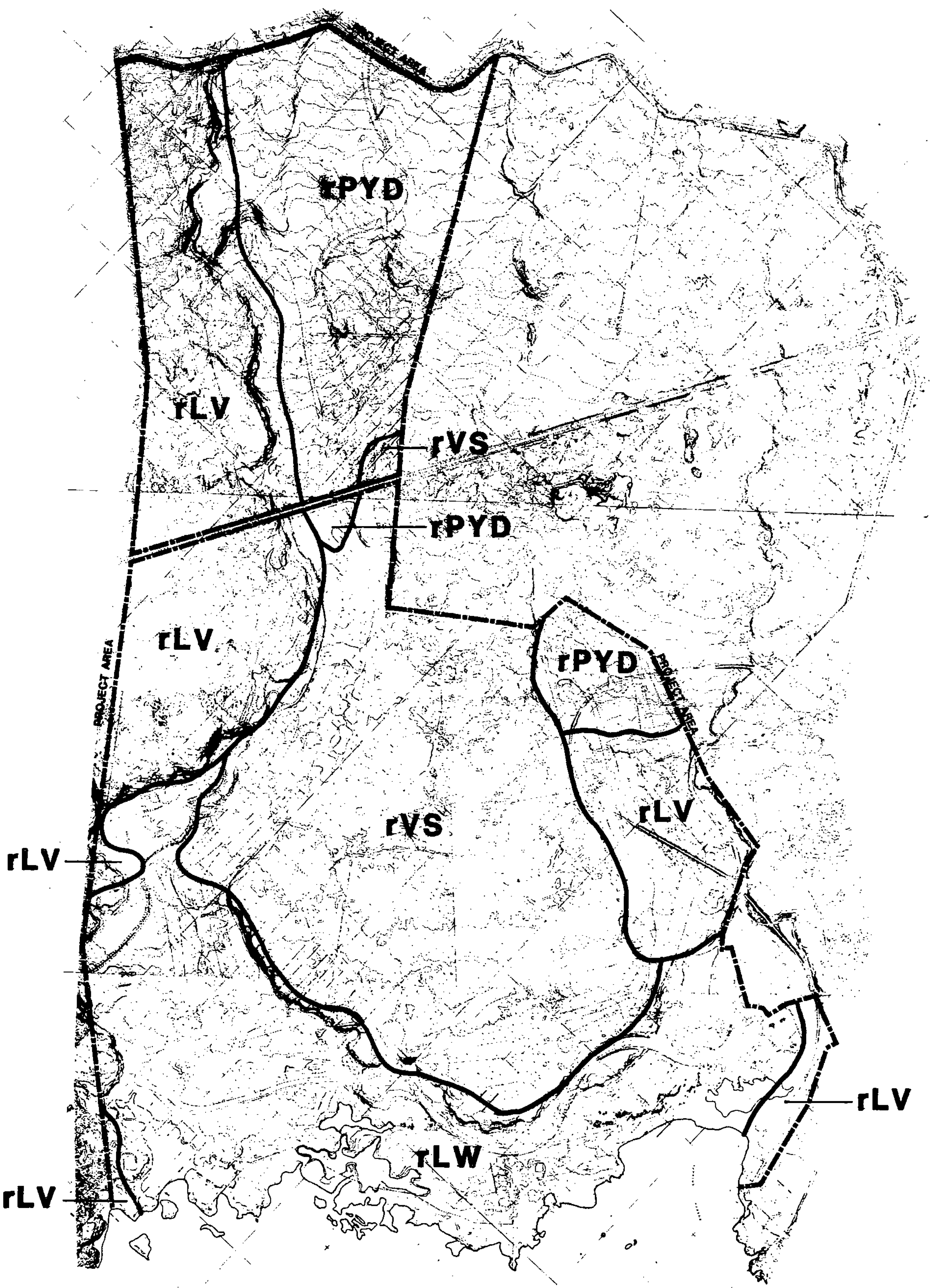
Punalu'u extremely rocky peat, 6 to 20 percent slopes (rPYD). This soil is low on the leeward side of Mauna Loa. Rock outcrops occupy 40 to 50 percent of the surface.

In a representative profile the surface layer is black peat about four inches thick. It is overlain by pahoehoe lava bedrock. This soil is medium acid.

The peat is rapidly permeable. The pahoehoe lava is very slowly permeable, although water moves rapidly through the cracks. Runoff is slow, and the erosion hazard is slight. Roots are matted over the pahoehoe lava.

(4) Very Stony Land: Very stony land (rVS) is a miscellaneous land type consisting of very shallow soil material and a high proportion of Aa lava outcrops. The dominant slope is between 10 and 15 percent. Between the lava outcrops and in the cracks of the lava, the soil material extends to a depth of 5 to 20 inches. This land type is at an elevation ranging from near sea level to 13,000 feet and receives from 10 inches to more than 150 inches of rainfall annually. The vegetation ranges from a sparse cover in dry areas to dense stands of Ohia and tree fern in areas of high rainfall. The erosion hazard is slight.

Both the Punalu'u and Very Stony Lands are further classified under capability Subclass VII. These soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or



LEGEND

rPYD	PUNALU'U EXTREMELY ROCKY PEAT	rLW	LAVA FLOW-PAHOEHOE
rVS	VERY STONY LAND	rLV	LAVA FLOW-AA

SOURCE: SOIL SURVEY OF THE ISLAND OF HAWAII,
STATE OF HAWAII, U.S. DEPT. OF AGRICULTURE,
SOIL SURVEY SERVICE, DEC. 1973

LAND AND SOIL TYPES

Punalu'u Resort

SCALE IN FEET 200 0 200 600

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FIGURE IV-3

wildlife. Both Aa and Pahoehoe lava flows are classified under Subclass VIII. These soils and landforms have undulations that preclude their use for commercial plants and restrict their use to recreation, wildlife or water supply, or to aesthetic purposes.

Land Study Bureau maps identify land type D290 as the only soil within the project site. The letter preceding the letter-number combination (Master Productivity Rating) denotes overall agricultural suitability; the number identifies land type. The Bureau rates all lands in the State on a scale of "A" to "E"; "A" rated lands have the most productive potential and "E" lands the least productive potential. The "C", "D", and "E" ratings mean the land is fair(ly), poor(ly), and very poor(ly) suited for agriculture, respectively.

The Land Study Bureau also rates agriculture alternatives for the land including vegetables, sugar cane, orchards, grazing, forage, crops, and forestry. Based on this rating all land types are either good or fairly suited for grazing; only the type "C" lands are rated "good to fair" for vegetables, orchard use or forage.

There are no Agricultural Lands of Importance to the State of Hawaii (ALISH) designations within the resort area (See Figure IV-4).

1.2.2 Impacts on Soils and Agricultural Potential

Impacts on the soils of the project site could be caused by roadway construction/realignment; underground sewer, water, drainage system modifications; electric and telephone utility installation; and the relocation and reconstruction of golf holes. Impacts on the agricultural potential of the project site are not anticipated due to (1) the lack of present agricultural activity and (2) the lack of planned future agricultural activity by the land owner.

Adverse impacts to the soils of the project site are not anticipated. The soils on the project site pose slight to moderate erosion hazards when exposed to wind and water. However, natural conditions occurring in the Ka'u area such as low annual rainfall and light winds (see Section 1.5) suggest soil loss would not pose a major problem.

1.2.3 Mitigation Measures

To mitigate potential problems during construction, several erosion control measures may be used. Soil is viewed as an asset by CBP and measures recommended by consulting engineers would be incorporated into grading plans in accordance with the

Grading Ordinance of the County of Hawaii. The lack of existing agricultural potential of the project site indicates that mitigation measures to minimize adverse impacts on the agricultural potential of the site are not warranted.

1.3 HYDROLOGY AND DRAINAGE

1.3.1 Hydrology

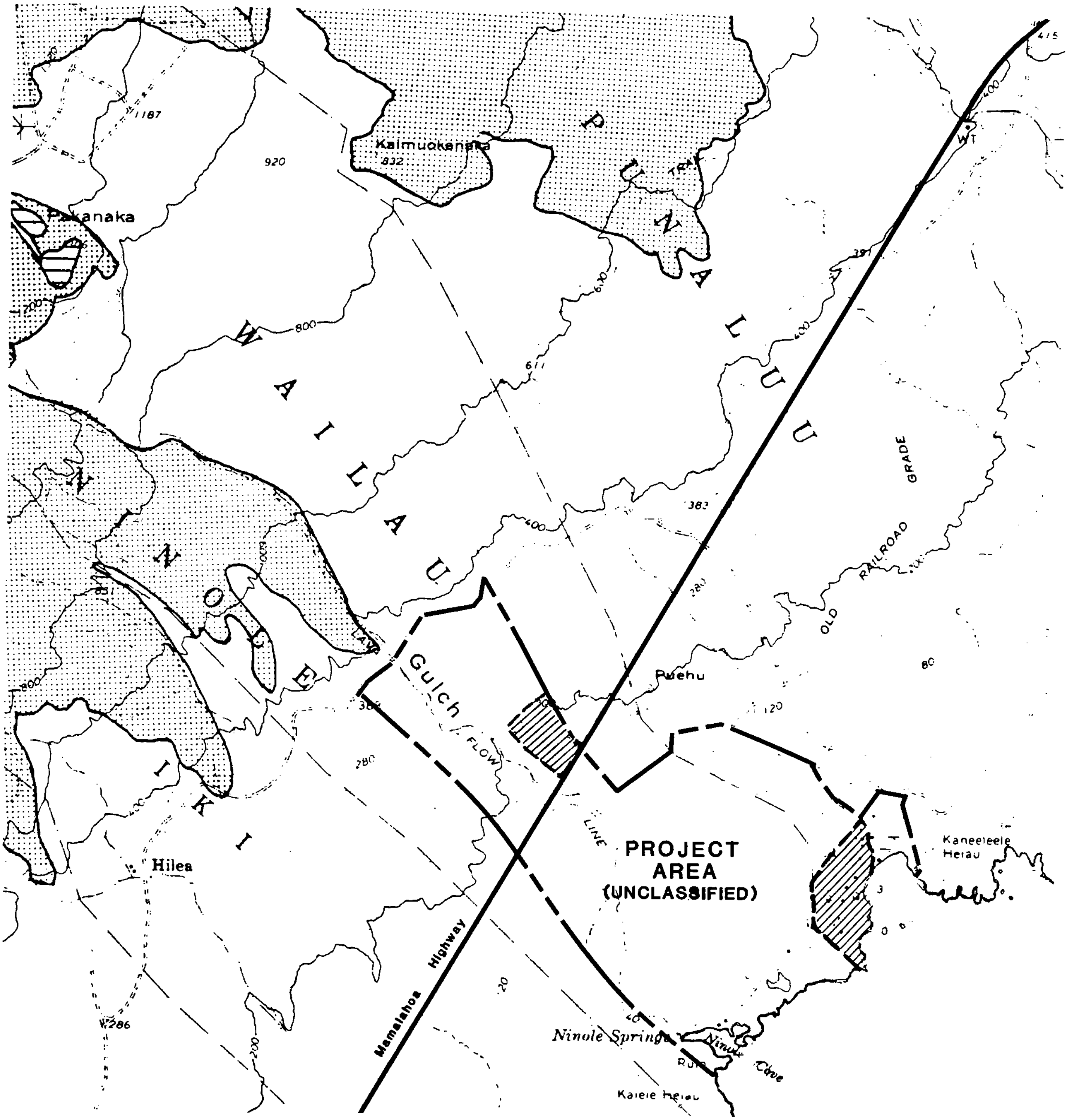
1.3.1.1 Existing Conditions

The hydrologic resources of southern Ka'u are divided into the two categories traditionally used in defining the region's resources, then subdivided into categories more relevant to planning. The major category, high level water, has had the longest history of examination; the other major category, basal water, is characteristic of Punalu'u, and has become an important water supply in the last decade. The water resources of south Ka'u are shown in Figure IV-5.

Basal ground water underlies the entire region seaward of the high level sector and may extend inland beneath areas in which intermediate high level ground water is found. Volumetrically, the basal groundwater is the largest water resource in Ka'u. High quality water is extracted from the basal lens by means of wells in the Pahala-Hilea and Na'alehu areas. Poorer quality water discharges as springs along the entire coast with the largest volumes emerging at Punalu'u and Kawa. Lesser visible volumes discharge in the embayments at Honuapo and Ka'alualu. All of the basal outflow starts its path to the sea as high quality water; it assumes various degrees of brackishness as it mixes with underlying salt water on its approach to the coastline.

The discharge of basal water is large, exceeding 100 million gallons per day (mgd) between Palima Point and Na'alehu, an average of about 10 mgd per mile of coastline. At Ninole Springs, which lies within the Resort boundaries, the average issue is 20 mgd having a chloride content of about 400 mg/l and a temperature of 64 degrees F based on USGS measurements (USGS, 1973). Additional basal water discharge along the Punalu'u coast has been estimated to be 10 to 12 mgd.

Coastal springs are the tangible evidence of the discharge of the basal groundwater where it opens to the sea. Rather than utilize the springs as a primary supply resource, it is better to drill wells inland where mixing is less effective. Three wells [Brewer's Palima and Sisal wells (State Well Nos. 1128-02 and 1129-01 respectively) and the County well at Na'alehu



SOURCE: DEPT. OF AGRICULTURE, STATE OF HAWAII, 1977

LEGEND

PRIME AGRICULTURAL LAND

UNIQUE AGRICULTURAL LAND

OTHER IMPORTANT AGRICULTURAL LAND

EXISTING URBAN DEVELOPMENT

AGRICULTURAL LANDS OF IMPORTANCE TO THE STATE OF HAWAII (ALISH)

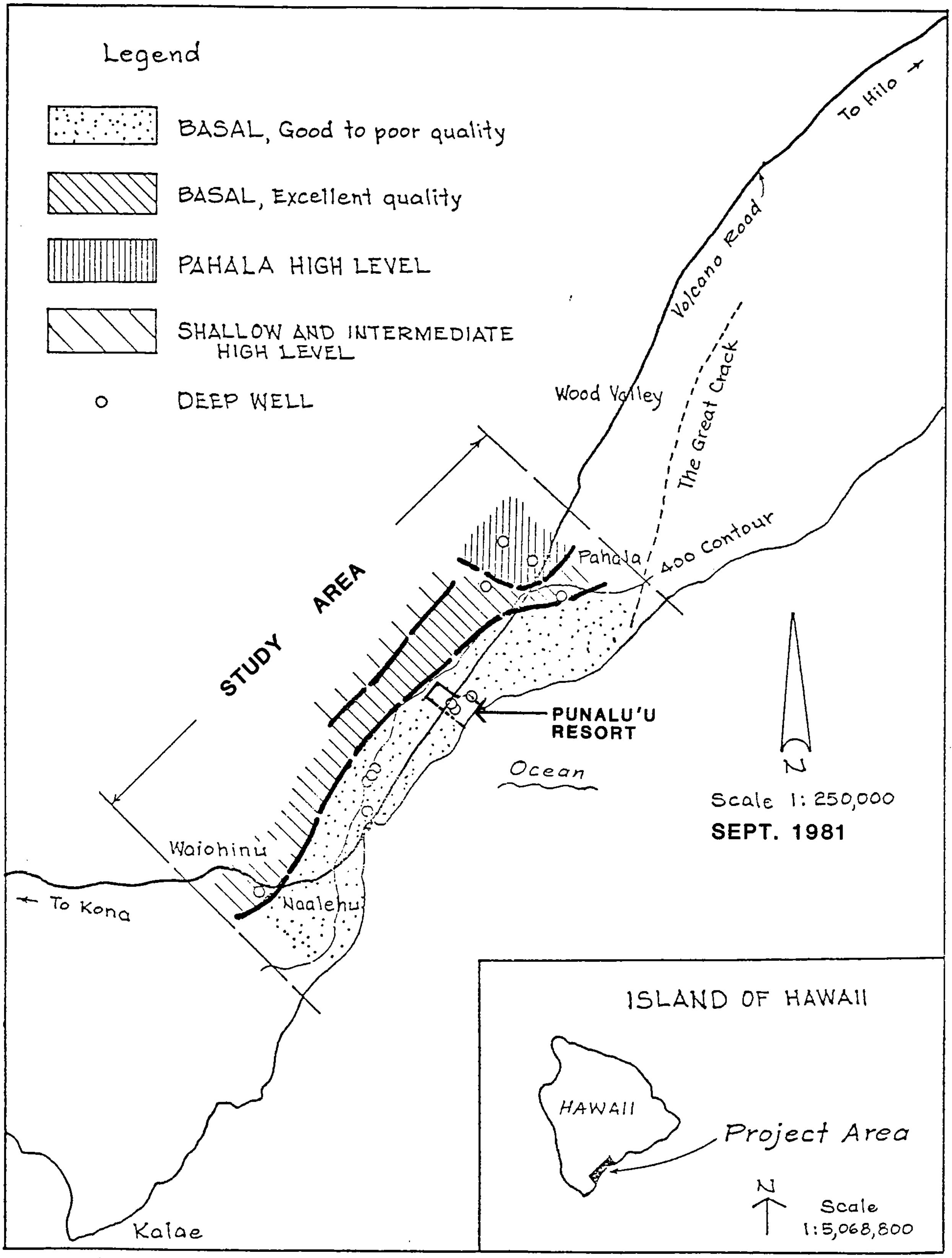
Punalu'u Resort

KA'U, ISLAND OF HAWAII

FEET
0 900 1800

pbr

FIGURE IV-4



SOURCE: OVERVIEW OF WATER RESOURCES, PAHALA-NAALEHU REGION, JOHN F. MINK, 1981.

WATER RESOURCES: PAHALA-NAALEHU REGION

(State Well No. 0335-01)] currently extract extremely high quality (less than ten mg/l chloride) water from the lens, and the Brewer Ninole wells (State Well Nos. 0831-01 and 0831-02) near the Belt Highway/Punalu'u Road intersection pump water of slightly lesser quality (about 175 mg/l chloride) but nevertheless well within potable limits (250 mg/l chloride). The plantation wells above Honuapo yield water that averages more than 500 mg/l chloride.

High quality basal water is obtainable in the region at a distance inland consistent with local geology. The deep wells developing high level and basal groundwater within the Resort area are listed in Table IV-1.

1.3.1.2 Impacts on Hydrology

Impacts to the hydrology (surface water and ground water resources) of the project area could result from increased withdrawal of potable water supplies as a result of the proposed project and the introduction of contaminants in the form of treated sewage used for golf course irrigation and/or biocides and fertilizers used on the golf course and landscape areas.

Potable water would continue to be drawn from the two Brewer Ninole wells A and B (State Well Nos. 0831-01 and 0831-02 respectively) currently supplying the Resort. These two wells, rated at 3.0 million gallons per day (gpd), are under utilized at present, due to the current low demand requirements. The continued and increased withdrawal of water from these two wells is not expected to adversely alter the ground water resources or conditions of the project area or region, due to the continued future low level gallonage requirements (2.1 mgd). It has been estimated (Mink, 1981) that more than ten mgd of high quality basal water could be safely extracted from the basal water supply two or more miles inland from the Resort. Should remedial work to the existing wells or modifications to the Resort water system be required, all work would be performed in compliance with State Department of Land and Natural Resources Administrative Rule, Title 13, Chapter 166 and Department of Health Administrative Rules, Chapter 20, Title 11.

Significant impacts to the ground water resources of Punalu'u due to the use of treated sewage for golf course irrigation and/or the use of biocides and fertilizers are similarly not expected as described in detail in Sections 2.4 and 2.5 below. Golf course areas mauka of the Hawaii Belt Highway are presently and will continue to be irrigated with potable water to prevent the possibility of pathogens or increased nutrient levels entering

TABLE IV-1

Characteristics of Deep Wells
Pahala to Waiohinu

Well Name	State No.	Ground Elev., ft.	Bottom Elev., ft.	Pump Cap., gpm	Max. Annual Production, mg	Head ft.	Chloride mg/l Initial	Chloride mg/l Later	Distance from Coast, miles	SIO_2	Ca	MG	Na	K	HCO_3	SO_4	CL	F	NO_3	Solids Det	Solids Calc	Hard Ca Mg	Hard NonC	Alk Carb	Cond	Ph	Temp C	CO_3
Basal																												
Palima	1128-02	304	-71	2000	215	9	8	8	2.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sisal	1129-01	672	-148	1500		14	6		3.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ninole A	0831-01	127		1000		4	130	170	0.7 *	41	9.2	12	80	4.4	43	24	136	0.2	1.2	NA	329	73	38	35	561	7.3	19.0	0
Ninole B	0831-02	129	-44	1000		4	130	180	0.7 *	46	10.0	16	88	4.8	40	28	165	0.2	0.8	NA	378	91	58	33	681	7.1	18.5	0
Honuapo Mill	0533-01			3900	1290	1		1300	0.1 *	43	33	86	680	24	46	169	1240	0.2	0.0	NA	2300	436	399	37	4180	7.0	19.0	0
Honuapo	0533-02	94	-36	1150	1099			580	0.6 *	43	20	44	320	14	42	86	580	0.1	0.7	NA	1130	231	197	34	2120	7.1	19.0	0
Honuapo	0533-03	89	-36	1150	417	3		500	0.6 *	43	18	38	272	12	41	75	500	0.2	1.7	NA	980	202	168	34	1850	7.0	19.0	0
Honuapo	0632-01	103	-37	1100	1100			440	0.6 *	41	17	33	245	11	44	66	440	0.2	1.3	NA	876	178	142	36	1620	7.3	19.0	0
County Naalehu	0335-01	746	-150	600	46	10	8	8	2.7	45	6.0	4.8	12	1.5	44	14	8.0	0.3	1.9	NA	114	34	0	36	128	9.0	19.5	0
Pahala High Level																												
Shaft 8	1128-01	774	-3	5000	1283	230	5	5	3.5 *	42	6.6	3.6	7.2	1.0	43	10	3.5	0.2	0.9	NA	96	32	0	35	99	7.2	19.0	0
County Pahala	1229-01	1112	+175	300		384	3		4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* Not Available

Sources: Mink, 1981 and U.S.G.S. 1973

Note: SIO_2, Ca, MG, Na, K, HCO_3, SO_4, CL, F, NO_3, Solids Det, Hard Ca & MG, Hard N on C and Alk Carb in mg/l
Cond. = 1/ohms

the well water aquifer. As noted in Section 2.5 below, the relatively low level of biocides and fertilizers used in the golf course and the absorptive properties of the soils either prevent or reduce concentrations to levels far below those that could affect public health, prior to their percolation into the basal ground water stream.

1.3.1.3 Mitigation Measures

Expansion of the Resort water system and/or increased usage of potable water for Resort purposes is not expected to have any adverse impacts on the potable or ground water resources of the area due to predicted low usage requirements versus the quantity of potable water available in basal water supplies. All elements of the water system would be designed in accordance with the most recently published water standards of the state and county, including the State Department of Health Administrative Rules, Chapter 20, Title 11 and Department of Land and Natural Resources Administrative Rule, Title 13, Chapter 166. In compliance with appropriate State Department of Health regulations, potable water supplies will continue to be monitored. Should measurements indicate that Resort operations are adversely affecting potable water supplies, appropriate mitigation measures would be taken.

1.3.2 <u>Drainage</u>

1.3.2.1 Existing Conditions

There are no perennial streams in the Ka'u District due to the highly permeable nature of the underlying lava. Rarely does runoff reach the sea coast, and infrequently do stream channels even in the wet mountain areas carry a substantial flow for more than a few days. Rain quickly infiltrates into highly permeable soil and rock formations and ultimately percolates to deep aquifers even though often temporarily arrested by perching ash beds. However during periods of intense rainfall over extended periods of time, these conditions can change as evidenced during the 1978 to 1982 storms that affected all of Ka'u District.

The project area is predominantly characterized by large open spaces and minimal paved areas. Ninole Stream, an ephemeral stream, flows along the western boundary. (Ephemeral streams flow only during and immediately after periods of heavy rainfall.) Storm runoff from the area mauka of the State Highway and west of Punalu'u Road drain to Ninole Stream. Surface runoff from Punalu'u Road is diverted into catch basins and into a reinforced concrete drain line which runs under the road and presently discharges to the ocean by a natural drainageway between Ninole

Cove and Punalu'u Beach Park. Two other drainage culverts, located within Punalu'u Beach County Park and near the Punalu'u Black Sand Restaurant area, discharge runoff from the nearby golf course areas to the ocean (Figure IV-6).

Portions of Ninole Stream experienced flooding in late 1981 and early 1982, as a result of unusually high and intense rainfall in the upper forest reserve areas. Subsequently, runoff into cultivated (sugar) lands was in volumes that were not containable in existing gulches. As a result of these storms, and those preceding 1980, Ninole Cove has been filled in with rocks and sediment. Two of the storms between 1978 and 1982 were classified as 100-year storms. The Hawaii County Floodway Boundary and Floodway Maps designate a floodway through a portion of the resort. Flood Insurance Rate Maps (FIRM) (Figure IV-7) further designate the floodway with zones AE, VE, and X. Zone AE is a flood hazard area inundated by 100-year flood and for which base flood elevations are determined. Zone VE is also a flood area inundated by 100-year flood and for which coastal flood with velocity hazard (wave action) and for which base flood elevations are determined. Zone X is an area of 500-year flood areas of 100-year flood with average depths of less than one foot or with drainage areas less than one square mile and areas protected by levees from 100-year floods.

As a cooperating member of the Ka'u Soil and Water Conservation District, Ka'u Agribusiness developed a valid land management plan in the early 1970's. The purpose of this plan is to minimize and direct water runoff and the accompanying movement of soil to preserve the land in or near an original state for subsequent generations. As noted above, during the 1978 to 1982 storms, rainwater runoff from upper forest reserve lands flowed into the planted areas in such force and volume that the measures taken by Ka'u Agribusiness to protect their lands were not sufficient to hold the water. Consequently, erosion control ditches were breached and the sides of naturally occurring gulches eroded, carrying sediment and debris downslope into Ninole Stream and Cove. It is noted that the intensity and volume of water coming out of the forested areas between Kaalaiki and Moaula was such that areas were flooded where water had not flowed in the past and that some 62 acres of sugar lands were destroyed and are no longer available for cultivation.

As a result of the late 1981 and early 1982 Ninole Stream flooding, CBP modified the stream channel by widening and deepening the stream bed; constructing retaining walls along a portion of the channel and placing earthen berms, composed of large boulders, along other portions; lining the stream in other places with boulders; and constructing a debris basin. Periodic remedial and maintenance work is performed as required to prevent future flooding.

LEGEND:

72 WATER SURFACE ELEVATIONS
100-YEAR FLOOD LIMIT
COASTAL HIGH HAZARD
CFS 50-YEAR DRAINAGE FLOWS

FLOOD STUDY AND TSUNAMI INUNDATION MAP
Punalu'u Resort
KA'U, ISLAND OF HAWAII

NORTH SCALE 200 0 300 600 FEET

APR. 1988

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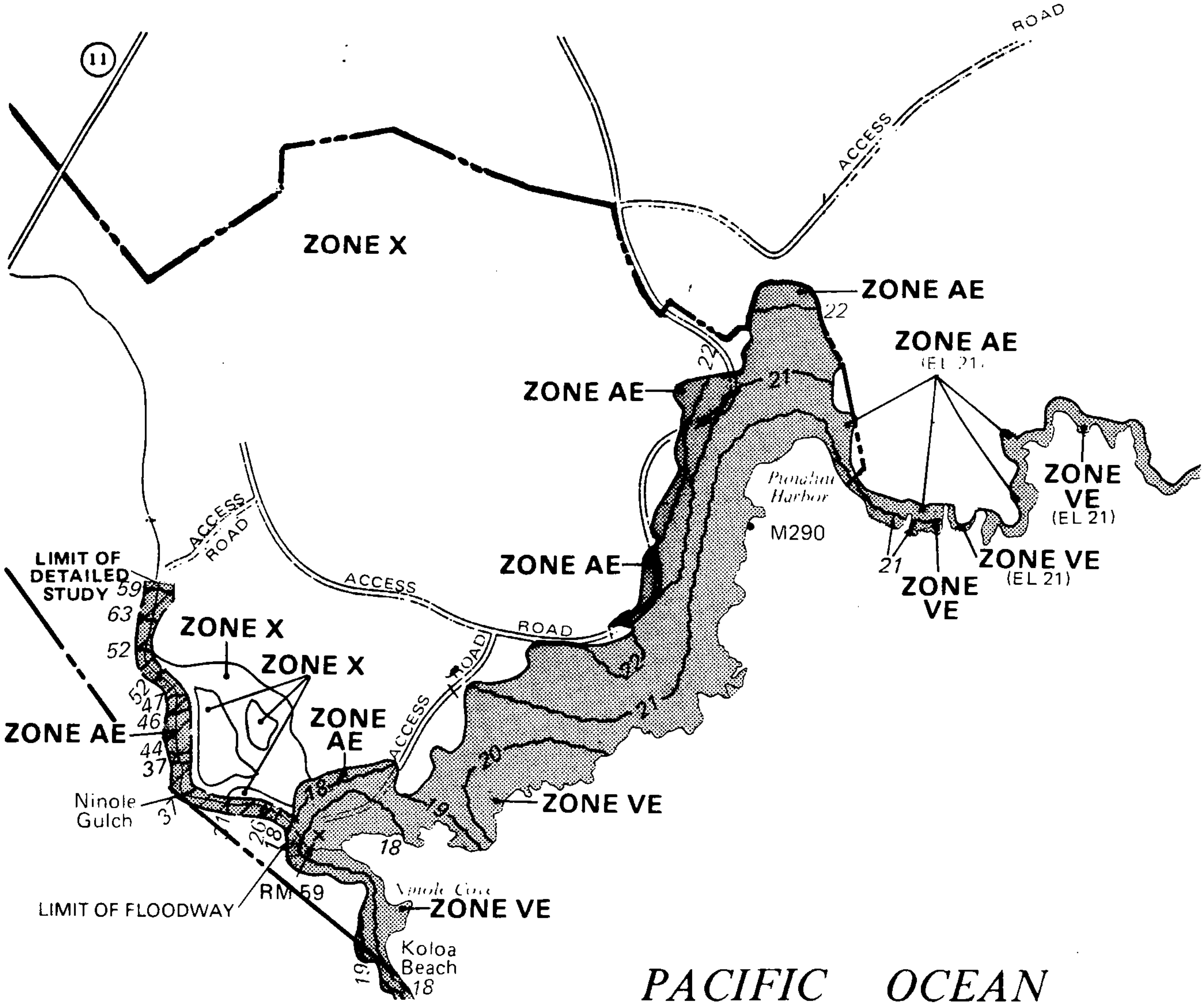
FIGURE IV-6



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A	No base flood elevations determined.
ZONE AE	Base flood elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
ZONE A0	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE A99	To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
ZONE V	Coastal flood with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X	Areas determined to be outside 500-year flood plain.
ZONE D	Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet*

D — D Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

$RM7_X$ Elevation Reference Mark

• M20 Coastline Mile

*Referenced to the National Geodetic Vertical Datum of 1929

FLOOD INSURANCE RATE MAP

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FEET
0 425 850

pbr

FIGURE IV-7

1.3.2.2 Impacts on Drainage

A drainage study was conducted on specific areas within the Resort area to determine the development's impact (Appendix E). These areas include the new Kalana II and III areas, Ninole Bluffs, Colony II, Central and Village Center. Existing areas such as Kalana I, Colony I and Golf Holes 9 through 18 will remain unchanged with future development and hence were excluded from the study.

The Rational Method, Q = CIA, was used to determine the discharges for the areas under existing conditions and with the proposed developments. Runoff from the Kalana and Ninole Bluffs areas will drain into Ninole Stream while the other areas will discharge their runoff into retention basins. In accordance with standard engineering procedures, all Resort areas were evaluated using a 50-year storm event. With the implementation of the planned developments, runoff into Ninole Stream is anticipated to increase from 92 cfs to 306 cfs a three percent increase in the 10-year Ninole Stream peak flow. Runoff from the lower areas toward the ocean is anticipated to increase from 100 cfs to 384 cfs.

Based on the drainage study, the revised drainage plan for the Resort (Figure IV-6) will utilize as much as possible the existing scheme of swales and diversion ditches in open areas. Roadway culverts and catch basins will be constructed where necessary to provide for adequate drainage of paved areas.

The catchment facilities (retention basins) serving the Colony II, Village Center and Central Area will be constructed at the downstream end of the drain line systems. They will be designed as large, irregularly-shaped depressions or basins on the edge of the golf course. Basin sizes will be constructed to contain the runoff of a 50-year storm event. These basins will have an average depth of three feet and will be grassed and integrated into the golf course grading plan.

A number of catchment schemes for the Colony II, Village Center and Central Area were examined to determine the most cost effective alternative. The selected scheme is a two-basin scheme (see Figure IV-6). Basin 1, located near the relocated golf hole 8 will receive runoff from the Colony II, Village Center and the majority of the Central Area. Basin 2, located near golf hole 7 will serve the balance of the central area.

All of the basins will be dry during most of the year. However, during large storm events, stormwater runoff will flow through the drainage system and into the basins. Debris, sediment and oil will accumulate there and will be removed by the golf course maintenance personnel.

The catchment facility for the Kalana area will be constructed at two sites on the upstream side of the Hawaii Belt Highway, one on each side of Ninole Stream. These basins will be circular, having an average diameter of 300 feet and an average depth of five feet. The basins will be grassed and integrated into the golf course grading plan.

Runoff collected in the basins will dissipate primarily by natural percolation into the porous lava subsurface. For storms larger than the 50-year storm event, part of the stormwater will flow out of the basin, into swales, and downslope toward the ocean. In the case of Basin 2 (see Appendix E), excess runoff will flow through an existing culvert and into Punalu'u Lagoon. For the worst case situation where all of the 50-year storm runoff discharges into the lagoon, a maximum ten-inch rise in water level will occur within the lagoon, assuming no losses by percolation.

It is also potentially possible that sediments suspended in runoff waters would, over time, tend to clog the porous lava substrate. Such a condition would effectively reduce the size of the retention basins, possibly cause water to stand in the retention basins for a longer period of time and/or cause the basins to overflow during periods of prolonged intense rainfall. Regular maintenance procedures are expected to reduce these potential impacts to acceptable levels.

The two other existing culverts will not be integrated into the future drainage system. The culvert in Punalu'u Beach County Park will be abandoned in place. The culvert near Ninole Cove will also be abandoned in place to prevent runoff from ultimately entering an existing coastal pond.

The present drainage system configuration, with the addition of the berm near the Colony II area (Figure IV-6) and the other drainage system modifications, is predicted to eliminate flooding on areas proposed for residential development.

1.3.2.3 Mitigation Measures

The increase in surface runoff from development can be adequately handled by the proposed expansions to the existing drainage collection system. A potential adverse impact resulting from development and increased runoff involves the discharge of oily substances into the ocean. Accumulated oil and grease will wash off the roads during storms, carrying the oily discharge to the retention basins.

To mitigate impacts of oily discharge and also to minimize potential coastal flooding problems, as noted previously, retention basins will be constructed at the downstream end of the drainage system. They will be designed as large, irregularly shaped depressions on the golf course grounds. An existing depression upstream of Punalu'u Lagoon near the 7th green, will also serve as a retention basin for runoff that discharges into the lagoon. The basins will be dry during most of the year; however, during large storm events, storm water runoff will flow through the drainage system and into the basins where debris and oil will accumulate. The retention basins will be maintained and cleaned on a regular basis by golf course maintenance personnel.

The basins will also aid in minimizing coastal floods by retaining the storm water and allowing a significant portion of the water to dissipate by percolating into the soil. Two existing culverts--one located near Ninole Lift Station and the second located in Punalu'u Beach Park--will be abandoned when the proposed retention basins are constructed. Runoff that would have drained to the two culverts will instead be diverted to a new basin to minimize future disturbance of the wetland and park areas. The existing basin near Punalu'u Lagoon will also serve as a containment facility to prevent flooding in and near Punalu'u Lagoon. By these mitigative measures, adverse impacts to the coast due to drainage will be minimized.

1.3.3 Hydrology and Drainage Summary

Based on existing conditions, i.e., large basal ground water supplies of varying quality; the high permeability of the soil and underlying lava and ash formations; and the measures that already have been taken to control surface water drainage and discharge, the proposed project is not expected to significantly affect either the hydrology or drainage patterns of the project region or site. Mitigation measures that have already been employed to contain, control and direct surface drainage into established stream channels or retention basins would be maintained and/or improved as required. The abandonment of two drainage culverts presently discharging surface runoff directly into coastal ponds or the ocean, are positive measures that would be taken to ensure the environmental integrity of the Resort coastal resources. Other mitigation measures do not appear warranted at this time. However, should it be determined in the future that the hydrology and drainage characteristics of the Resort site are being adversely affected by the proposed project, appropriate mitigation and corrective measures would be taken.

1.4 NATURAL HAZARDS

There are four major types of natural hazards that affect Punalu'u Resort: (1) storm waves and tsunamis, (2) volcanoes and seismic activity; (3) floods; and (4) subsidence.

1.4.1 <u>Storm Waves and Tsunamis</u>

1.4.1.1 Existing Conditions

Because of its exposure to southern storms, Punalu'u Resort shoreline is subjected to storm waves arriving from the southeast, south and southwest. Although the waves generally break on the beach and rocky reefs fronting the Resort, occasionally rocks and other debris are washed up onto the lower portions of the Resort. In 1975 a tsunami inundated the lower portion of the project area, contributing to the filling of Ninole Cove. Hawaii County Floodway Boundary and Floodway Maps designate the 100-year flood boundary along the shoreline as a Coastal High Hazard area and Flood Insurance Rate Maps (FIRM) (Figure IV-7) define the area as zones AE, VE and X. Zone AE is an area of 100-year flood with base flood elevations and flood hazard factors determined. Zone VE is a coastal flood area with velocity hazard (wave action) and with base flood elevations determined. Zone X are areas of 500-year flood with average depths of less than one foot or with drainage areas less than one square mile and areas protected by levees from 100-year floods.

1.4.1.2 Impacts of/on Storm Waves and Tsunamis

Impacts on the proposed project as a result of storm waves and tsunamis could be due to structures and facilities located within the storm wave and tsunami inundation area. Punalu'u Black Sand Inn, the 8th and 9th golf holes, portions of access roadways, Punalu'u Beach Park and the new shoreline access road and parking area east of Ninole Cove would be located within the storm wave and tsunami inundation area. Punalu'u Black Sand Inn would be constructed on engineered fill, thereby placing the facility above the historic coastal high water level due to storms or tsunamis. All other facilities have been designed to be flooded with little or no damage expected. Park and golf course areas may require removal of debris and sediment, depending on the extent of inundation.

1.4.1.3 Mitigation Measures

As noted above, Punalu'u Black Sand Inn would be constructed on engineered fill, thereby placing the structure above the historical high water level. The fill would be designed and engineered and landscaped with trees, shrubs and ground cover to maintain stability and to prevent erosion. Additionally, all facilities would be designed and constructed in compliance with applicable federal, state and county building standards and codes. Park and golf course areas within the historical high water level would be designed to accommodate inundation with a minimum of damage. Debris, sediment and sand removal from these areas may be required, depending on the level and extent of flooding and inundation that is experienced. In addition, a tsunami warning system would be installed at the Resort, to alert visitors and guests of an impending tsunami. Assistance would be provided by the facilities operators to ensure that people are above the historical high water level and in a safe location should a tsunami or storm waves affect the project site. Signs, advising people of the potential of high waves, would also be placed along the shoreline as a precaution to those using the shoreline areas.

Relocation of Punalu'u Road to higher elevations and reducing the developable area of the Resort by relocating the 8th and 9th golf holes to the coastal zone would also minimize the potential for storm waves and tsunamis causing damage to Resort residential and commercial facilities. Relocation of Punalu'u Road to higher elevations would also ensure that an all-weather evacuation route is available to the residents and visitors to the Resort, as well as the residents of the private property parcels within the Resort boundaries.

1.4.2 Volcanic and Seismic Activity

1.4.2.1 Existing Conditions

Volcanically, the land on which the project site is located was formed by prehistoric lava flows from Mauna Loa Volcano (Figure IV-2) (Macdonald and Abbott, 1970), whose summit rises 13,677 (see Appendix L) feet above sea level and is northwest of the project area. Mauna Loa is believed to have been formed around three successive centers and the present active cone has covered the earlier ones, thus forming one enormous shield volcano. On the island of Hawaii, seismic activity is fairly common but few earthquakes are strong enough to cause major damage. Buildings will be built in conformance with provisions of the County Building Code for Seismic Zone 3. Because of frequent eruptions on Mauna Loa, most recently in 1984, and the vulnerability of its slopes to lava flows, the project area has been designated as a risk zone "E" which is the second highest risk area on the island of Hawaii on a range of A to F and in risk of Zone 3 (the third most hazardous of nine) relative to lava flows as defined by Mullineaux, et. al. (1987). This designation represents 0.5 to 3 percent of lands in area "E" as having been buried by lava during various 20 year intervals (since 1800), leaving 97 to 99.5 percent of the land unaffected. In addition, "Area E" includes the flanks of Mauna Loa that lie directly downslope from the summit areas and rift zones where lava flows originate. Land designated "E" is susceptible to burial by lava flows erupted within the summit and rift areas designated "F". Vents along minor rift zones on Mauna Loa have erupted a few times within area "E". Mullineaux, et. al. (1987) state that only about one to three percent of the Mauna Loa area in Zone 3 has been covered by lava in historical time and about 15 to 20 percent in the last 750 years. Degree of risk within this area varies widely, but in general, it becomes less with increasing distance from the summits and major rift zones and is less on the southeast flank than on the northwest. No historic flows have reached the ocean on Mauna Loa's southern flank (Mullineaux, 1987). It is noted that a portion of the 1950 Mauna Loa lava flow descended to about 5,250 feet elevation, approximately 10 miles immediately upslope of Punalu'u in the head waters of Ninole Stream (Figure IV-2). Lipman (1980) shows the latest flows at the project site to be in Age Units 2 and 1, about 1,500 to 3,000 years old and 3,000 to 30,000+ years old, respectively. It appears, based on flows since 1800, that Punalu'u Resort is clearly in the low end of the risk range. The lowest point in the range has a likelihood of .005 per 200 years, or one every 40,000 years.

At present, Pu'u O'o vent of Kilauea Volcano, approximately 35 miles east of Punalu'u, continues to erupt intermittently with lava generally flowing to the south towards Kalapana and the coastline. These eruptions do not appear to directly impact the Punalu'u Resort area due to their distance from Punalu'u and significant topographical variations between the volcano and Punalu'u. Relatively minor effects on regional (Ka'u District) air quality and low-level earthquakes that accompany the eruptions, affect the project area as well as the majority of the Big Island.

In addition to volcanic risks associated with lava flows, the project site and all of the Big Island are subject to risks associated with tephra fall, volcanic gases and pyroclastic surges. Mullineaux, et. al. (1987), place the project site in Zone 2 (of 3) for tephra fall hazards. Tephra (volcanic ash) is produced primarily at the source of a volcanic eruption and the hazard dissipates rapidly with distance from the eruption site, although less quickly in the downwind direction. Tephra falls within Zone 2 are expected to be "frequent but thin" (Mullineaux, et. al., 1987). At the project site, light ash falls from eruptions along Kilauea's southwest rift zone would likely be the most significant.

The hazard zones for volcanic gases shown by Mullineaux, et. al. (1987), are the same as for tephra falls. Effects of volcanic gases on vegetation in the Ka'u area have been reported for Kilauea eruptions, but apparently there have been no significant effects on humans.

Deposits from pyroclastic surges (pyroclasts are the shattered and fragmented material ejected by volcanoes) have been recognized on Hawaii only adjacent to Kilauea's caldera. Mullineaux, et. al. (1987), consider a hazard zone to exist only within 10 km from the caldera, which is about 25 miles from the project site. Explosive eruptions are theoretically possible closer to the project site where Kilauea's southwest rift zone meets the coastline (approximately 8 km northeast of Punalu'u).

Seismically, the southern portion of Hawaii island is the most active area in the state. The two largest historical earthquakes occurred in the region, one on April 2, 1868 estimated to be magnitude 7.5 (Richter Scale) with an epicenter probably in Ka'u District, and one on November 29, 1975 with a magnitude of 7.2 with its epicenter in Kalapana. Other large earthquakes with epicenters near the project site included a magnitude 6 event near Pahala in 1941 and two in 1982 with magnitudes of 5.4 and 5.6 respectively (Tanigawa, et. al., 1983). "A diffuse east-west band of earthquakes located 30 km south of Mauna Loa's summit" has been named the Hilea seismic zone by Klein and Koyanagi (1985) and probably represents the location of large earthquakes closest to the project site.

The geologic reasons for the earthquakes are not clearly understood. They appear to be related to the movement of volcanic magma within the masses of Mauna Loa and Kilauea, forcing the mountain's south flanks to move to the south. Much of the surface faulting is considered to be a reflection of this movement.

Although the Mauna Loa area has been less seismically active in recent years than Kilauea, the entire region is considered to have similar seismic risk, as reflected by the provisions of the Uniform Building Code (UBC) that all structures be designed for Seismic Zone 3. Very strong ground motions are possible.

1.4.2.2 Impacts of Volcanic and Seismic Activity

Volcanic and seismic activity of Mauna Loa and/or Kilauea volcanoes could cause damage to structures proposed for the Resort. As noted above, the Resort area is almost continually subjected to microearthquakes centered around Kilauea

Volcano. Based on USGS information, it appears, as noted above, that the Resort area is clearly in the low end of the risk range of damage due to volcanic activity. Significant volcanic or seismic activity has not affected the Resort area since the great mud flow in 1868, which did damage to the Honuapo and Punalu'u areas, as well as other areas within Ka'u District.

1.4.2.3 Mitigation Measures

There are essentially no feasible mitigation measures for most volcanic and seismic hazards with the exception of adherence to appropriate building codes. To minimize the potential for damage caused by volcanic and seismic activity, appropriate design and structural measures would be taken for all buildings. This includes design and construction in conformance with provisions of the UBC and County Building Code for Seismic Zone 3. As noted above, it appears that Punalu'u Resort is clearly in the low end of the volcanic/seismic risk range and, although possible, the probability of the Resort being subjected to inundation by lava is low and less likely than at the upper section of the City of Hilo.

1.4.3 Floods

1.4.3.1 Existing Conditions

As noted previously (Section 1.3.2.1), portions of Ninole Stream experienced flooding between 1979 and 1982. As a result Ninole Cove has been filled with sediment and debris, primarily due to the early 1982 storm. The Hawaii County Floodway Boundary and Floodway Maps designate a floodway through a portion of the resort. Flood Insurance Rate Maps (FIRM) (Figure IV-7) further designate the floodway with zones AE and X. Zones AE and X are defined above in Section 1.4.1.1.

1.4.3.2 Impacts of Floods

Intense rainfall over extended periods of time in the Resort area and at upper elevations, could cause flooding of Ninole Stream and sheet flooding through the Resort.

To determine the impact of flooding on the proposed resort development, a FIRM flood study was continued to the mauka boundary of the resort (Appendix E). The purpose of the study was to predict the limits of flooding within the Resort in order to determine if further flood mitigating measures are required. The FIRM 100-year flood of 10,800 cubic feet per second was used. The flood limits of Ninole Stream through the property are shown in Figure IV-7.

The flood limit generally coincides with the limits observed by residents and employees of the resort. In general, the flood study indicated that the limits of flooding are contained within the golf course. The study also indicates that the flood overtops the State Highway on the Pahala side of Ninole Stream at the low point of the road and that a portion of the proposed Colony II will experience minor flooding if remedial action is not taken. Similar occurrences were observed during the 1981 and 1982 floods, including minor flooding (less than six inches) of Colony I from the flood fringe through the vacant Colony II parcel.

Based on the results of the FIRM study, the measures that have been taken to date to alleviate flooding (widening and deepening Ninole Stream channel in specific areas; partially lining the stream channel with rock; and expanding retention basins), in addition to proposed expansions to retention basins and the construction of diversion walls and ditches, flood conditions within the Resort area makai of the Hawaii Belt Highway are not expected to occur in the future. Resort areas mauka of the Hawaii Belt Highway may experience some flooding during periods of prolonged, intense rainfall. However, the planned retention basin and elevation of structures are expected to alleviate potential damage to inhabited buildings. Flooding is not expected to affect ingress/egress from the mauka areas.

1.4.3.3 Mitigation Measures

As indicated above, measures have already been taken by CBP to minimize the potential for flooding of the Resort. Portions of Ninole Stream have been widened. deepened or lined with rock to handle increased flows originating in upper elevations. In addition, the stream channel is periodically cleaned of debris. Other measures that have been taken include the expansion of golf course retention basins and construction of diversion walls and berms to direct potential floodwaters away from Resort facilities. Future mitigation measures that will be taken include further expansion of golf course retention basins and construction of the revised drainage system (see Section 1.3.2.3).

1.4.4 <u>Subsidence</u>

1.4.4.1 Existing Conditions

The south flanks of both Mauna Loa and Kilauea volcanoes are cut by faults, some of which have shown movement during historic earthquakes. The Honuapo fault system (Stearns and MacDonald, 1946), is approximately 3 miles west and north of the project site, and may be an extension of the seismically active Kaokiki fault system, also on Mauna Loa's flank to the northeast. These faults may represent scarps of landslide-type movement, similar to the south flank of Kilauea (Swanson, et. al., 1976), and represent one reason for the region, including the project site, to be placed in hazard zone 3 (of 4) for ground fracturing and subsidence by Mullineaux, et. al.(1987).

Long-term, gradual subsidence is occurring on the entire island of Hawaii with rates of 1.5 and 1.9 mm/yr. calculated at Honaunau and Kealakekua respectively (Moore, 1987). These rates are in addition to a worldwide rise of sea level of about 1.5 mm/yr. Thus, total long-term subsidence on the island is expected to be about 0.3 to 0.45 meters per century.

Risk of coastal subsidence on Mauna Loa is less severe than on Kilauea, where as much as 3.5 meters of subsidence occurred at the coastline during the 1975 magnitude 7.2 earthquake (Lipman, et. al., 1985). In contrast, approximately 0.1 meters uplift, essentially no movement within the accuracy of the measurements, was determined to have occurred at Punalu'u during the same earthquake. No other historical vertical movements at the project site area are known to have been documented. The geologic structural setting at the project site appears to be similar to that on Kilauea, so that subsidence similar to that noted above may be possible.

1.4.4.2 Impacts of Subsidence

Long-term subsidence is occurring throughout the island of Hawaii, and sudden earthquake-induced subsidence may also occur, but the risk is difficult to assess from historical data. Subsidence, either long-term or sudden, could cause damage to structures and facilities located within the coastal zone. As noted previously, the only major Resort structure to be located in the coastal area that might be affected by subsidence is the Punalu'u Black Sand Inn and it would be constructed on engineered fill above the historic tsunami and storm wave inundation level. Also, as noted previously, all structures would be designed and constructed to meet Seismic Zone 3 building code requirements.

1.4.4.3 Mitigation Measures

The siting of buildings and other Resort facilities above the maximum tsunami and storm wave level will more than compensate for any likely subsidence effects. Structural design and construction in accordance with the provisions of the County Building Code and UBC in effect for Hawaii County will also mitigate against possible subsidence damage.

1.4.5 Natural Hazards Summary

Storm waves, tsunamis, volcanic and seismic activity, floods and subsidence could cause damage to the Resort and/or threaten life and property. Based on the professional analyses performed (see Chapter I for list of specialty consultants), the mitigation measures that have been designed into the proposed project are expected to minimize and/or eliminate potential adverse effects caused by natural hazards. Structures within the coastal high water area would be constructed on engineered fill above the historical high water level; new and existing stream and flood retention/diversion measures have been or would be taken; and structures would be designed and constructed in accordance with applicable building code provisions. In the event of potential catastrophic seismic, volcanic, tsunami, storm wave or subsidence events, appropriate warnings would be issued and evacuation measures taken.

1.5 CLIMATE AND METEOROLOGY

1.5.1 Regional Climate and Meteorology

1.5.1.1 Existing Conditions

Ka'u District has a mean annual temperature of 72.6 degrees (F) and a mean annual rainfall of approximately 46 inches (County of Hawaii Data Book, 1980). Both temperature and rainfall vary with elevation, with upper levels tending to have lower temperatures and higher rainfall than lower coastal areas.

Based on measurements taken at several locations, wind speed and direction within Ka'u District appear to be typical of other Hawaiian island locations. In general, northeast tradewinds predominate with southerly or calm wind conditions occurring during the winter months. In addition, it is presumed that, based on the wide topographic variations found within the district and the presence of Mauna Loa, typical diurnal Big Island adabatic-katabatic (upslope-downslope) and land/sea breeze phenomena are experienced throughout the district.

1.5.1.2 Impacts on Regional Climate and Meteorology

Because of the relatively small size of the proposed project relative to the region in general, it appears unlikely that the proposed project would affect the climatic or meteorologic characteristics of the region (Ka'u District).

1.5.1.3 Mitigation Measures

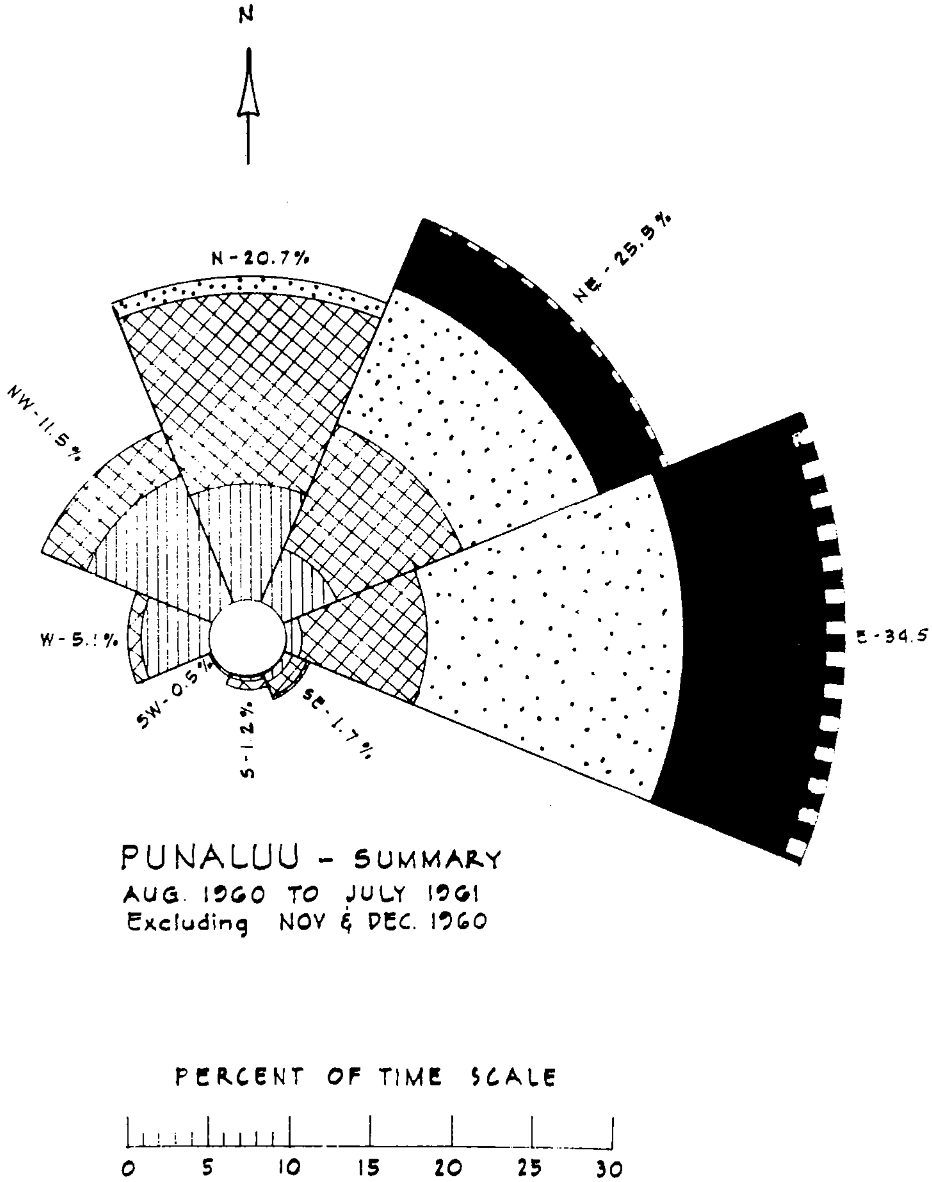
Due to the lack of expected impacts of the proposed project on regional climatic and/or meteorologic characteristics, mitigation measures to minimize adverse impacts are not warranted. Should it be determined in the future that the proposed project is impacting regional climatic and/or meteorologic conditions, appropriate measures would be taken to minimize those impacts.

1.5.2 Project Site Climate and Meteorology

1.5.2.1 Existing Conditions

The project area is fairly typical of Hawaii's climate with little seasonal or diurnal temperature variation. Monthly average temperature, based on measurements taken at the Resort, vary only about five degrees from the warmest months (August and September) to the coolest months (December and January).

Surface winds at Punalu'u are predominantly east northeast trades with stronger breezes experienced between June and September. Figure IV-8 indicates wind speed and direction data as measured at Punalu'u over a 10-month period (August 1960 to July 1961, excluding November and December 19860). As shown, average surface wind speeds are easterly 34.5 percent of the time and 8 to 12 mph approximately 15 percent of the time. Surface wind speed data for September 1960 (Figure IV-9) indicate that easterly winds prevail about 50 percent of the time and average 8 to 12 mph about 25 percent of the time. January 1961 winds (Figure IV-10) were predominantly northeast (37.3 percent) with wind velocities of 4 to 7 mph and 1 to 3 mph each about 15 percent of the time. Surface winds from the southerly quadrants are experienced less than 4 percent of the time annually and are generally less than 7 mph. During the winter months, southerly winds are experienced more frequently. January 1961 wind data (Figure IV-10) indicate that southerly winds were experienced about 14 percent of the time and were predominately 4 to 7 mph. During the same period, northeasterly winds were experienced about 37.3 percent of the time and were generally between 1 to 7 mph (30 percent of the time). Although day time/night time wind data are not available, based on the Resort's location and surrounding topographic features, and observations by Resort operations and management personnel, Punalu'u experiences typical diurnal Big Island adabatic-katabatic (upslope-downslope) and land/sea breeze phenomenon.



LEGEND

- WIND VELOCITIES 1-3 MPH
- WIND VELOCITIES 4-7 MPH
- WIND VELOCITIES 8-12 MPH
- WIND VELOCITIES 13-18 MPH
- WIND VELOCITIES 19-24 MPH

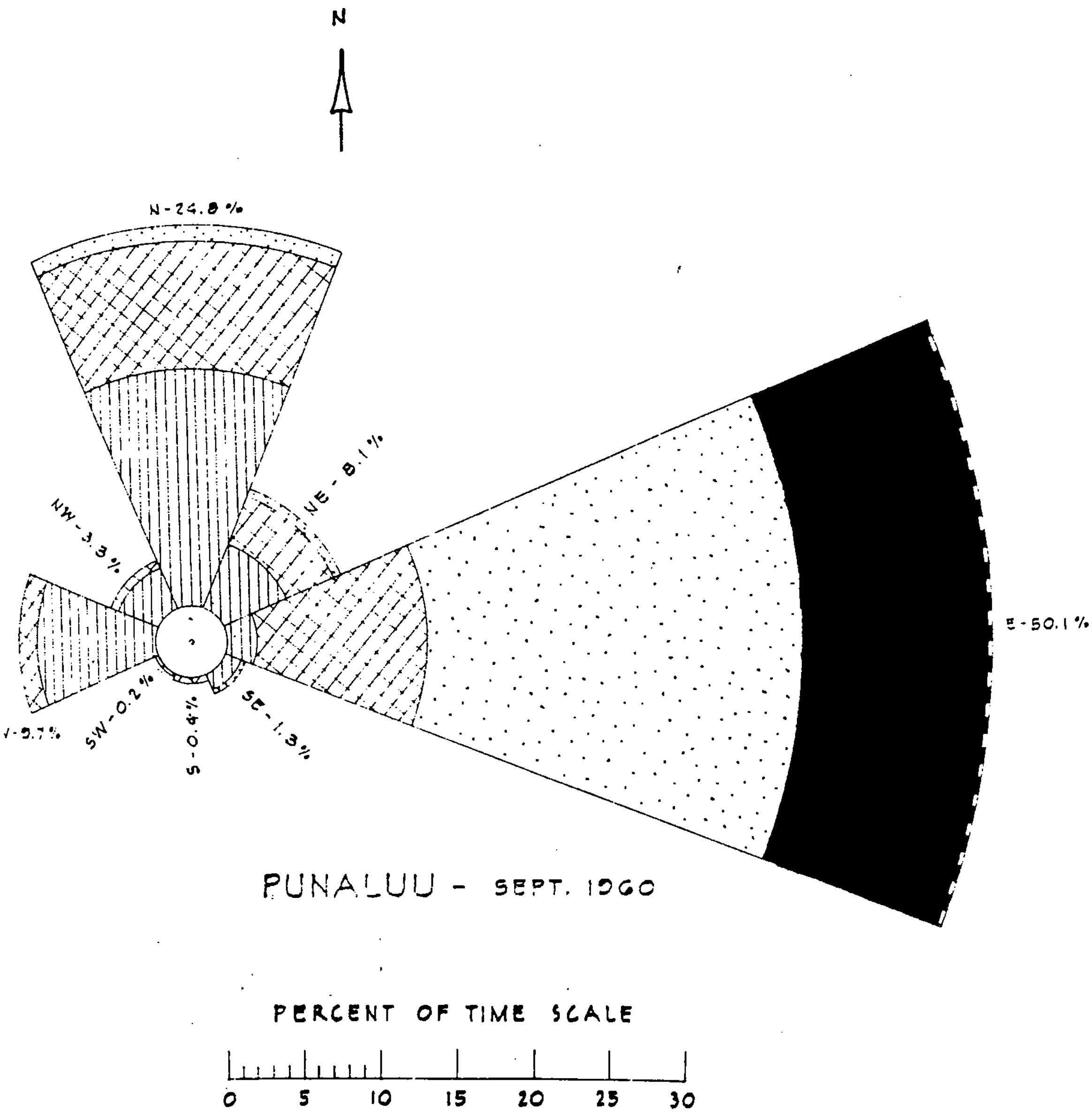
SUMMARY WIND ROSE: AVERAGE ANNUAL SURFACE CONDITIONS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

pbr

FIGURE IV-8



LEGEND

WIND VELOCITIES 1-3 MPH

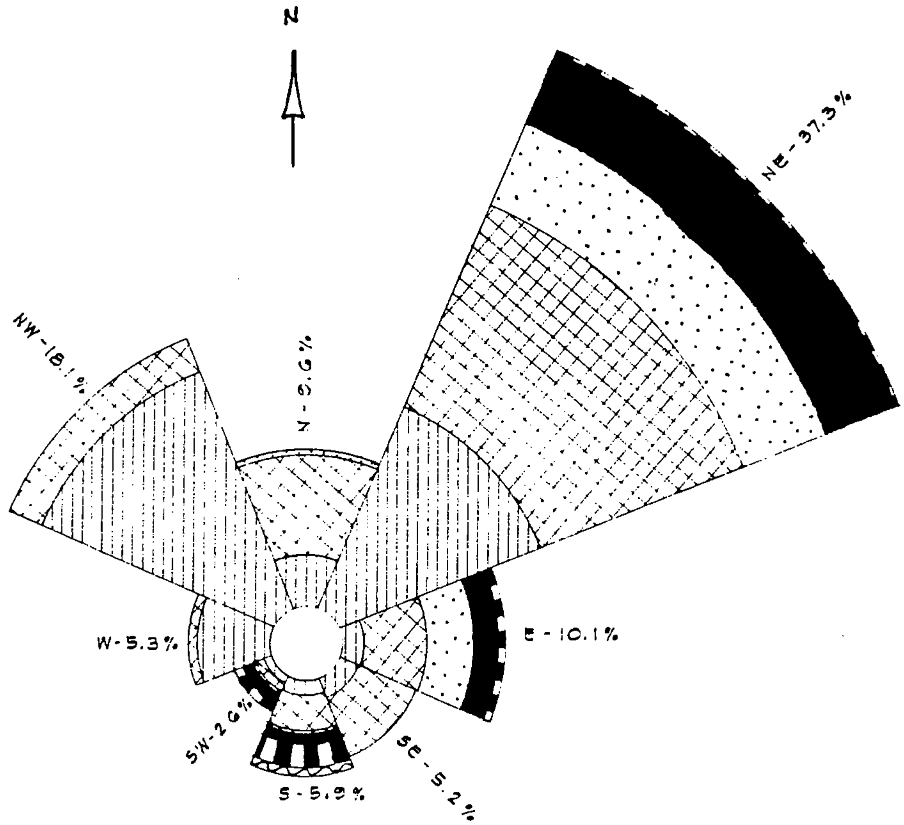
WIND VELOCITIES 4-7 MPH

WIND VELOCITIES 8-12 MPH

WIND VELOCITIES 13-18 MPH

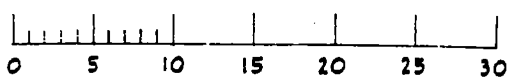
WIND VELOCITIES 19-24 MPH

WIND ROSE: SEPTEMBER 1960
AVERAGE ANNUAL SURFACE CONDITIONS



PUNALUU - JAN. 1961

PERCENT OF TIME SCALE



LEGEND

WIND VELOCITIES 1–3 MPH

WIND VELOCITIES 4–7 MPH

WIND VELOCITIES 8–12 MPH

WIND VELOCITIES 13–18 MPH

WIND VELOCITIES 19–24 MPH

WIND ROSE: JANUARY 1961
AVERAGE ANNUAL SURFACE CONDITIONS

1.5.2.2 Impacts on Project Site Climate and Meteorology

Impacts on the proposed project site climate and meteorology could be caused by significant increases or decreases in the amount of vegetation found on the project site, significant alterations to the topography of the site and/or construction of structures that would significantly alter existing wind patterns or the addition of large sources of heat generating equipment or facilities. Although landscaping plans for the proposed project would alter the existing plant species composition (see Section 2.1.5) of the Resort area, significant changes (increases or decreases) in the amount of vegetation are not planned. Similarly, significant alterations in the site topography and/or construction of structures that would significantly alter wind patterns are not planned. It is likely that localized, site specific to individual facilities, wind patterns may be slightly altered. However, the overall upslope-downslope, land/sea breeze and dominant northeast tradewind patterns are expected to remain unchanged from existing conditions. Large sources of heat (and/or cold) generating facilities are not planned for the Resort. It is possible that hotel/condominium/restaurant facilities would be air conditioned and, as such, air conditioning equipment could generate low levels of heat. However, existing site specific wind patterns, acting in concert with regional wind patterns, would tend to disperse relative minor point source heat discharges over the wider regional area, thereby negating the minor point source heat discharge effects.

1.5.2.3 Mitigation Measures

Based on the expected lack of impacts on the existing and forecast future project site climatological and meteorological characteristics, mitigation measures to minimize potential adverse impacts are not warranted at this time. Should future climatic and meteorologic conditions change as a result of the proposed project, appropriate adverse impact mitigation measures would be taken.

1.5.3 <u>Climate and Meteorology Summary</u>

The existing regional and site specific climatic and meteorologic conditions are representative of the coastal portions of the southwestern part of the Big Island. Northeast tradewinds predominate with southerly or calm conditions occurring during the winter months. Average temperatures vary with elevation and, in general, on the coastline average around 75 degrees (F). Rainfall also varies with elevation and averages about 46 inches in Ka'u District and about 25 inches at Punalu'u. Impacts to the regional and project site climatic and meteorologic conditions could be caused by significant alterations to the topography of the site, significant changes in the quantity of vegetation on the site and the addition of heat (or cold) generating sources. Relatively minor alterations in the topography of the site would be made to accommodate new and relocated facilities and roadways and new, low-rise structures would be constructed that would be air conditioned. Increased landscaping on the project site would represent a minor portion of the district and project area vegetation. The proposed project is not expected to significantly alter either the regional and/or site specific climatic or meteorologic conditions. As such, adverse impacts are not expected and mitigation measures are not warranted.

1.6 AIR QUALITY

Both federal and state air quality standards (Table IV-2) apply to the proposed project. State standards for nitrogen dioxide (NO_2), carbon monoxide (CO) and photochemical oxidants (as O_3) are more stringent than federal standards for these pollutants. State and federal standards for total suspended particulate matter (TSP), sulfur dioxide (SO_2) and lead (Pb) are the same. Federal standards are separated into primary and secondary standards, with primary standards intended to protect public health with an adequate margin of safety, and secondary standards intended to protect public health through prevention of damage to soils, water, vegetation, man-made materials, animals, wildlife, visibility, climate and economic values. In the case of automotive pollutants [carbon monoxide (CO), oxides of nitrogen (NOx) and photochemical oxidants (as O_3)] there are only primary standards.

1.6.1 Regional Air Quality

1.6.1.1 Existing Conditions

The southeastern region of the Big Island does not have any large stationary sources of air pollutants and vehicular traffic levels are relatively low as discussed in Section 5.1. Similarly, the region is not highly urbanized so that mobile source activity is not yet a serious problem. However, the southeastern region of the island could, to a limited extent, be subjected to the effects of Kilauea volcano and the almost continuous volcanic activity that has been occurring over the past three to four years. There are no continuous air quality monitoring stations in Ka'u, nor have there been any short- or long-term air quality monitoring programs in the district by either the State Department of Health or private organizations. Based on prevailing wind conditions and regime, the results of the numerous air quality studies that have been performed in Puna and eastern Ka'u Districts

Table IV-2

SUMMARY OF STATE OF HAWAII AND FEDERAL
AMBIENT AIR QUALITY STANDARDS

POLLUTANT	SAMPLING PERIOD	FEDERAL STANDARDS PRIMARY	FEDERAL STANDARDS SECONDARY	STATE STANDARDS
1. Total Suspended Particulate Matter (TSP)	Annual Geometric Mean	75	60	60
(micrograms per cubic meter)	Maximum Average in Any 24 Hours	260	150	150
2. PM-10	Annual	50	50	--
(micrograms per cubic meter	Maximum Average in Any 24 Hours	150	150	--
3. Sulfur Dioxide (SO2)	Annual Arithmetic Mean	80	--	80
(micrograms per cubic meter)	Maximum Average in Any 24 Hours	365	--	365
	Maximum Average in Any 3 Hours		1,300	1,300
4. Nitrogen Dioxide (NO2)	Annual Arithmetic Mean	100		70
(micrograms per cubic meter)				
5. Carton Monoxide (CO)	Maximum Average in Any 8 Hours	10		5
(milligrams per cubic meter)	Maximum Average in Any 1 Hour	40		10
6. Photochemical Oxidants (as O3)	Maximum Average in Any 1 Hour	240		100
(micrograms per cubic meter)				
7. Lead (Pb)	Maximum Average in Any Calendar Quarter	1.5		1.5
(micrograms per cubic meter)				

SOURCES: State of Hawaii, Title 11, Chapter 59, Air Quality Standards
Title 40, Code of Federal Regulations, Part 50

Table IV-3

SPECIAL AIR MONITORING DATA
KONA & HILO, HAWAII
1983

Date	Kona SO2	Kona TSP	Hilo SO2	Hilo TSP
	24-Hour Concentrations (ug/m3)			
----	---	---	---	---
08 Jan 83	---	---	654.7	22.6
09 Jan 83	---	---	447.7	30.6
12 Jan 83	27.0	23.4	0.6	6.9
14 Jan 83	12.0	22.2	----	----
19 Jan 83	----	----	12.2	17.6
20 Jan 83	18.9	----	----	----
04 Mar 83	4.4	39.1	32.9	53.6
05 Mar 83	0	28.4	----	30.1
07 Mar 83	----	----	0.6	37.0
08 Mar 83	0	11.9	0.6	27.5
10 Mar 83	0	12.8	21.3	38.5
11 Mar 83	----	----	0	28.2

Notes: SO2= sulfur dioxide
TSP= total suspended particulates

SOURCE: Department of Health

(relative to geothermal resource development), and the lack of stationary sources in Ka'u District, it is presumed that the present air quality in the project area is good during the majority of any given year.

Regional air quality studies that may be applicable to the Punalu'u area are those that have been performed in conjunction with the development of geothermal resources in Puna District (see Anderson, 1984; Anderson and Oyama, 1987; Houck, 1983a, 1983b, 1984a, 1984b, 1985a, 1985b, 1985c and 1985d and Morrow, 1987). These studies indicate the following conclusions regarding the general air quality of Ka'u District and impacts of volcanic activity on the air quality of the Kilauea East Rift Zone (Puna and eastern Ka'u Districts):

- Total suspended particulate (TSP) levels on the East Rift Zone are extremely low. The inhalable levels of particulates are extremely low as compared to mainland sites and standards.

- Sea salt aerosol, road and soil dust, volcanic emissions, diesel exhaust and organic material (pollen, spores, vegetative fragments and smoke particles) are the principal sources of total suspended particulates.

- Hydrogen sulfide (H_2S) and chlorine gas levels are very low and well below biological impact levels. At Volcano Village (measurement site closest to Punalu'u), hydrogen sulfide gas occurs only infrequently above the instrumental detection limits and then only slightly above it. All hydrogen sulfide levels measured were well below standards and biological impact levels.

- Sulfur dioxide (SO_2) concentrations due to volcanic activity can exceed standard values, values typical of urban areas and human health and plant impact values for days at a time. Higher SO_2 values have been measured in the upper part of the Rift Zone than in the lower portion. In the absence of volcanic impact, SO_2 values are low.

- Rain water is slightly acidic in the Puna and Ka'u districts due to the long range transport of pollutants across the Pacific. Locally, additional acidification occurs due to volcanic emissions of SO_2, and rainfall collected within approximately ten kilometers downwind of sources of volcanic fume have a consistently lower pH. Conversely, sea salt aerosol reduces the acidity of rain and areas closer to the coastline have a tendency to have a higher pH.

- The chemical composition of rain shows the impact of sea salt and, to a lesser extent, geological material. The impact of sea salt on rain water chemical composition decreases with distance from the ocean (increase in elevation).

- The complexity of the land/sea breeze and trade wind interaction is apparent in the diurnal fluctuation of wind direction and the drainage wind phenomenon that carries volcanic fume over the pali along the Chain of Craters/Kalapana Road.

- The environmental significance of the diurnal shift in wind (which is the result of downslope-upslope mountain flows and the land-sea breeze phenomenon interacting with the prevailing tradewinds as deflected by local topography) is that there is not a single prevailing downwind point from any given emission source (volcanic or anthropogenic) and that the point of maximum impact from any given source (volcanic or anthropogenic) can be expected to shift from 45 to 90 degrees daily.

- In general, all state and federal air quality standards are being met except during intensive, short-term, episodic volcanic activity periods.

In addition to the above, the air quality monitoring programs revealed that the levels of selenium, arsenic, indium, gold, sulfur, iridium and mercury increased during eruptive phases of Kilauea volcano. Rainwater samples analyzed indicated that, in general, the concentrations of these elements were below national drinking water standards (Houck, 1985d).

Additional air quality monitoring on the Big Island is conducted by the Department of Health in Hilo, some 60 miles from the project area. Total suspended particulates and sulfur dioxide are monitored and the most recent data (Table IV-3) indicate that both federal and state standards are being met. Table IV-4 shows the County of Hawaii 1980 Emissions Inventory.

More recently, air quality modeling has been performed relative to the proposed Hawaiian Riviera project at Kahuku, approximately 15 miles southwest and downwind of Punalu'u (Morrow, 1987). It was concluded (Morrow, 1987) that, based on the lack of urban development in the area and extrapolation of air quality monitoring data from Kailua-Kona, in all probability, in Ka'u District, the State's stringent air quality standards for most, if not all, air pollutant categories would be met at present. Further, although the proposed Hawaiian Riviera project would result in increased air pollutant emissions, ambient pollutant levels would continue to be well within state and federal standards.

TABLE IV-4

Emissions Inventory
County of Hawaii
1980

SOURCE CATEGORY	EMISSIONS (Tons/Year)				
	TSP	SOx	NOx	CO	HC
Steam Electric Power Plants	262.9	3232.9	1308.9	65.9	21.8
Gas Utilities	0.0	0.0	11.5	0.0	0.0
Fuel Combustion in Agricultural Industry	2251.7	995.8	798.0	0.0	7.3
Refinery Industry	0.0	0.0	0.0	0.0	0.0
Petroleum Storage	0.0	0.0	0.0	0.0	391.9
Metallurgical Industries	0.0	0.0	0.0	0.0	0.0
Mineral Products Industry	1080.1	13.6	11.5	0.0	0.0
Municipal Incineration	0.0	0.0	0.0	0.0	0.0
Motor Vehicles	262.9	177.3	3048.5	42177.3	4035.4
Construction, Farm and Industrial Vehicles	40.0	31.8	453.5	1515.7	152.4
Aircraft	5.7	4.5	45.9	1449.8	174.2
Vessels	11.4	90.9	63.2	65.9	29.0
Agricultural Field Burning	1800.2	0.0	0.0	20627.3	2445.9
TOTAL IN TONS PER YEAR:	5715	4547	5741	65902	7258

SOURCE: State of Hawaii
Department of Health

1.6.1.2 Impacts on Regional Air Quality

Impacts on regional air quality as a result of the proposed project could be caused by increased levels of vehicular traffic, increases in the generators of air pollutants, such as electrical power plants outside of the immediate vicinity of the project and continued volcanic activity at Kilauea Volcano.

Traffic generated by the Resort, in conjunction with that which would be generated by the proposed Hawaiian Riviera resort project at Kahuku and a possible space launch facility in Ka'u, would result in increases in vehicle generated pollutant emissions in the district. Based on air quality analyses performed for other proposed Big Island resorts (Morrow, 1986 and 1987), for traffic generated by Punalu'u Resort only it is estimated that, in Ka'u District, vehicular emissions of carbon monoxide, nitrogen oxides and hydrocarbons would increase, about five percent or less as compared to the county's 1980 pollutant inventory (Table IV-4). The estimated five percent increase, when added to the estimated vehicle emissions and pollutant concentrations generated by Hawaiian Riviera project (Morrow, 1987), is expected to result in the maintenance of all federal and state air quality standards along all highways and corridors leading to/from Punalu'u. Specific information relative to the potential level of vehicle activity and/or space launch vehicles is not available, and, therefore, is not included in this air quality analysis. Similarly, the lack of specific information precludes estimates of regional air quality impacts that might result from space launch activities. The primary impact of any increases in vehicle emissions would be experienced in the immediate vicinity of the Hawaii Belt Highway and, to a lesser extent, in the area downwind of the highway. Tables IV-5 through IV-8 indicate expected pollutant levels along major highway corridors on the Big Island. The traffic levels upon which these data were compiled include traffic generated by the Hawaiian Riviera Resort and Punalu'u Resort but do not include traffic that would be generated by a space launch or associated facilities.

Emissions from fossil fuel combustion for electrical power generation could be significant. The long-term impact from this source is difficult to predict due to the long-term phasing of the proposed Resort project as well as the variability in electrical generation technologies presently being examined by state agencies and private developers. For example, should the Big Island geothermal resources be developed as presently projected, there could be a decrease in fossil fuel generated electrical power and an increase in geothermally produced power. An increase in geothermally produced power would result in a decrease in fossil fuel combustion emissions but an increase in geothermal produced emissions, primarily hydrogen sulfide. Recent advances in air quality control technology tend to indicate that hydrogen sulfide, as well as other possible air pollutants, can be adequately controlled such that public health would be unaffected. Regardless of the power generation method, electrical power generation facilities are and will continue to be required to meet applicable state and federal emission control standards.

TABLE IV-5

Estimated Maximum 1-Hour CO Concentrations
1987-1997

		CO Concentration (mg/m3)		
No.	Links	1987	1992	1997
1	Hilo-Keaau	1.9	1.4	1.0
2	Keaau-Volcano	0.5	0.6	0.5
3	Volcano-Pahala	0.3	0.4	0.3
4	Pahala-Punaluu	0.3	0.5	0.6
5	Punaluu-Honoapu	0.4	0.7	0.6
6	Honoapu-Naalehu	0.3	0.6	0.6
7	Naalehu-Waiohinu	0.2	0.4	0.5
8	Waiohinu-S. Point	0.2	0.4	0.5
9	S. Point-Support	0.2	0.4	0.5
12	H. Riviera-H. Ocean	0.2	0.2	0.3
13	Haw. Ocean-Hilolii	0.1	0.1	0.2
14	Hilolii-Honaunau	0.2	0.2	0.2
15	Honaunau-Cpt Cook	1.0	1.2	1.1
	Hawaiian Riviera Access - Mamalahoa Highway Intersection	0.3	0.9	1.4
	Regional Airport Runway	n/a	0.1	0.1

Conditions:

Receptor distance	=	10 m
Wind speed	=	1 m/sec
Wind/road angle	=	20 deg
Stability	=	"D"
Background CO	=	0.1 mg/m3
Traffic volume	=	PM peak hour

Source: Morrow, J.W. 1987

TABLE IV-6

Estimated Annual Emissions of Carbon Monoxide

		Annual Emissions (T/yr)				
			w/o Project		w/Project	
No.	Link	1987	1992	1997	1992	1997
1	Hilo-Keaau	1081	734	482	759	512
2	Keaau-Volcano	493	394	259	544	426
3	Volcano-Pahala	330	265	173	507	399
4	Pahala-Punaluu	68	55	36	120	109
5	Punaluu-Honoapu	67	54	35	120	102
6	Honoapu-Naalehu	64	55	42	116	115
7	Naalehu-Waiohinu	46	40	30	112	132
8	Waiohinu-S. Point	13	11	9	32	39
9	S. Point-Support	44	37	29	108	135
12	H. Riviera-H. Ocean	100	85	66	197	227
13	Haw. Ocean-Hilolii	112	96	74	151	160
14	Hilolii-Honaunau	341	292	224	386	372
15	Honaunau-Cpt Cook	589	505	387	551	460
		3349	2623	1847	3703	3190
	Percent change: (from 1987)		-21.7	-44.8	+10.6	-4.7

Source: Morrow, J.W. 1987

TABLE IV-7

Estimated Annual Emissions of Nitrogen Oxides

No.	Link	1987	Annual Emissions (T/yr) w/o Project 1992	w/o Project 1997	w/Project 1992	w/Project 1997
1	Hilo-Keaau	183	152	125	157	133
2	Keaau-Volcano	83	81	67	112	110
3	Volcano-Pahala	56	55	45	105	103
4	Pahala-Punaluu	12	11	9	25	28
5	Punaluu-Honoapu	11	11	9	25	26
6	Honoapu-Naalehu	8	8	7	17	16
7	Naalehu-Waiohinu	6	6	5	16	21
8	Waiohinu-S. Point	2	2	1	5	6
9	S. Point-Support	5	5	4	15	21
12	H. Riviera-H. Ocean	12	12	10	28	35
13	Haw. Ocean-Hiloiii	14	14	11	22	25
14	Miloiii-Honaunau	43	42	35	55	58
15	Honaunau-Cpt Cook	73	72	60	79	72
		508	470	389	660	656
	Percent change: (from 1987)		-7.4	-23.4	+29.9	+29.1

Source: Morrow, J.W. 1987

TABLE IV-8

Estimated Annual Emissions of Non-Methane Hydrocarbons

No.	Link	1987	Annual Emissions (T/yr) w/o Project 1992	w/o Project 1997	w/Project 1992	w/Project 1997
1	Hilo-Keaau	195	123	88	127	94
2	Keaau-Volcano	89	66	48	91	78
3	Volcano-Pahala	60	44	32	85	73
4	Pahala-Punaluu	12	9	7	20	20
5	Punaluu-Honoapu	12	9	6	20	19
6	Honoapu-Naalehu	10	8	6	17	16
7	Naalehu-Waiohinu	7	6	4	16	18
8	Waiohinu-S. Point	2	2	1	5	5
9	S. Point-Support	7	5	4	15	19
12	H. Riviera-H. Ocean	16	12	9	28	31
13	Haw. Ocean-Miloiii	18	14	10	22	22
14	Miloiii-Honaunau	54	42	31	55	51
15	Honaunau-Cpt Cook	93	72	54	79	64
		576	411	300	578	511
	Percent change: (from 1987)		-28.7	-47.9	+0.3	-11.3

Source: Morrow, J.W. 1987

Volcanic activity at Kilauea could also cause long-term adverse impacts to the air quality of the Ka'u District. However, as noted above, due to the distance to the volcano, prevailing wind conditions and the present lack of adverse impacts except locally during intensive episodic volcanic activity, continued Kilauea volcanic activity is not expected to adversely affect the proposed project region air quality. In addition, volcanic activity is unpredictable and could end or begin at any time, thereby rendering predictions regarding the long-term effect on the project region air quality speculative.

1.6.1.3 Mitigation Measures

Long-term impacts on the Ka'u District regional air quality, due to increased vehicular emissions, would be mitigated partly by the natural replacement of older vehicles by newer vehicles, presumably with better emission control equipment. There are no known means of controlling or mitigating volcanically generated emissions, and as noted above, it is expected that electrical power plant emissions would be controlled by the operators of those plants in compliance with appropriate federal and state standards. Should volcanically induced pollutant emissions exceed safe public health and welfare conditions, presumably state and federal agencies would take appropriate actions, which could include evacuation of large segments of the Big Island population. Regional air quality impacts that might result from space launch facilities may require mitigation following a determination regarding those impacts as would be discussed and disclosed in any environmental impact documents prepared for a specific or conceptual space launch facility.

1.6.2 Site Specific Air Quality

1.6.2.1 Existing Conditions

The proposed project is defined in the Federal Clean Air Act as an "indirect source" of air pollution because its primary effect on air quality results from the vehicular traffic that it presently and would continue to generate at completion. In general, existing sources of air pollutants in the project area, in addition to vehicular traffic, are sea salt aerosols, roadway and soil dust, organic material (pollen, spores, vegetative fragments and smoke particles) and the limited effects of volcanic emissions. Construction activities on projects in the vicinity of the project site are also contributors to the air quality of the project site.

Although, as noted above, specific air quality data representative of local air quality in the Punalu'u area are not available, the data noted above for Puna and eastern Ka'u Districts may be instructive and possibly applicable to the project area (Punalu'u). The closest monitoring site to Punalu'u (Volcano National Park Observatory) is over 30 miles away; at a higher elevation (approximately 4,000 feet); in a totally different ecological setting (mountain versus coastal); and directly affected by active fumerole and volcanic activity within close proximity to the monitoring site. Further, the Volcano monitoring site is separated from Punalu'u by Ka'u desert and significant topographic and microclimatic changes. These differences indicate that the effects of volcanic emissions resulting from Kilauea would not, to any significant degree, directly affect the air quality aspects of the project area. Residents of population centers in Ka'u and/or visitors to the Resort have not reported health or nuisance problems associated with the present volcanic activity.

As noted above, automobile traffic entering and leaving the Resort contribute to the air quality of the project site. It appears, based on visual examinations of the site and experiences at other similar projects, that the prevailing northeast trade winds serve to rapidly disperse air pollutants generated by the present low levels of vehicular traffic.

1.6.2.2 Impacts on Site Specific Air Quality

The principal source of site specific, short-term air quality impacts would be construction activity such as grading and site development activities. Construction vehicle activity would increase automotive pollutant concentrations along the Hawaii Belt Highway as well as in the vicinity of and within the project site. Because of the relatively low volume of existing vehicular traffic, the additional construction vehicle traffic should not exceed road (Hawaii Belt Highway) capacity, although the presence of large trucks and other construction vehicles could reduce the Highway's capacity as well as lower average travel speeds, thereby locally increasing vehicle pollutant emission concentrations.

The site preparation and earth moving work would create particulate emissions as would building and on-site road construction. Construction equipment movement on unpaved on-site roads would also generate particulate emissions. EPA studies on fugitive dust emissions from construction sites indicate that about 1.2 tons/acre per month of activity may be expected under conditions of medium activity, moderate soil silt content and a precipitation/evaporation index of 50 (U. S. Environmental Protection Agency, 1978). Although there is little or no naturally occuring soil on the project site, the soil that has been and will be brought in for landscaping and golf course purposes may have more than a moderate silt content.

Vehicular pollutant emission levels for Punalu'u Resort have been inferred from analyses performed for the proposed Kaupulehu Resort in West Hawaii and the proposed Hawaiian Riviera project. Kaupulehu Resort would consist of 1,050 to 1,550 hotel/condominium units versus the 2,051 to 2,981 hotel/condominium/single-family units planned for Punalu'u. The analyses conducted for Kaupulehu indicated that traffic generated emissions of CO, NOx and hydrocarbons would increase by about 1.7 percent or less during the ten-year planning period (1985 to 1995) as compared to the county's 1980 pollutant inventory. If it is assumed that Punalu'u Resort traffic volume increases by a factor of three over that projected for Kaupulehu (due to a greater number of hotel/condominium units), vehicle generated pollutant emissions would increase about 5.1 percent over the 15 to 20-year planning period as compared to the county's 1980 pollutant inventory. It is probable that the 5.1 percent increase overstates the vehicle generated pollutant increase because it is likely that the Punalu'u Resort operators would institute a shuttle bus operation between Hilo and/or Kona airports, thereby potentially reducing the number of vehicles travelling to/from the Resort. The estimated 5.1 percent increase in vehicle generated pollutant emissions is thought to represent a "worst case" situation.

It is further estimated that ambient levels of carbon monoxide, in the vicinity of the Hawaii Belt Highway - Punalu'u Road/Alahaki Road intersection, are projected to meet both state and federal ambient air quality standards through the development period (15 to 20 years). Also, as noted previously, adding the cumulative impact of increased traffic along the Hawaii Belt Highway that would be generated by the Hawaiian Riviera project to that which would be generated by the proposed Punalu'u Resort project indicates that ambient vehicle generated air pollutant levels would continue to be within state and federal standards.

1.6.2.3 Mitigation Measures

Short-term impact mitigation measures would include water spraying during earthmoving and grading operations to control fugitive dust and assurance that construction vehicles meet federal emission control standards. The EPA has estimated that twice daily watering can reduce fugitive dust emissions by as much as 50 percent. In addition, dust barriers near existing on-site buildings might be considered should problems arise from wind-driven dust. The soonest possible landscaping, including planting of ground cover, would also assist in controlling fugitive dust.

Long-term, site specific air quality mitigation measures to minimize potential adverse impacts caused by increased vehicular traffic, would be the same as those for regional air quality. That is, it is expected that as the island's vehicular fleet is replaced by newer vehicles, emissions would be better controlled to meet state and federal standards. In addition, as noted above, it is likely that the Resort hotel operators would establish a shuttle bus system between Hilo and/or Kona airports and the Resort, thereby potentially decreasing the number of vehicles entering and leaving the Resort.

1.6.3 Air Quality Summary

Based on the analyses conducted for this EIS, it appears that the proposed project itself and/or cumulatively with the proposed Hawaiian Riviera project, would have little impact on the air quality of the Punalu'u region (Ka'u District) and/or the Punalu'u area itself. It is recognized that there would be short-term air quality impacts as a result of construction activities and long-term impacts as a result of increased automobile traffic entering and leaving the Resort as well as electrical power generation activities outside the project area. The analyses conducted indicate that these impacts would be relatively minor and would probably occur without the proposed project due to increased population levels on the Big Island. The mitigation measures to be taken during the construction period would minimize construction related adverse air quality impacts. Similarly, the in-place and to be implemented state and federal air quality protection controls have been designed to protect the health and welfare of the residents and visitors to the Big Island. Resort construction, operation and maintenance would be performed in accordance with applicable federal, state and county air quality protection regulations.

1.7 NOISE

1.7.1 Existing Conditions

Existing noise sources on the project site are limited to the relatively low volume of traffic along the Hawaii Belt Highway and Punalu'u Road, the intermittent action of the pump station located near the intersection of Hawaii Belt Highway and Punalu'u Road and natural sources such as wave action and wind. Also, fishing and pleasure craft operating in Punalu'u Harbor and visitors to the Resort contribute to the existing noise regime.

1.7.2 Impacts of Noise

Potential impacts from noise are primarily limited to those generated by the increased volume of traffic that the proposed project is expected to cause. Actual field noise measurements have not been made at the project site. The present relatively low level of traffic on either the Hawaii Belt Highway and/or Punalu'u Road did not appear to warrant field noise measurements. Discussions with acoustical experts indicated that in all probability natural noises, i.e., wind and wave actions, would dominate the present noise regime. Therefore, published noise source averages for vehicles, the principal noise generator, have been used to estimate future noise levels.

Traffic noise measurements made at other sites on the island indicate that traffic noises are within national averages. For example, noise measurements made on Queen Ka'ahumanu Highway in west Hawaii showed vehicular traffic at 50 miles per hour generated sound levels of 60.9 Leq (dB) at 50 feet and 52.5 Leq (dB) at 100 feet. Predicted sound levels were 62.0 Leq (dB) and 52.6 Leq (dB) respectively. It is expected that these levels would be the same or nearly so, at the project location, i.e., the intersection of Hawaii Belt Road and Punalu'u Road. Sound levels within the Resort are expected to be significantly lower due to reduced vehicular speed.

Due to the infrequency of operations, aircraft generated noises are not expected to impact the project area. Fishing and pleasure craft operations in Punalu'u Harbor are also not likely to impact the project area noise regime due to the low level of operations during any given day. Nighttime aircraft or boating operations are not expected to occur.

It is possible that increased use of the Resort by guests could increase noise levels in the immediate vicinity of guest activities. This potential source of noise is generally short-term and does not impact other areas.

Short-term noise impacts from construction activities are also not expected to cause adverse impacts due to their short-term nature and daytime only occurrence.

1.7.3 Mitigation Measures

Traffic and increased visitor activity generated noise would be mitigated through the use of landscape buffers along roadways and around noise sensitive buildings. Similarly, adequate roadway setbacks and other mitigation measures, such as landscaped berms and/or walls may be integrated into the proposed project. All buildings will be designed and constructed such that outdoor noises are not intrusive and to ensure that exterior and interior noise levels meet accepted standards for planned commercial, residential, and recreational uses.

1.7.4 Noise Summary

The noise analyses conducted for this EIS indicate that the proposed project is not expected to cause and/or generate significant increases in the regional or site specific ambient noise characteristics of the area. As noted above, wind and wave actions are expected to dominate the present and future noise regime of the Resort area. Vehicular traffic generated noise levels are expected to be within acceptable ranges and noise generated by resident and guest activities are expected to be short-term and localized such that they do not impact other areas.

1.8 VISUAL ATTRIBUTES

1.8.1 Views From The Hawaii Belt Highway

1.8.1.1 Existing Conditions

The existing visual character of the Resort area, when visible from the Hawaii Belt Highway, is one of a golf course and low-level multi-family residential development with landscaping, ocean and limited coastline views. For the most part, due to the vegetation along the Highway, little of the Resort is visible. The Belt Highway/Punalu'u Road intersection is landscaped and signed to indicate the Resort entrance and provides the best view into the Resort. Mauka portions of the Resort are barely visible from the Highway, with the Highway/Alahaki Road intersection affording a brief glimpse of the single family residences along the road.

1.8.1.2 Impacts on Views From The Hawaii Belt Highway

Impacts on views from the Belt Highway could be caused by an increase in the number of buildings and other facilities within the Resort and the concurrent capability to view those facilities from the highway. The proposed project would increase the number of buildings on the site, including Punalu'u Village and Village Hotel, Punalu'u Black Sand Inn and new single and multi-family residential units. These new structures would retain the present low-rise character of the Resort and the golf course would be retained, thereby maintaining the present open space character of the Resort. Additionally, the present landscaping along the highway would be maintained and new landscaping established around the new facilities. It is likely that, at completion, no more of the Resort would be visible from the highway than is presently visible, with the possible exception of portions of the multi-family structures on the west side of the Resort. Line of sight views of the Resort from points east and west of the Resort would present greater visual impacts of the Resort than at present. Based on line of sight studies (see Figures IV-11, IV-12, and IV-13), views of the coastline (where they are presently available), Punalu'u Harbor and offshore areas would not be obstructed by the Resort facilities. As noted previously in Chapter II, the Resort has been designed to blend in with and be compatible with the surrounding views to the maximum extent possible.

1.8.1.3 Mitigation Measures

To mitigate possible adverse effects on the visual character of the site from the Belt Highway, the Resort facilities will be low-rise and designed to blend in with and be compatible with the surrounding visual character of the area. As low-rise structures, all building complexes would be appropriately landscaped. The open space character of the Resort would be maintained by the golf course and the planned park and play areas. Landscaping along the project's frontage of the Belt Highway would be maintained and added to as required.

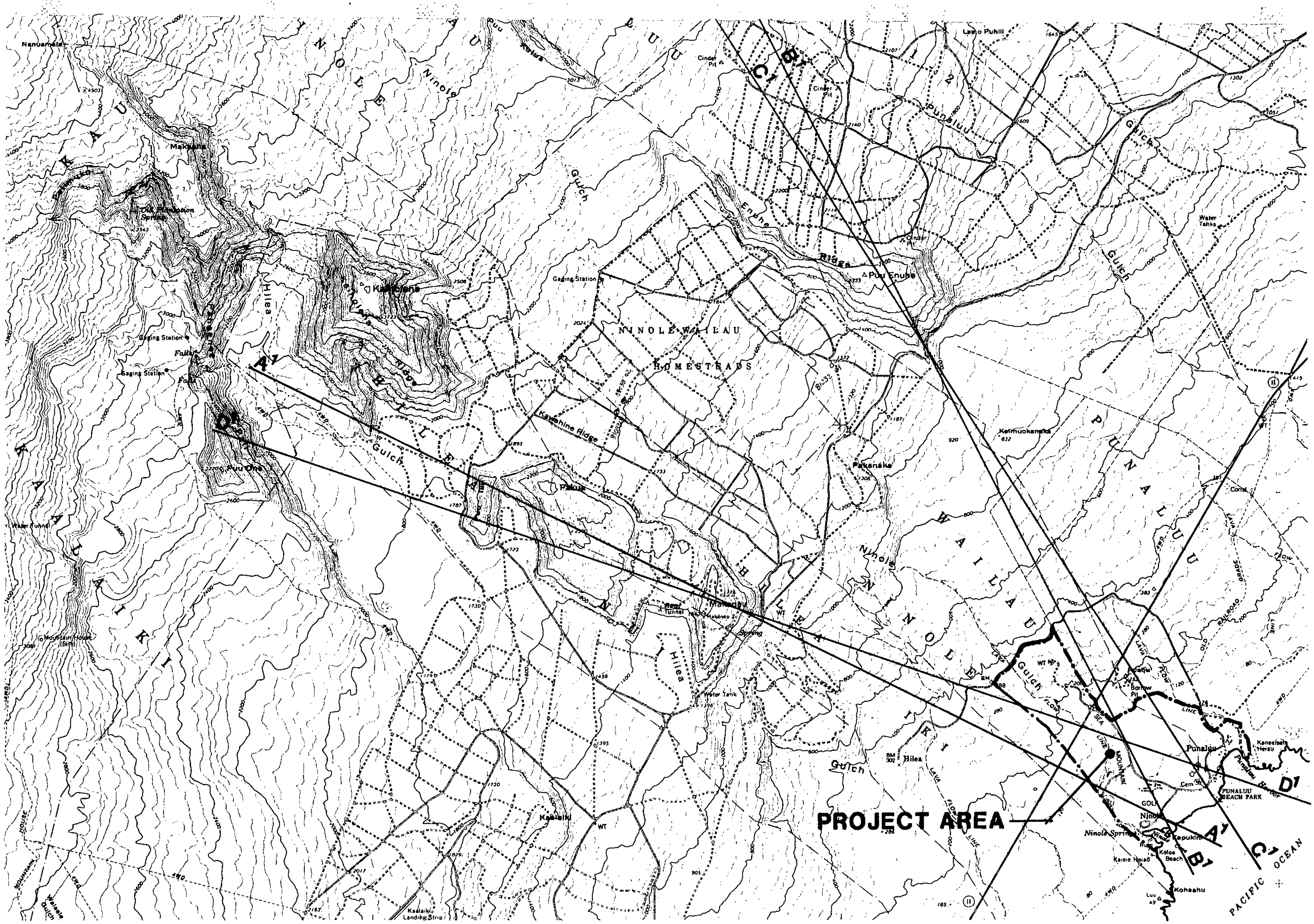
1.8.2 <u>Views From The Shoreline and Offshore</u>

1.8.2.1 Existing Conditions

At present, the view of the Resort from the shoreline and offshore is similar to that from the Belt Highway, i.e., low-rise buildings and golf course. The most prominent features are the golf course, Colony I condominiums, Punalu'u Beach Park structures, golf clubhouse and the cemetery chapel. The heiau located on both sides of the Resort and the inland views of the sugar cane fields and macadamia nut orchards, puu's (Puu Makanau and Puu Enuhe) and Mauna Loa are the most prominent features outside the Resort. According to local informants and residents of the area, the puu's inland of the Resort assist fishermen and boaters in locating offshore fishing spots and in navigating the narrow channel into the boat ramp area.

1.8.2.2 Impacts on the Views From the Shoreline and Offshore

Impacts to the views from the shoreline and offshore will be caused by the proposed hotel, inn, Punalu'u Village, multi-family residences and lagoon club structures partially blocking (depending on particular viewer location) views of the inland puu's, sugar cane fields, macadamia nut orchards and Mauna



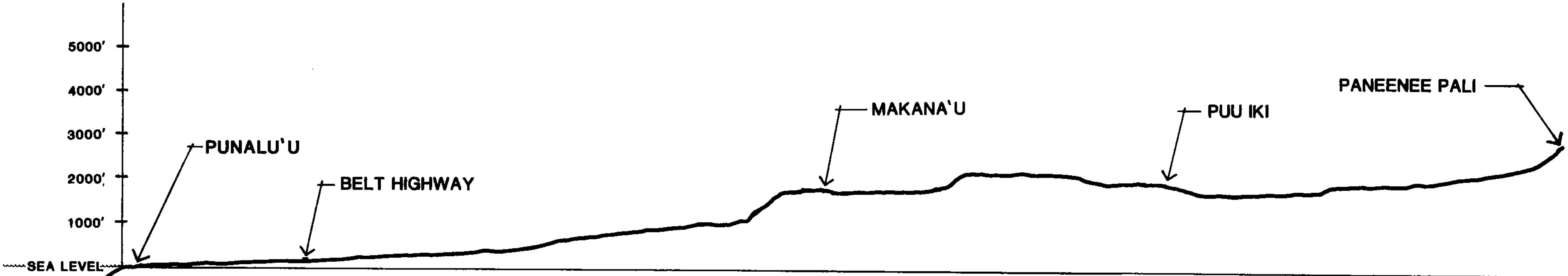
REGIONAL VIEW ANALYSIS - SECTION LINES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

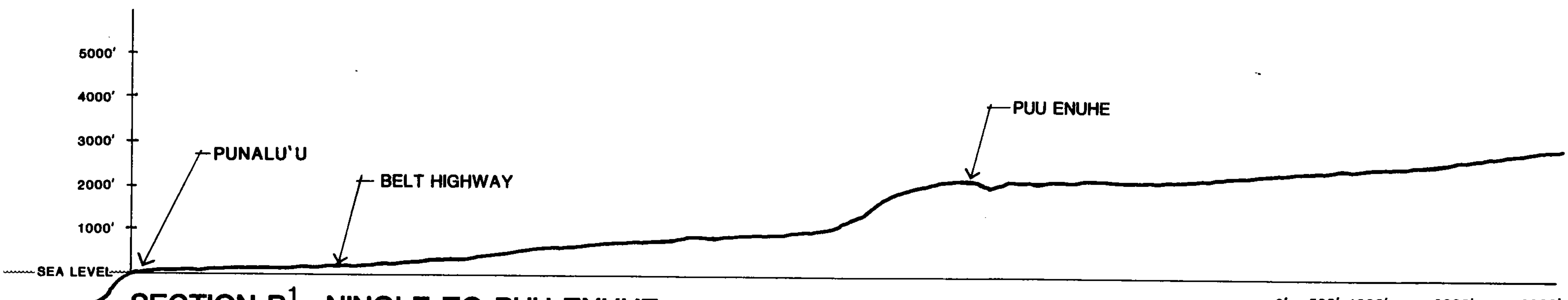
0' 2000' 4000' 6000' (FEET)

FIGURE IV-11



SECTION A[1] : NINOLE TO MAKANA' U

0' 500' 1000' 2000' 3000' (FEET)



SECTION B[1] : NINOLE TO PUU ENUHE

0' 500' 1000' 2000' 3000' (FEET)

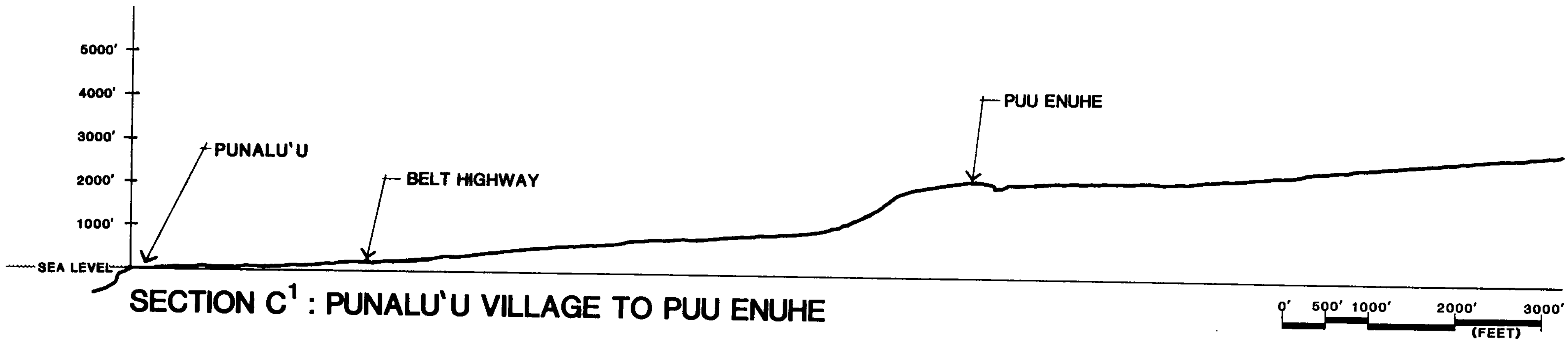
REGIONAL VIEW ANALYSIS - SECTION A AND B

Punalu'u Resort

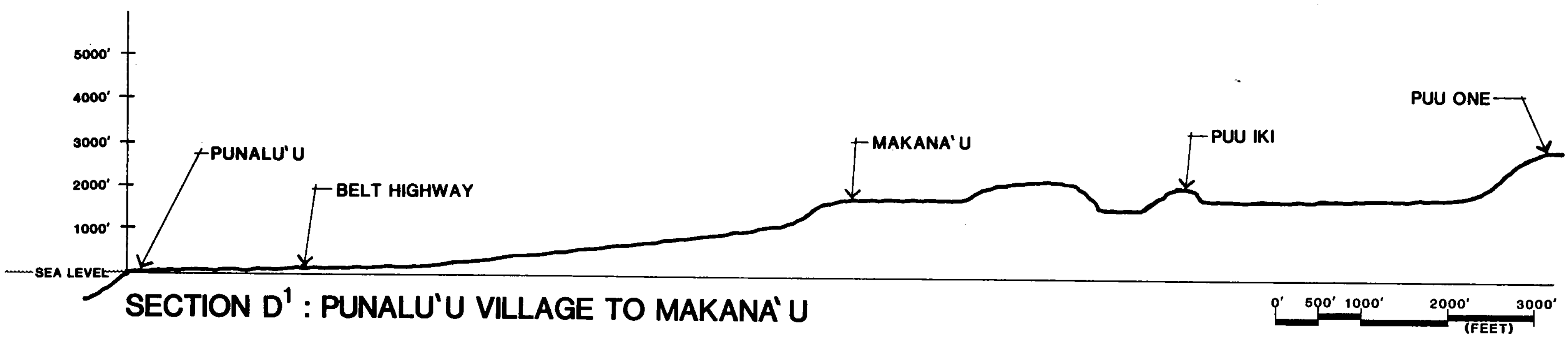
KA'U, ISLAND OF HAWAII

pbr

FIGURE IV -12



SECTION C[1] : PUNALU'U VILLAGE TO PUU ENUHE



SECTION D[1] : PUNALU'U VILLAGE TO MAKANA'U

REGIONAL VIEW ANALYSIS - SECTION C AND D

Punalu'u Resort

KA'U, ISLAND OF HAWAII

pbr

FIGURE IV-13

Loa. Changes to the coastal plain area will be caused by relocating the 8th and 9th golf holes to the coastal area and improvements to the beach park. From along the shoreline, views of the scenic backdrop created by Mauna Loa and puu's will be impacted by varying degrees depending on where along the shoreline the viewer is standing and what type of vegetation or topographic features are in the immediate foreground. Due to the low-rise nature of the proposed development, the distance the structures will be setback from the shoreline (350-600 feet), as well as the views, in general, will not be significantly impacted.

To visualize the impact of the buildings, landscaping and other improvements on the views from the shoreline, photographs were taken of the project site from various locations along the shoreline from Punalu'u Beach Park to Ninole Cove area. To accurately depict the scale of the proposed improvements, 20 foot high poles were placed within the proposed development areas during the photographs. These provide an accurate reference point and scale to construct the conceptual building forms and masses. Renderings of the conceptual improvements were then prepared that show the conceptual development of the resort from three vantage points that were selected following consultation with the County Planning Department:

A - Punalu'u Beach Park (next to pavilion)

B - Shoreline Area Along Pond #1

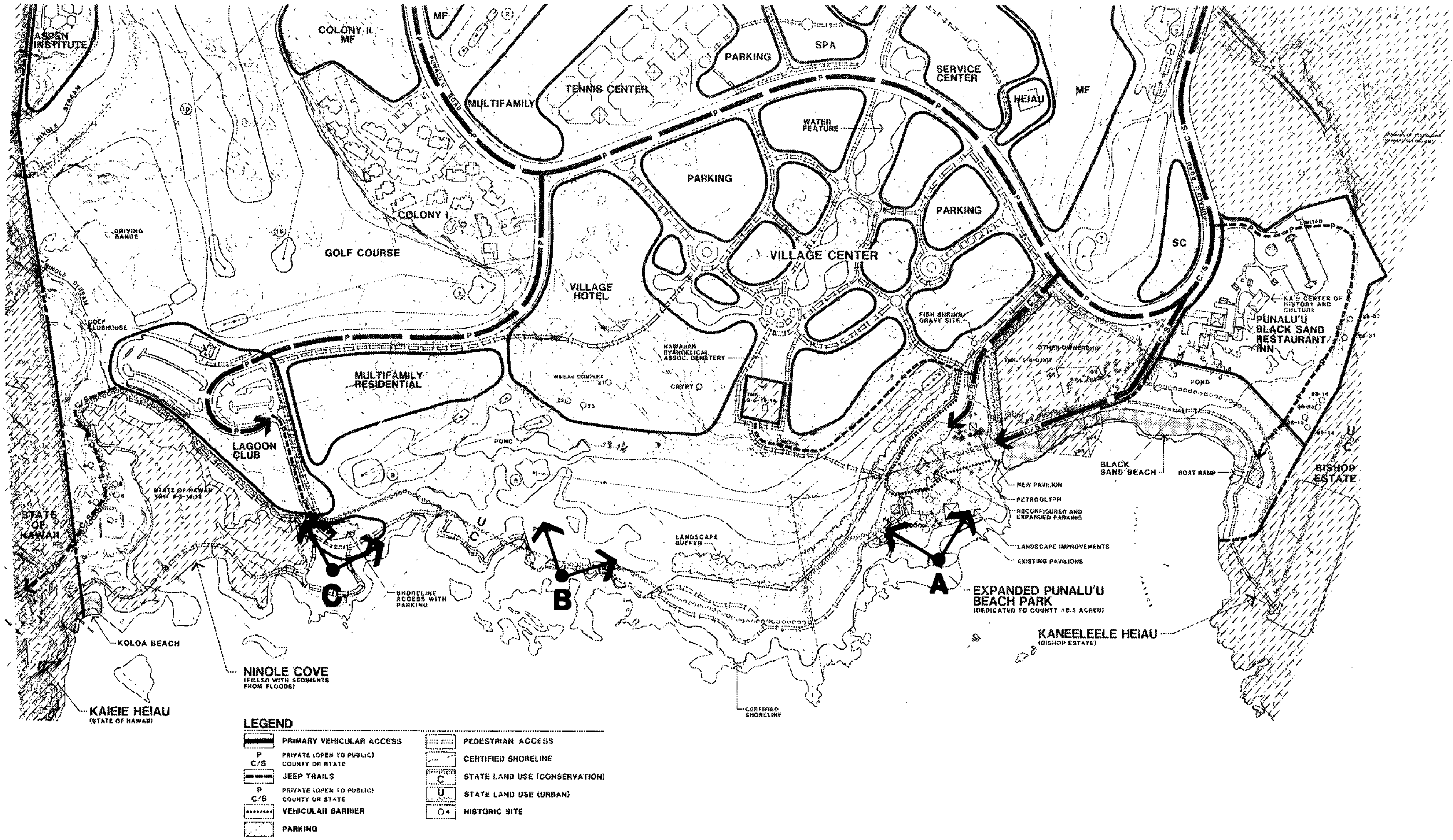
C - Ninole Cove Area

Figure IV-14 depicts the location where the photographs were taken from and Figures IV-15, IV-16 and IV-17 illustrated the expected news of the resort facilities and amenities from points A, B and C, respectively.

It is recognized that more structures would be visible from the shoreline and offshore areas at completion of the proposed project and that some view planes would be impacted. However, as shown on Figures IV-15, 16 and 17, these structures are not expected to significantly obstruct views of the areas and features inland of the Resort. The open space character of the Resort would be maintained and new buildings would be designed to blend in with and complement the visual character of the Resort.

1.8.2.3 Mitigation Measures

To mitigate possible adverse visual impacts to the inland and shoreline views of the Resort from the shoreline and offshore areas, Resort structures and facilities would be designed to blend in with, complement and enhance the present



POINTS ALONG SHORELINE WHERE PHOTOGRAPHS WERE TAKEN TO ILLUSTRATE VISUAL IMPACTS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

NORTH SCALE FEET

pbr

FIGURE IV-14

VIEW OF PUNALU'U RESORT
FROM PUNALU'U BEACH PARK, POINT A

Punalu'u Resort

KA'U, ISLAND OF HAWAII

APRIL 1988
ARCHITECTS HAWAII LTD. pbr

FIGURE IV-15

VIEW OF PUNALU'U RESORT
FROM COASTAL PONDS, POINT B

Punalu'u Resort

KA'U, ISLAND OF HAWAII

APRIL 1988

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FIGURE IV- 16

VIEW OF PUNALU'U RESORT
FROM NINOLE COVE AREA, POINT C

Punalu'u Resort

KA'U, ISLAND OF HAWAII

APRIL 1988

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FIGURE IV-17

visual character of the area. The open space character of the Resort would be maintained and enhanced through additional landscaping and maintenance of the chapel and cemetery area as open space.

1.8.3 Visual Attributes Summary

The existing visual character of the project site is one of landscaped golf course open space and low-rise multi-family residential development with appropriate landscaping. In general, the majority of the Resort is not visible from the Hawaii Belt Highway due to vegetation along the highway. The view of the Resort from the coastline and offshore areas is similar to that from the highway, i.e., low-rise buildings and golf course. Impacts to these views will be caused by the addition of new structures and alterations to existing facilities. The proposed changes will be designed to blend in with the surrounding area and to complement the existing views. Based on line-of-sight analyses and photographic view studies, the inland views of the puu, sugar lands and macadamia nut orchards would, in general, not be significantly impacted nor would the coastline views from the highway. Mitigation measures designed to minimize potential adverse effects include the design of the new facilities and retention of the present open space character of the site. No significant adverse impacts on the visual character of the site are expected to result from the proposed project.

2. NATURAL ENVIRONMENT

2.1 TERRESTRIAL FLORA

A "Terrestrial Botanical Reconnaissance Survey" of the vascular plants occurring in the undeveloped portions of Punalu'u Resort was conducted by a qualified and experienced botanist to search for and inventory rare and endangered plant species (See Appendix B). The flora within the resort is composed largely of exotic species due to development of residential and recreational facilities. The only portion of the study site where native plants form the dominant cover is along the coast. A few native palms (*Pritchardia affinis*) are found in the landscape areas among some of the coconut groves.

Four broadly defined vegetation types, described below, can be found in the project area, including Koa-haole scrub, open scrub, strand and wetland (Figure IV-18). Only the wetland vegetation has been surveyed to any great extent by Elliot and Hall (1977) in their inventory *Wetlands and Wetland Vegetation of Hawaii* which provides short descriptions and species checklists for the wetlands at Punalu'u (Site 57) and at Ninole (Site 58).

retain its present status. Vehicular and pedestrian access to the Hawaiian Evangelical Association Church and Cemetery would be provided generally following the existing route. The present vehicular access to the shoreline via jeep trails from Punalu'u Road and the beach park would be closed to protect environmentally sensitive areas and for public safety purposes.

In the Kalana area (mauka of the Hawaii Belt Highway), Alahaki Road would be extended to provide access to the new residences and condominiums. In the Ninole Bluff area, a 1,000 linear foot access road would be constructed, originating from Punalu'u Road.

Basic geometric design for these streets would be based on Ordinance No. 62 (Subdivision Ordinance) of the County of Hawaii (March 1967), the "Hawaii Statewide Uniform Design Manual for Streets and Highways" (October 1980), and the "Standard Details for Public Works Construction" (September 1984) as modified for internal Resort purposes. These modifications would include right-of-way widths, line-of-site distances and turn radii designed for a maximum speed limit within the Resort of 15 miles per hour and curbs, gutters and sidewalks only where required for safety and stormwater collection and drainage purposes. The realigned Punalu'u Road would be a collector street and would have a 60-foot right-of-way with 32-foot wide pavement. The cul-de-sacs, the road to Ninole Bluff, the realigned section of Ninole Cove Place, Alahaki Road and the access road to Punalu'u Beach Park would be minor streets with 50-foot right-of-ways and 20-foot pavements. Figure IV-25 indicates typical roadway cross sections. Subject to county approval, this typical cross-section may be modified to address specific roadway conditions and locations.

To reinforce the central theme of the resort, the streets would be designed to promote a pedestrian oriented, uncongested, and slow paced environment. The posted speed limit for the resort would be 15 miles per hour. Street parking would be prohibited along the realigned Punalu'u Road. Drainage swales, grass/groundcover planting strips, and a 4-foot wide, paved pedestrian walkway would be provided on both sides of the street. Adequate line-of-site visibility would be provided at all intersections to ensure crossings and golf cart/roadway crossings would be adequately signed to warn golfers and vehicles of the crossing. The 15 mile per hour speed limit would be enforced by Resort security personnel and the street signage, including stop signs.

Impacts due to modifications to the Resort internal access roadway system are expected to be positive or minimal. The realignment of Punalu'u Road and the beach park access road may be perceived by some as being adverse impacts. As noted previously, access to the beach park would be maintained and

The Elliot and Hall survey pre-dated the devastating flash flood events between 1978 and 1981 which radically altered the physical and biological environment of Ninole Cove.

2.1.1 Koa-haole Scrub (K)

2.1.1.1 Existing Conditions

Koa-haole (*Leucaena leucocephala*) scrub is the most commonly observed vegetation type on the project site and adjacent areas. It occurs in rather dry to moderately wet areas at low to middle elevations. Koa-haole forms dense stands. The majority of the plants during the time of this survey had almost no leaves. The defoliation is probably the result of the abnormally low rainfall received in 1984 and the recent introduction of an insect (aphid) which feeds on *Leucaena*.

The soil type (or substrate) on which Koa-haole scrub grows has a great affect on the structure and composition of this vegetation type. Two types of Koa-haole scrub recognized within the study site are:

(1) Tall-stature Koa-haole scrub with Guinea grass (KG): This vegetation type occurs in the area above the Hawaii Belt Highway (mauka parcel) and the central portion of the makai parcel (below the highway) behind the tennis courts. The substrate consists of a rocky, orange-brown soil similar to Pahala ash. The Koa-haole scrub is dense and three to six meters tall. Guinea grass (*Panicum maximum*), one to two meters tall, covers roughly 90 to 95 percent of the ground under the Koa-haole. A few large Monkeypod trees, six to ten meters tall, are scattered through the scrub. In the areas which are grazed (western boundary of mauka parcel) the Koa-haole scrub is more open, there is more Lantana (*Lantana camara*) and, although Guinea grass is abundant, a number of other grasses such as Sour grass (*Tricachne insularis*) and Natal redtop (*Rhynchelytrum repens*) are more commonly observed. Where this vegetation type borders the Ninole Gulch stream bed in the mauka parcel, a number of species which require moister environmental conditions, such as Java plum (*Eugenia cuminii*) and Kukui (*Aleurites moluccana*), are found.

(2) Short-stature Koa-haole scrub with Natal redtop (KN): This vegetation type is found in the area between the Belt Highway and the Aspen Institute. The substrate consists of very stony land. The Koa-haole scrub is rather dense, two to four meters tall, with a ground cover composed largely of Natal redtop (*Rhynchelytrum repens*). Ground cover varies from 50 to 60 percent; there are patches or piles of rocks in many areas. A number of native plants such as *Peperomia sp.*, huehue (*Cocculus ferrandianus*), 'a'ali'i (*Dodonaea sandwicensis*), and alahe'e (*Canthium odoratum*) are frequently found in these rocky areas.

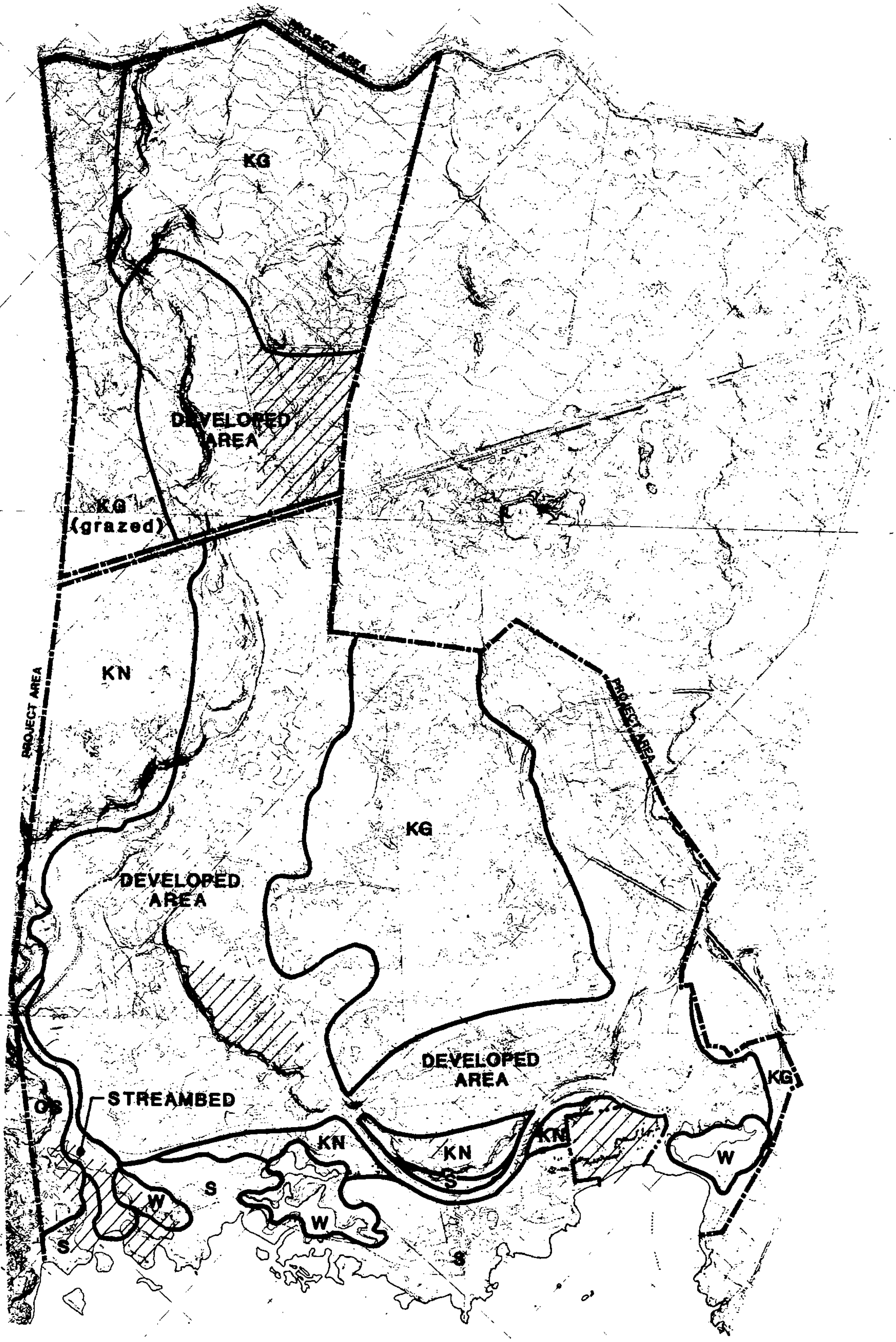
of Punalu'u Road that runs mauka of the black sand beach and makai of the private property parcels located near the Black Sand Restaurant. This section of roadway is a continual maintenance problem due to frequent covering by rock and sand washed onto the roadway by high waves and wind action. This section of county roadway would be unaffected by the proposed project. Additionally, local area residents and visitors to the Resort area frequently drive to the coastal ponds and shoreline fishing areas on jeep trails that have been created by these users on CBP property. Although accurate vehicle counts are not available, observations indicate that on any given weekend five to ten vehicles can be seen using these coastal jeep trails and numerous individuals (adults and children) can be seen walking all around the coastal area, both on and off established trails. Figure IV-23 shows existing shoreline access patterns.

5.1.2.2 Impacts to Internal Access Roadways

New road construction within the Resort would include the addition of streets in the new residential areas and the realignment of a segment of Punalu'u Road and tow access roads.

The 3,000-foot segment of Punalu'u Road between the Tennis Center and Punalu'u Black Sand Restaurant would be abandoned. In its place, a 2,500-foot segment with a new alignment would be constructed to loop around Punalu'u Village (Figure IV-24). Two new cul-de-sac roads and two realigned roads would stem from this newly aligned section: the cul-de-sacs would be constructed through the Central Area between golf course holes No. 3 and 4; an 800-foot access road would be realigned to the Punalu'u Beach County Park; and a new 500-foot section of road would connect the realigned Punalu'u Road with the existing Ninole Cove Place (Figure IV-23). All roads would be constructed in accordance with the design standards of the County of Hawaii with some modifications noted below. As noted, access to the expanded and reconfigured Punalu'u County Beach Park parking lot would be maintained via a new access road. The expanded and reconfigured beach parking lot would essentially remain in its present location, allowing people to park adjacent to the park.

Access via the realigned Ninole Cove Place would be provided in the golf clubhouse parking lot that would be expanded as indicated by a demonstrated need. Additionally, a new shoreline access road and parking area would be constructed on the east side of Ninole Cove to allow direct access from the clubhouse parking area to the shoreline. Access to the boat launch and Kane'ele'ele heiau area would essentially remain as it is, with the exception that the access road would loop around the proposed Punalu'u Black Sand Inn complex. (See Figures IV-23 and IV-24). Pedestrian access to Kane'ele'ele heiau would retain its present status. Similarly, the boat launch ramp and parking area would



LEGEND

▪▪▪▪	Approximate boundary of study site	S	Strand
KG	Tall-stature Koa-haole scrub with Guinea Grass	W	Wetland
KN	Short-stature Koa-haole scrub with Natal Redtop		PROJECT BOUNDARY
OS	Open Scrub		OTHER OWNERS

VEGETATION ZONES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

SCALE IN FEET
200 0 200 600

pbr

FIGURE IV-18

The analyses performed indicate that traffic volumes on the Belt Highway in the Resort area would increase due to the proposed project. The analysis of future conditions at completion of the project indicates that adequate capacity is available at the Hawaii Belt Highway intersection with Punalu'u and Alahaki Roads. Along the highway, volumes would be well below capacities. As noted previously, slow moving vehicles can give the appearance that highway capacity has been reached. To ensure that traffic continues to move safely and efficiently along the Belt Highway, and that safe ingress/egress to the Resort are maintained, CBP would continue to work with the State Department of Transportation and County Department of Public Works.

5.1.1.3 Primary Roadway Mitigation Measures

Because the existing capacity of the Hawaii Belt Highway is adequate to accommodate forecast traffic volumes and because the Levels of Service expected for left turning vehicles out of the mauka and makai Resort areas range between B and C (Table IV-53), traffic mitigation measures do not appear warranted at this time. Should traffic levels exceed those forecast, appropriate measures would be taken to ensure that traffic entering and leaving the Resort does not adversely impact traffic movements on the Belt Highway. As noted, CBP will continue to work with the State Department of Transportation and County Department of Public Works to ensure the safe and efficient flow of traffic.

5.1.2 <u>Resort Internal Access Roadways</u>

5.1.2.1 Existing Conditions

The present Resort internal access roadway system includes that portion of Punalu'u Road (Alanui Road) that loops from the eastern boundary of the property mauka to its intersection with the Hawaii Belt Highway; Ninole Cove Place, that intersects with Punalu'u Road and proceeds to Ninole Cove and the golf clubhouse; an unnamed roadway that leads from Punalu'u Road to the Resort maintenance yard and shops and the Aspen Institute of Humanistic Studies; and Alahaki Road that intersects with the Hawaii Belt Highway and proceeds mauka through the Kalana I single family residential area. These roadways, although generally designed to meet County of Hawaii Ordinance No. 62 design standards, do not have sidewalks or, in some cases, the county specified right-of-way width.

As noted previously, within the Resort boundaries, access to Punalu'u Beach Park is provided via the county portion

An unsignalized east Punalu'u Road/Hawaii Belt Highway intersection could provide secondary access for the Punalu'u Resort. With the increasing traffic volumes on the Hawaii Belt Highway, a separate left turn lane would be needed at the east Punalu'u intersection for Kona-bound traffic. The increase in traffic could be from general island-wide growth or any development in the vicinity, such as the Hawaiian Riviera, spaceport, or the Punalu'u Resort. The separate left turn lane would be warranted when peak hour traffic volumes on the Hawaii Belt Highway reach approximately 700 vehicles per hour; the lane would allow through traffic at the intersection to continue in the Kona-bound direction even when there are cars waiting to turn left off of the highway.

Alternative control measures, such as the prohibition of left turns at the east intersection, could alleviate the need to construct additional highway improvements. As indicated earlier, the west intersection, if signalized, would have adequate capacity to serve the project traffic.

The analyses conducted indicate that the unsignalized intersection will serve the traffic demand for both the low and high ranges of development. Levels of Service D to E would describe conditions for traffic exiting the makai Resort area and to turn left toward Kona. Left turns from the mauka residential area toward Hilo would experience Levels of Service C to E. Right turn movements, which would be provided separate lanes, would experience Level of Service A. Similarly, left turns off the highway, which would be provided a left turn storage lane, would experience Level of Service A. Levels of Service for the different turning movements are shown in Table IV-50.

On the higher speed two-lane highway (Hawaii Belt Highway), Levels of Service are related to opportunities to pass slower moving vehicles. Two-way traffic volumes and physical characteristics are used to determine highway Levels of Service. In addition, a volume-to-capacity (V/C) ratio can be calculated to indicate the highway's ability to serve traffic demand. Results of the highway analyses are shown in Table IV-51. It is noted that although Tables IV-52 and IV-53 indicate that peak hour intersection and highway traffic conditions are expected to range between Levels of Service A and E, the approximate volume-to-capacity ratios will range between 17 and 35 percent, as shown in Table IV-51. That is, the Hawaii Belt Highway is expected to have reserve capacity to handle the expected increase in traffic that will be generated by the proposed project even with the additional traffic that would be generated by the Hawaiian Riviera project. Levels of Service C to E would be caused primarily by slower moving vehicles and the inability of other vehicles to pass those slower moving vehicles, rather than by the increased number of vehicles.

2.1.1.2 Impacts on Koa-haole Scrub

Development of the Resort as proposed would require roadway relocation, realignment and construction; clearing and grading of approximately 41 acres of land; construction of buildings and related resort amenities, including golf course modifications and tennis court construction; and the establishment of new landscaped areas in place of existing vegetation. These changes are expected to result in the loss of about 40 acres of Koa-haole scrub vegetation currently existing within the Resort boundaries. As noted in Section 2.2.1.1 below, the Koa-haole scrub vegetation type is one of the habitats for several species of introduced birds, including the Japanese white-eye (Zosterops japonica), both Barred (Geopelia striata) and Spotted (Streptopelia chinensis) doves and the House finch (Carpodacus mexicanus). These birds also inhabit other vegetation habitat types, including the presently built up areas of the Resort. The loss of approximately 30 percent of the Koa-haole scrub vegetation could place population and food availability strains on these species and result in some individuals relocating to other nearby and/or adjacent areas that would be unaffected by the proposed project. It is estimated that there is sufficient Koa-haole scrub vegetation immediately adjacent to the proposed project area that could serve as habitat for those individuals who relocate to other areas without overpopulating those adjacent areas. Other individuals are expected to remain on-site and adopt the new landscaped habitat that would replace the Koa-haole scrub vegetation type. The species of birds inhabiting the Koa-haole scrub habitat are readily found in other vegetation types and are adaptable to their surroundings.

2.1.1.3 Mitigation Measures

The Koa-haole scrub habitat that is lost due to the proposed project would be replaced with new landscaped areas. The new landscaped areas are expected to serve as habitat for the species of birds that presently inhabit the Koa-haole scrub vegetation type. Native plants found within the Koa-haole scrub habitat, including Peperomia sp., huehue, 'a'ale'i and alahe'e, would be retained to the extent possible and/or replanted in other areas as part of the Resort landscaping plans.

2.1.2 Open Scrub (OS)

2.1.2.1 Existing Conditions

The open scrub occupies only a small portion of the study site. It occurs on the aa lava flow west of Ninole Cove. The aa flow is 85 to 95 percent bare; small patches of scrub

TABLE IV-52

Unsignalized Intersection
Hawaii Belt Highway/Punalu'u Road/Alakahi Road
Levels of Service

Controlled Approaches	Level of Service	
	Low Range	High Range
Mauka-bound: West Punalu'u Road		
Left/through lane	F	F
Right turn lane	B	D
Makai-bound: Alahaki Road	E	F
Hawaii Belt Highway left turns		
To makai (from Hilo)	B	C
To mauka (from Kona)	A	A

TABLE IV-53

Signalized Intersection
Hawaii Belt Highway/Punalu'u Road/Alakahi Road
Levels of Service

Approach	Level of Service	
	Low Range	High Range
Mauka-bound: West Punalu'u Road		
Left/through lane	B	C
Right lane	B	B
Makai-bound: Alakahi Road	B	B
Hilo-bound: Hawaii Belt Highway		
Left turn lane	A	B
Through lane	A	B
Right turn lane	A	B
Kona-bound: Hawaii Belt Highway		
Left turn lane	C	C
Through/right turn lane	A	B
Overall Intersection	B	B

usually consisting of the shrubs Pluchea odorata and Schinus terebinthifolius and grasses and herbs such as Natal redtop and 'ihi (Portulaca cyanosperma) are scattered over the flow. A few shrubs of the native False sandlewood or naio (Myoporum sandwicense) are found in this vegetation type. In between the large aa boulders where some organic material has settled and where it is moister, the Sword fern or kupu-kupu (Nephrolepis multiflora) and 'iwa'iwa fern (Doryopteris decora) are frequently found.

2.1.2.2 Impacts on Open Scrub

Impacts to the open scrub vegetation type could be caused by clearing and grading operations and construction within the vegetation type. However, impacts on the open scrub vegetation type are expected to be minimal due to the limited extent of the open scrub habitat and the lack of construction activity in the habitat. As noted above, this vegetation type is found mostly within the Ninole Cove area that would be unaffected by the proposed project.

2.1.2.3 Mitigation Measures

As indicated above, the open scrub vegetation would be unaffected by the proposed project. As such, mitigation measures do not appear warranted at this time. Should future conditions indicate adverse impacts are occurring to the open scrub habitat, appropriate mitigation measures would be taken to minimize those impacts.

2.1.3 Strand (S)

2.1.3.1 Existing Conditions

The strand vegetation is found along the shore where it is subject to varying amounts of salt spray and wind exposure. The largest numbers of native species occurs in this vegetation types. Close to the water's edge on the pahoehoe lava, low mat-forming species such as 'akulikuli (Sesuvium portulacastrum), nehe (Lipochaeta integrifolia), 'ilima (Sida fallax), Fimbristylis pycnocephala and 'ihi (Portulaca cyanosperma) occur. Further inland, where salt spray and wind exposure are less, shrubs of Naupaka (Scaevola taccada), noni (Morinda citrifolia), and Tree heliotrope (Messerschmidia argentea), as well as vines such as Kauna'oa (Cuscuta sandwichiana) and Nanea (Vigna marina) are found.

TABLE IV-51

Highway Conditions
Peak Hour

	Highway Condition Low	Highway Condition High
Hawaii Belt Highway - Pahala side		
Two-way volume	1,372	1,672
Level of Service	E	E
Approximate V/C Ratio	0.58	0.71
Hawaii Belt Highway - Na'alehu Side		
Two-way volume	1,099	1,265
Level of Service	E	E
Approximate V/C Ratio	0.46	0.53

For unsignalize intersections, the delays encountered by drivers on a stop or yield controlled approach determine the level of service. With separate turn lanes, an unsignalized west Punalu'u Road/Alakahi Road/Hawaii Belt Highway intersection would be able to accommodate traffic generated by up to 56 percent of the proposed high range (or about 1,670 units). However, if the Punalu'u development proceeds at a slower rate, the increasing highway traffic will cause over-capacity conditions at this intersection with the completion of as few as 1,450 units (71 percent of the low-range). The Level of Service F, shown in Table IV-52 for the west Punalu'u Road and Alakahi Road approaches indicate that full development of the resort would create over-capacity conditions at this unsignalized intersection of west Punalu'u Road, Alakahi Road, and Hawaii Belt Highway.

For signalized intersections, levels of service are determined by the average length of delay in seconds; delay is a measure of driver discomfort, frustration, fuel consumption and lost travel time. Table IV-53 summarizes the results from the signalized analysis of the west Punalu'u Road/Alakahi Road/Hawaii Belt Highway intersection. With the signals, this intersection would be able to handle all of the traffic generated by the proposed development if turn lanes are provided. For the west Punalu'u Road approach, a separate right turn lane would be needed. On the Hawaii Belt Highway, separate left and right turn lanes should be provided at the Hilo-bound approach, while the addition of a separate left turn lane would be sufficient for the Kona-bound approach. A single lane to serve all movements would be adequate for the Alakahi Road approach. Overall, the signalized intersection would operate with good conditions at Level of Service B.

2.1.3.2 Impacts on Strand Vegetation

Impacts on the strand vegetation could be caused by construction activities within the strand area, the continued uncontrolled use of the strand area by fishermen, hikers and vehicles and natural forces such as storm waves and tsunamis. The only construction activities planned for the strand area are the planned improvements to Punalu'u Beach Park and the relocation of the 8th and 9th golf holes. The relocation of the 8th and 9th golf holes would require removal of a limited extent of strand vegetation (approximately 10 acres). This vegetation would be replaced by the golf course grass and surrounding vegetation buffers that would include native strand plants. The planned improvements to Punalu'u Beach Park would also require removal of a limited amount of strand vegetation that would be replaced by grass and native strand vegetation. As presently planned, vehicular access to the coastal strand areas would be restricted and it is possible that pathways would be established along the shoreline, thereby allowing the strand vegetation to regenerate.

2.1.3.3 Mitigation Measures

As indicated above, strand vegetation that would be lost as a result of the proposed project would be replaced with native strand vegetation where possible and grasses to be planted in the park and golf course areas. Restricting vehicular access from the coastal strand area and the establishment of pathways would allow the strand vegetation to regenerate and become a significant component of the Resort area vegetation.

2.1.4 Wetland (W)

2.1.4.1 Existing Conditions

The wetland vegetation occurs along the coastal margin where there are a number of springs; the water varies from fresh to slightly brackish. Water is the major factor controlling the development of soils and vegetative cover. The soils are waterlogged and often composed of organic matter. The vegetation consists of hydrophytic (water-loving) species. Only the wetland vegetation around the Ninole Springs area was surveyed. The area around the Punalu'u Spring was not surveyed as it has been greatly modified and consists largely of landscape plantings. Elliot and Hall (1977) did an intensive survey of both areas. The smaller ponds near Ninole Cove have vegetative cover that consists of low growing species such as Seashore beach grass (*Paspalum vaginatum*), Honohono (*Commelina diffusa*), and *Eleocharis geniculta*. The two large ponds, closer to Punalu'u Park, have taller growing vegetation such as bulrush (*Scirpus*

TABLE IV-50

Traffic Level of Service Descriptions

The Highway Capacity Manual defines "Levels of Service" as qualitative measures which describe traffic operational conditions considering speed and travel time, freedom to maneuver, traffic interruptions and delays, comfort and convenience, and safety. Six levels of service, from "A" (best) to "F" (worst), are defined.

- Level of Service A represents free flow. Individual users are virtually unaffected by the presence of others. For a two-lane highway, passing demand is well below passing capacity; platooning of three or more vehicles is rare. For unsignalized intersections, little or no delay is experienced.

- Level of Service B represents stable flow where the presence of other users in traffic becomes noticeable. On a two-lane highway, platooning is common as passing demand approached passing capacity. Short traffic delays occur at unsignalized intersections.

- Level of Service C describes stable flow with greater constraints on maneuvering. Long platoons and lower speeds are experienced on two-lane highways. Delays at unsignalized intersections are described as "average."

- Level of Service D represents high density, stable flow. Significant restrictions in speed and maneuverability begin to occur. The opposing traffic streams of a two-lane highway operate separately as passing capacity approaches zero. Delays at unsignalized intersections are long as acceptable gaps in the main traffic stream become infrequent.

- Level of Service E represents capacity or near-capacity conditions. Speeds are low and flow is considered unstable. Passing on two-lane highways is virtually impossible and platooning becomes intense where there are slow moving vehicles or other interruptions. Very long delays occur at unsignalized intersections.

- Level of Service F describes a condition in which traffic demands exceed capacity. Forced flow, with extreme delays and long queues, occur.

validus) and makai (Scirpus paludous) and supports a denser growth of Honohono, Waterfern (Azolla filiculoides), Ung-choi (Ipomoea aquatica), and California grass (Brachiaria mutica). A thicket of Pluchea odorata and California grass borders the landward perimeter of these wetlands.

2.1.4.2 Impacts on Wetland Vegetation

Impacts on the wetland vegetation could be caused by construction activities within the wetland zone, natural forces such as storm waves, tsunamis and floods and the continued uncontrolled use of vehicles in and around this vegetation zone. Construction activities planned within the wetland zone are limited to connecting the dry mauka pond and Pond No. 1 and the construction of the Punalu'u Black Sand Inn. As shown on Figure IV-18, the wetland zone is limited to the Ninole Cove and Punalu'u Lagoon areas. It is likely that a portion of the existing wetland vegetation around the mauka boundary of Punalu'u Lagoon would be lost due to construction of the Punalu'u Black Sand Inn. However, some of the wetland vegetation would be replanted and other portions replaced with introduced species as part of the Resort landscape plans. Impacts to the wildlife inhabiting the wetland vegetation are described below in Section 2.2.5. Connecting Pond No. 1 and the dry mauka pond is expected to positively impact the wetland vegetation through the retention of existing plants and the addition of native wetland and strand vegetation as vegetation buffers around the enlarged pond area.

2.1.4.3 Mitigation Measures

The wetland vegetation around Punalu'u Lagoon that would be affected by development of the Punalu'u Black Sand Inn would be retained or replaced with introduced landscape plantings. Existing wetland strand vegetation around the margins of Pond No. 1 and the dry mauka pond would be retained and added to as necessary to create vegetation buffers on the golf course sides of the ponds. These measures, in addition to those planned for the strand vegetation zone are expected to maintain the quality of the wetland vegetation as a wildlife habitat and example of Hawaiian wetland vegetation.

2.1.5 Resort Master Plan Plant Materials

Landscaping for the proposed project would include the use of native and indigenous plants whenever possible and the use of native wetland and coastal plants around the relocated 8th and 9th golf holes and coastal ponds. Most plant materials would be used throughout the Resort to enhance the aesthetics and to provide the screening and/or buffer effect required for a specific area.

TABLE IV-49

Traffic Generation

	Trip Rate (vehicle trips/unit)*	Project Traffic Low	Project Traffic High
New Units Proposed			
Residential	-	71	78
Resort	-	1,980	2,903
Daily Traffic (In + Out)			
Residential	3.2	225	247
Resort	6.6	13,068	19,160
Peak Hour Traffic			
Residential - In	0.11	8	8
- Out	0.16	11	12
Resort - In	0.23	549	803
- Out	0.23	448	657

*Source of rates:
Residential: Institute of Transportation Engineers, Trip Generation, Third Edition.
Resort: Parsons Brinckerhoff, various studies.

Rates represent traffic that enters and leaves the property, and do not account for trips completely internal to the site. Traffic entering and leaving includes employee and service vehicles.

The two-lane Hawaii Belt Highway and the intersection of west Punalu'u Road, Alakahi Road and Hawaii Belt Highway were analyzed by the appropriate methodology from the 1985 Highway Capacity Manual. Definitions for levels of service are described in Table IV-50.

Traffic volumes and physical characteristics are used to indicate highway levels of service. In addition, a volume-to-capacity ratio measures the highway's ability to serve the traffic demand. Table IV-51 contains the results of the highway analyses. Although the Hawaii Belt Highway would operate at Level of Service E, the highway has adequate capacity to accommodate the expected traffic volumes.

Native plants presently found on the proposed project site that would be appropriate for landscaping and buffers include naupaka-kahakai (Scaevola taccada), alahe'e (Canthium odoratum), ilie'e (Plumbago zeylanica), naio (Myoporum sandwicense), 'ilima (Sida fallax) and nehe (Lipochaeta integrifolia). Around the margins of the wetlands (existing and new), plants such as naupaka-kahakai, 'ahu 'awa (Cyperus javanicus), 'aka 'akai (Scirpus validus), makaloa (Cyperus laevigatus), water hyssop (Bacopa monnieria) and 'akulikuli (Sesuvium portulacastrum) could be used. While the larger plants such as naupaka-kahakai would probably not attract native waterbirds such as the Hawaiian coot (Fulica americana alai) and the Hawaiian black-necked stilt (Himantopus mexicanus knudseni), they would serve to screen the areas from human disturbance. Information relative to the birds (fauna) of the project site is provided in Section 2.2.

2.1.6 Species of Note

The majority of the plant species found on the project site are introduced. No rare, endangered or threatened species of plants were found during the botanical survey conducted for this EIS. It is noted that there are several species of native plants found on the site, the majority of which are also found throughout the Ka'u region. It is also now known, through the efforts of the Hawaii Audubon Society, that a new bryophyte (liverwort) (Riccia hawaiiensis) (species nova) has been found near the shoreline of the proposed project site. Additionally, liverworts have been sighted around the bases of palm trees around the Colony I condominium units. The botanical knowledge of the bryophytes of the Hawaiian Islands, especially liverwort taxonomy and distribution, is incomplete. A Riccia species has also been collected along the Kona coast in about the same type of habitat as the Punalu'u species and may prove to be the same species. The liverworts are not thought by qualified botanists to be particularly significant (botanically) components of the Resort area vegetation. In addition to the Riccia hawaiiensis, several species of native plants are found on the proposed project site. These include naupaka-kahakai (Scaevola taccada), alahe'e (Canthium odoratum), naio (Myoporum sandwicense), 'ilima (Sida fallax), nehe (Lipocheata integrifolia), loulu palms (Pritchardia affinis) and those noted previously.

2.1.7 Summary of Flora

At present there are four broadly defined vegetation types found within the proposed project area. No threatened or endangered species of plants are found on the project site, although a new species of bryophyte has been found in the coastal area. Impacts to these vegetation types would be caused by construction activities, the replacement of existing vegetation

Destination resorts will typically have low traffic generation rates (vehicle trips per unit) because many activities are provided on site. Earlier studies of similar resorts were used to predict the traffic generated by the makai portion of the Resort. Average rates compiled by the Institute of Transportation Engineers in their informational report, Trip Generation, Third Edition, were used for the recreational homes in the mauka residential development (Kalana II).

For this traffic assessment, all of the generated traffic demand was first assumed to be served totally at the intersection of the Hawaii Belt Highway with the west end of Punalu'u Road (Alanui Road) and second, assumed to be served by both the west and east Punalu'u Road/Belt Highway intersections. Traffic demand on the eastern part of Punalu'u Road is not expected to naturally increase due to the proposed project. The relative distances to Hilo and Kona, and to nearby communities of Pahala and Na'alehu, were used to estimate the turning movements of project traffic at the west intersection under the first analysis.

In addition to traffic generated onto the highway, travel between the main resort area makai of the highway and the mauka residential area will affect intersection conditions. The traffic across the highway was estimated to be equal to the residential area's highway traffic generation.

Non-project traffic volumes on the makai and Hilo legs of the intersection were estimated using data from a March 1982 traffic count by the State Highways Division, and published information regarding Hawaiian Riviera Resort traffic generation. The rates used and the estimates of project generated traffic are shown in Table IV-49.

Future Traffic Conditions

Future conditions refer to the year 2005, when the project is expected to be completed. Existing traffic volumes at intersection of west Punalu'u Road, Alakahi Road and Hawaii Belt Highway were increased to account for general growth on the island; a rate of two percent per year, based on state population projections, was used for future conditions. Traffic generated by the nearby Hawaiian Riviera and spaceport projects were also included. The traffic data in the Final Environmental Impact Statement for the Hawaiian Riviera project indicated that it would increase two-way traffic volumes on the Hawaii Belt Highway in Punalu'u by about 400 vehicles per hour. For the spaceport project, an estimated 300 daily trips could be expected, with about 40 percent of these trips occurring during the PM peak hour Thus, traffic from the Hawaiian Riviera and spaceport projects would result in an additional increase in two-way traffic volumes on the Hawaii Belt Highway near Punalu'u of about 460 vph.

with new landscape vegetation and, possibly, increased human activity in and around the various vegetation types. Mitigation measures designed to protect and/or minimize adverse impacts include using native plant materials wherever possible in the landscaping plans, restricting vehicular traffic from the strand and wetland vegetation and limiting alterations to the existing vegetation to only that which is necessary. Significant adverse impacts to the vegetation of the proposed project site are not expected.

2.2 TERRESTRIAL FAUNA

A Vertebrate Reconnaissance Survey (see Appendix B) of the project area was conducted to identify probable impacts resulting from the proposed project to existing fauna of the Punalu'u area.

Five basic faunal habitats, each defined in part by associated plant habitats, were identified. These include Koa-haole and Monkeypod scrub; golf course; resort area; grassland and coastal zone and brackish pond habitats. The following paragraphs describe the habitats and the birds and mammals found in each of those habitats. No rare, endangered or threatened species of birds or mammals were observed in the project area during the survey period. As noted in Section 2.3, several species of protected birds and marine organisms are known to frequent the project area. Additionally, as noted in Appendix B, several species of birds that might be expected to be present in the project area were not sighted during the faunal survey. The absence of these birds may have been due to the absence of the species from land during the winter months. Species of birds notably absent from the project site during the faunal survey include the Ruddy Turnstone ('Akekeke) (Arenaria intrepres), Great Frigatebird ('Iwa) (Fregata minor), species of Terns (Family Steridae) that have been reported from Punalu'u, and Bristle-thighed Curlew (Kioea) (Numenius tahitiensis). These species have been informally reported, i.e., not documented in scientific journals or publications, as occurring within the proposed project area.

In their survey of the literature, Payton and Scott (1985) do not record the Hawaiian duck (Koloa) (Anas wyvilliania) or Hawaiian coot ('Alae-ke'oke'o) (Fulica americana alai) from the coastal ponds at Punalu'u. As noted in Appendix B, a Hawaiian coot may have been heard at the coastal ponds during the faunal survey, but the dense vegetation did not allow a confirmed sighting to be made. Similarly, undocumented sightings of species absent from the proposed project area during the faunal survey are quite common. The absence of species, as noted above, does not mean that the species are not occasionally found at the site, but more likely demonstrates the seasonality of the birds, presently a two-lane highway with adequate capacity to serve present and estimated future traffic volumes. The highway right-of-way is 80 feet wide, allowing for future widening if determined necessary by the state Department of Transportation. On occasion slow moving vehicles may appear to reduce capacity by generally slowing traffic movements. Punalu'u Road is also a two-lane roadway with a 60-foot wide right-of-way. Punalu'u Road is 10,800 feet long and loops through the Resort, beginning and ending at the Belt Highway. Punalu'u Road becomes a privately owned roadway within the Resort and is also known as Alanui Road within the Resort. On the mauka side of the Belt Highway, Alahaki Road, a 1,100 foot-long, privately owned roadway that forms an intersection with the Belt Highway and the western end of Punalu'u Road, provides access to the Kalana I single family residential area of the Resort.

Existing two-way traffic (1986) volumes on the Hawaii Belt Highway are about 1,730 vehicles per day (vpd); the peak hour occurs during the afternoon (PM) with two-way volumes of 180 vehicles per hour (vph). Traffic volumes on west Punalu'u Road were 490 vpd and 40 vph during the PM peak hour.

5.1.1.2 Impacts on Primary Roadways

A traffic study conducted for the proposed Resort (Appendix J) indicates that the expected impacts on the primary roadways within the project area would be as described below. Note: The traffic assessment described below initially assumed a worst case situation and the entire traffic load was assigned to the Resort's intersections with the Hawaii Belt Highway. Subsequently, based on requests for the County Department of Public Works, and with the availability of information regarding Hawaiian Riviera Resort traffic generation, the traffic analyses were reperformed to include the preceding and a situation in which 80 percent of the Punalu'u Resort traffic would enter and leave at the main intersection and 20 percent at the east intersection. Anticipated levels of service at the county Punalu'u Road and Belt Highway intersection are not expected to increase significantly, thereby negating the need for county provided improvements or traffic controls as a result of the proposed project.

<u>Trip Generation</u>

Current plans show a combined range of 2,051 to 2,981 new hotel and residential units at Punalu'u Resort upon its completion. To identify potential traffic impacts, peak hour volumes for the low and high range of development were estimated.

and their migratory and wide-ranging character. Punalu'u is not one of the State's annual bird census sites due to the transitory nature of the species frequenting the area and due to the fact that there are better habitats available in other areas of the island.

2.2.1 Koa-haole/Monkeypod Scrub Habitat

2.2.1.1 Existing Conditions

This habitat comprises the major portion of the study site above the Hawaii Belt Highway and also occurs to a lesser extent on the makai side of the road. A broken canopy of Monkeypod (Samanea saman) is present, with an understory dominated by Koa-haole [Leucaena glauca (leucocephala)] and several non-native grass species. Characteristic bird species in this habitat include the Japanese white-eye (Zosterops japonica), both Barred (Geopelia striata) and Spotted (Streptopelia chinensis) doves and the House finch (Carpodacus mexicanus). Other species are present in smaller numbers. This habitat is also frequented by the Hawaiian hawk ('Io) (Buteo solitarius) and the Hawaiian hoary bat ('Ope'ope'a) (Lasiurus cinerius semotus). The extent of this habitation is not known. It is known that both species have wide ranges and are not consistently present in the Resort area. The Koa-haole/Monkeypod scrub areas are also frequented by the relatively common small Indian Mongoose (Herpestes auropunctatus). Mongoose are probably abundant in many portions of the Resort area.

2.2.1.2 Impacts on Koa-haole/Monkeypod Scrub Habitat

As noted in Section 2.1.1.2, development of the proposed Resort would require the removal of a portion of this habitat for roadway, buildings and facilities construction purposes. As such, approximately 30 percent of this habitat will be lost. The birds inhabiting this habitat are introduced species that readily adapt to new habitats, such as landscaping vegetation. Some of the birds currently inhabiting the areas to be lost due to construction are expected to move to the newly landscaped areas that will replace much of the Koa-haole/Monkepod scrub habitat. This could place population and food availability strains on some species and/or individuals and result in the possible loss of some some portion of the species populations. Potential adverse impacts on the Hawaiian hawk ('Io) (Buteo solitarius) and/or the Hawaiian hoary bat ('Ope'ope'a) (Lasiurus cinereus semotus) are not expected to occur due to the wide ranging nature of both species and the presence of available habitat adjacent to the proposed Resort.

2.2.1.3 Mitigation Measures

A portion of the Koa-haole/Monkeypod scrub habitat will be replaced by newly landscaped areas, thereby providing habitat for some of the species and individuals forced to relocate. Other species or individuals are expected to relocate to areas adjacent to the Resort that are undisturbed by the proposed project.

2.2.1.4 Unavoidable Adverse Impacts

It is possible that the loss of existing natural habitat, although replaced by landscaping, could cause a reduction in the present population levels of the introduced birds. It is not possible to estimate the numbers of individuals that might be lost because estimates of the quantity of habitat required to support population levels are not known.

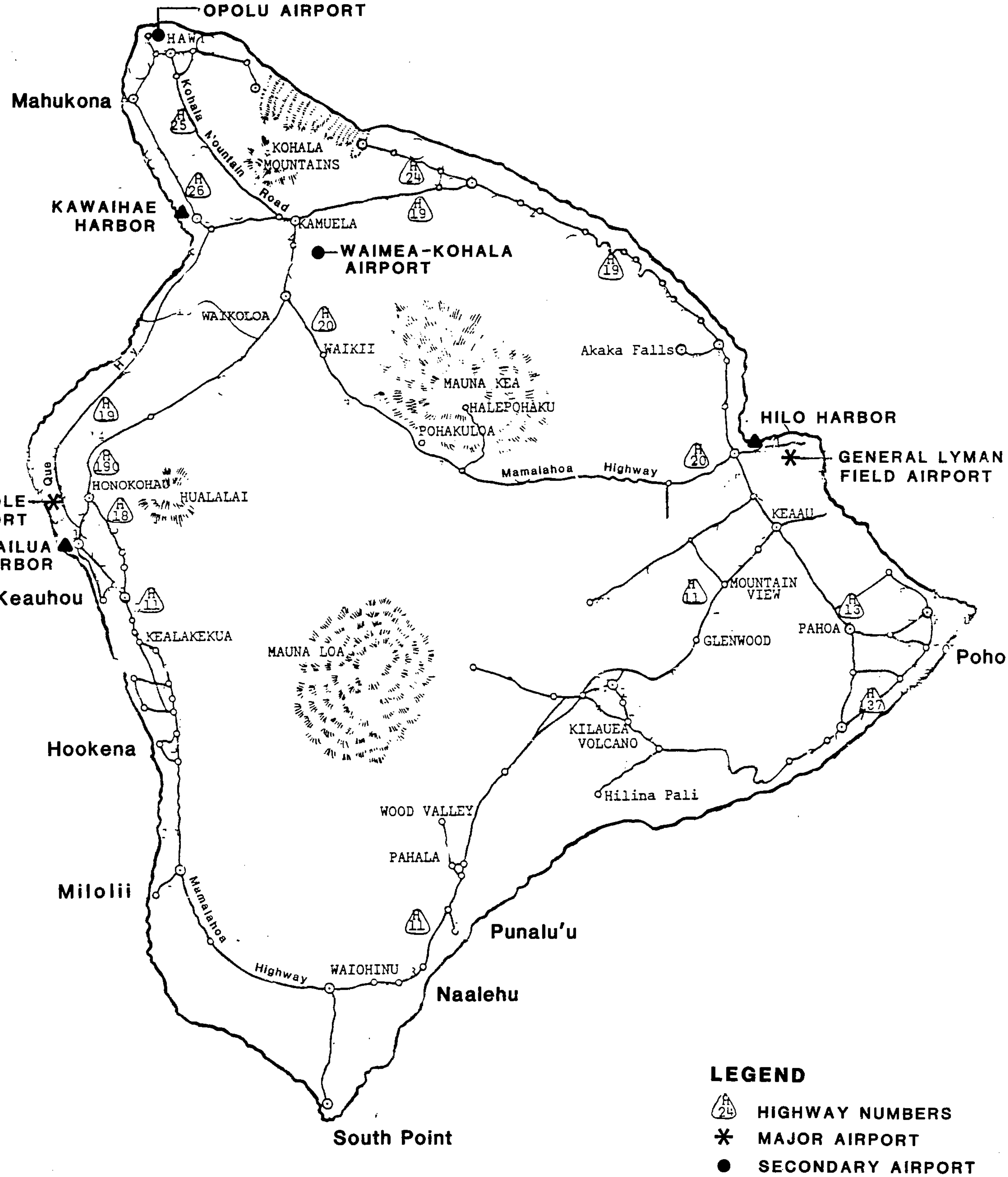
2.2.2 Golf Course Habitat

2.2.2.1 Existing Conditions

This habitat includes the golf course and immediately adjacent grassed (rough) areas of the Resort. Bird species present in large numbers in the golf course portions of the study area include the Barred dove (Geopelia striata), Golden plover (Kolea) (Pluvialis dominica) and the Common myna (Acridotheres tristis). Other species present include domestic varieties of goose, duck, and pigeon with the geese and ducks primarily found in an around the water ponds and retention basins in the 17th fairway.

2.2.2.2 Impacts on Golf Course Habitat

Impacts on the golf course habitat could be caused by relocation of the golf holes and construction of the new 8th and 9th golf holes in the coastal area. In general, the majority of the golf course would be unaffected by the proposed project. The ponds (water hazards) and retention basins in the 17th fairway would be enlarged to accommodate the expected increase in sewage effluent inflow. As such, more pond shoreline and surface area habitat would be created, possibly attracting more birds. The creation of the 8th and 9th golf holes in the coastal area is expected to provide habitat for both migratory and resident seabirds, as well as improve the habitat for these birds through the establishment of landscape buffers around the coastal ponds.



HAWAII COUNTY TRANSPORTATION FACILITIES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

MILES 0 2.5 5 10

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FIGURE IV-22

2.2.2.3 Mitigation Measures

Because the planned improvements and modifications to the golf course habitat are expected to benefit the birds inhabiting this habitat, adverse impacts are not expected. Mitigation measures designed to protect and/or improve the existing habitat include enlargement of the ponds and retention basins within the 17th fairway and the establishment of landscape buffers around the coastal ponds.

2.2.3 Resort Area Habitat

2.2.3.1 Existing Conditions

The Resort area habitat includes the landscaped areas in the vicinity of resort buildings and other developed areas. The Common myna (Acridotheres tristis) is especially prevalent here, as are the Japanese white-eye (Zosterops japonica) and the House finch (Carpodacus mexicanus). Present in smaller numbers were the Northern cardinal (Cardinalis cardinalis) and the Nutmeg mannikin (Lonchura punctulata).

2.2.3.2 Impacts on Resort Area Habitat

Impacts on the Resort area habitat could be caused by increases to the extent of this habitat and changes to the existing built-up habitat. Increases in this type of habitat are expected to cause an increase in the numbers of birds utilizing the habitat, including use by species presently found in the Koa-haole scrub habitat. The extent of new landscaped areas is expected to be a positive impact on the birdlife in that new nesting and feeding areas would be created.

2.2.3.3 Mitigation Measures

The creation of new landscape areas is expected to be a positive impact on the birdlife inhabiting this habitat. As such, mitigation measures do not appear warranted at this time. However, should future conditions indicate mitigative measures are required, appropriate steps would be taken to provide the required habitat.

4.4 SUMMARY OF SOCIOECONOMIC FACTORS

The present socioeconomic character of Ka'u District and the project area is rural and agricultural. The estimated present district population is 4,500 persons. The majority of the present working force of about 1,500 persons is engaged in sugar or macadamia nut farming, with service industries and commercial fishing accounting for some employment. About 90 persons are presently employed at the Resort.

The majority of the economic impacts expected to result from the proposed project are anticipated to be positive in that additional job opportunities would be created; personal and household incomes are expected to increase; state and county revenues would be greater than expenditures induced by the project; and new opportunities for entrepreneurialship would be presented. Social impacts are expected to be both positive and negative. Positive impacts are expected to result from increased job opportunities and income levels and the opportunity to provide added public services. Negative impacts could be experienced due to increases in population levels; a loss of some of the rural lifestyle currently experienced; and potential family related problems due to perceived intrusions by outsiders, both parents working and a general perceived loss of traditional cultural values. The present population characteristics of the district are changing with naturally occurring increases in population levels.

Mitigation measures that would be employed to minimize adverse impacts include facilitating the delivery of existing job training services and possibly supplementing them with some developer-sponsored activities; possible employee ride-share and child care programs; and implementation of plans that would maximize local residents employment and economic benefits.

5. TRANSPORTATION FACILITIES

5.1 HIGHWAY NETWORK

5.1.1 Primary Roadways

5.1.1.1 Existing Conditions

Major roadways on the island of Hawaii are shown on Figure IV-22. Access to Punalu'u Resort from Hilo or west Hawaii is via the Hawaii Belt Highway (State Highway 11). On the east side of the Resort, Punalu'u Road, a county roadway, provides access to the Punalu'u boat launch ramp and Punalu'u Beach Park. The Hawaii Belt Highway, in the vicinity of the Resort, is

2.2.4 Grassland Habitat

2.2.4.1 Existing Conditions

Several small open grassy areas are present in the study area. The largest of these occur in the Ninole Cove area and adjacent to the golf course in the northern portion of the study area. Unlike the grasses in golf course habitats, those in grassland habitat are unmaintained and are allowed to grow to maturity. Large numbers of Nutmeg mannikins (Lonchura punctulata) are attracted to the flowering heads of these plants. The mannikins may be found in flocks of 75 or more individuals in these areas. Although not sighted during the faunal survey, it is possible that the Hawaiian owl (Asio flammeus sandwichensis) also inhabits the grassland habitat.

2.2.4.2 Impacts to Grassland Habitat

Impacts to the grassland habitat could be caused by construction activities and the removal of a portion of this habitat. Construction of the Colony II condominiums is expected to cause the loss of about three acres of grassland habitat. As noted above, the principal species inhabiting the grasslands are Nutmeg mannikins, which also inhabit the resort area habitat. It is possible that the loss of a portion of the grassland habitat would cause a decrease in the population levels of the introduced Nutmeg mannikin. It is also possible that those individuals forced to relocate would relocate to the increased resort area habitat and/or grassland habitat available adjacent to the Resort. Some portion of existing population levels may decrease as a result of the loss of habitat.

2.2.4.3 Mitigation Measures

The planting of new landscape areas would mitigate the loss of a portion of the grassland habitat. It is recognized that a portion of the habitat would not be replaced, thereby possibly placing added strains on adjacent grassland habitat and potentially resulting in decreases to population levels of those birds utilizing the grassland habitat for food and cover.

2.2.4.4 Unavoidable Adverse Impacts

As noted above, the loss of a portion of the grassland habitat would not be replaced by the new landscaped resort areas and could cause a decrease in the population levels of some of the species utilizing the grassland habitat for food and cover. The extent of population level decreases and/or the added pressures during the operational as well as the project development phase. CBP has initiated and held several meetings with various community groups and will continue these meetings in their effort to assure the public that correct information regarding the proposed project is made available.

4.3.5.2 Quantitative Social Impact Mitigation Measures

Quantitative social impact mitigation measures would include measures to provide present Ka'u residents with adequate and proper job training to allow them to participate in the expansion of the Resort both during the construction and operation phases and measures to enable present Ka'u residents to either participate in the provision of the expected demand for housing and/or afford to continue to live in the district. These two factors are closely interrelated. Job training programs would allow Ka'u residents to be hired by the Resort, either during the construction or operational phases or both, and consequently continue to be able to afford housing in the district. As indicated previously, various state, county and private programs are available to the residents of Ka'u and others would be made available as part of the Resort development and community relations program established by C. Brewer Properties, Inc. The Draft program described in Appendix I is the beginning of the required efforts and mitigation measures.

4.3.5.3 Qualitative Social Impact Mitigation Measures

Qualitative social impact mitigation measures would include programs designed to ease the transition of many people into a more urban lifestyle from the largely rural lifestyle practiced at present. A portion of these mitigation measures would be embodied in the job training programs previously noted. Other portions of these mitigation measures may be associated with and accompanied by the relatively long Resort development period and may not require formal mitigation measure action. That is, as progress on the Resort development project proceeds over time, it is expected that many people who may suffer initial anxieties due to the first increase in the number of newcomers, or changing lifestyles, may adjust naturally to future increases and changes. In other cases it may be necessary to establish formal adjustment programs to enable people to mentally and physically accommodate the expected population increases and lifestyle changes. The exact nature of the programs that would be required would be part of the assessment process noted in Appendix I.

that may accrue to adjacent grassland habitat cannot be predicted with any degree of certainty.

2.2.5 Coastal Zone and Brackish Ponds Habitat

2.2.5.1 Existing Conditions

These habitats, stretching from Ninole Cove to Punalu'u Harbor are of great intrinsic biological interest as they provide habitat for both migrant shorebirds and native waterbird species. The principal species of birds utilizing this habitat include Hawaiian duck (Koloa) (*Anas wyvilliana*), Hawaiian coot ('Alae-ke' oke'o) (*Fulica americana alai*), Hawaiian black-necked stilt (Ae'o) (*Himantopus mexicanus knudseni*), Golden plover (Kolea) (*Pluvialis dominica*) and numerous species of migratory waterbirds such as Wandering tattlers ('Ulili) (*Heteroscelus incanus*). Coastal ponds, such as those in the study area, also provide apparent favored feeding areas for the endangered Hawaiian hoary bat (*Lasiurus cinerius semotus*).

2.2.5.2 Impacts to Coastal Zone and Brackish Ponds Habitat

Impacts to the coastal zone and brackish ponds habitat could be caused by construction activities and increased human activity in and around the habitat. The vegetation buffers that would be planted around the coastal ponds are expected to provide the screening necessary to minimize potential adverse impacts on the waterbirds utilizing the habitat. New grassed areas within Punalu'u Beach Park and on the relocated 8th and 9th golf holes are expected to provide feeding and resting areas for both resident and migratory birds such as the Golden plover (Kolea). It is recognized that the creation of new grassed areas for park and golf course areas may have an adverse impact on some bird species such as the Wandering tattler ('Ulili). Increasing the vegetation around the coastal ponds is expected to provide cover and habitat for the Hawaiian duck (Koloa), Hawaiian coot ('Alae-ke' oke'o) and Hawaiian black-necked stilt (Ae'o). Restricting vehicular access in the coastal portion of the Resort is also expected to improve the vegetative cover of the area and thereby improve the habitat for both resident and migratory birds.

2.2.5.3 Mitigation Measures

Increasing the amount of vegetation around the coastal ponds and in the coastal zone would increase the available cover and habitat for the species of birds using that habitat. Similarly, restricting vehicular access in the coastal area would allow existing native vegetation to regenerate and provide cover

Similarly, some of the differences may have to do with residence in established communities vs. more "country" locations. People in Pahala and Na'alehu -- who comprised three-fourths of the Ka'u population in 1980 -- are more likely to have a vested interest in the preservation of family and community networks dependent on conventional economic activities. People outside these towns -- who comprise the fastest growing part of the Ka'u population -- are more likely to include people who rely on subsistence practices, who are "urban refugees," and/or whose sources of income do not depend on the regional economy.

To the extent that such social correlates exist, any proposed major new economic development has some potential for generating social conflict. However, the underlying set of interests reflect individual rather than social-group differences: whether survival is perceived as more dependent on lack of new population or on an improved regional economy.

4.3.5 Social Environment Mitigation Measures

To the extent that social impacts require mitigations which can be clearly identified today, they would generally be incorporated in the key social management actions previously discussed (i.e., job training, child care, housing, etc.).

4.3.5.1 Community Issues and Concerns Mitigation Measures

The 1986 State Legislature has provided the seed money for an ongoing "Tourism Impact Management System" within the Department of Business and Economic Development (DBED). This system, still under design, is intended to monitor tourism impacts in designated areas throughout the state and recommend actions to reduce problems and increase benefits. To assure that this system effectively addresses future social impacts of tourism in Ka'u, it is recommended that the County of Hawaii seek to participate in the system design. Two desirable changes to the initial strategy outlined in the consultant report underlying the new system (Coopers & Lybrand, 1986) would be: (1) designation of Ka'u as a separate study area, rather than merging it with Hilo or Kona (a change which is currently under consideration by the State Tourism Office); and (2) modification of the system purpose to include the effects of tourism induced population growth, which may be responsible for some of the more significant indirect social impacts of resort development in rural areas.

Community concerns and apprehensions may possibly be mitigated by improved communication. Possible mechanisms could include establishment of a long-term advisory committee which might also provide a vehicle for community-resort interchange and feeding areas for the bird life. To further mitigate potential adverse impacts to the coastal zone and brackish pond habitat, it is possible that islets would be constructed in Pond No. 1 to provide nesting and breeding sites for the Hawaiian stilt; the Water hyacynth would be controlled in the Punalu'u spring; and signs and displays describing the biological importance of the coastal area would be placed at appropriate places.

2.2.6 Summary of Terrestrial Fauna

Completion of the proposed Resort project could involve alterations to the species composition of the existing vegetation which, in turn, could alter available habitat for some species of birds. The majority of the vegetation to be lost due to construction activities would be replaced with landscape plantings consisting of both native and introduced plants (see Section 2.1.5 above). As a result of the replanting and the establishment of landscape buffers around the coastal ponds, as well as restricting vehicles from the beach and coastal pond areas, the availability of wildlife habitats that are suitable for the species of birds frequenting the Resort area are expected to be retained and/or improved. It is recognized that some of the existing habitats would be changed. In general, the species of birds inhabiting these habitats, especially the Koa-haole/ Monkeypod scrub and resort areas, are adaptable to new habitats (vegetation) and would not experience adverse impacts due to the planned changes. The proposed establishment of landscape buffers around Pond No. 1 and the presently dry mauka pond is expected to have a positive impact on the resident and migratory waterbirds frequenting the ponds by providing cover and screening against human intrusion.

In general, the major mitigative measure that would be employed to minimize potential adverse impacts to the terrestrial fauna inhabiting the Resort area would be the implementation of the Environmental Protection Plan (see Appendix H). This plan, which has been prepared with the assistance of U.S. Fish and Wildlife Service, National Marine Fisheries Service, State Department of Land and Natural Resources and knowledgeable private groups and individuals, has been designed to provide the level of protection required for the species of wildlife frequenting the Resort area and to enhance and maintain the the habitats available to the wildlife.

once planned for this area by Ninole Cove. They will have a substantially reduced impact on viewplanes. (For further discussion of visual impacts, see Section 1.8).

Limited information is available on community perceptions of the current project design. In letters to the editor, a few residents have stated that the design changes do not meet their concerns, such as the perception that hotels should be mauka of the highway. They have voiced support for General Plan Amendments which would limit the height of hotels in the area and designate the Punalu'u area makai of the highway as an Open Space Recreation Area (Winterbottom, 1987; Domondon, 1987; Breithaupt, 1987).

However, the complete range of community opinions has not been sampled by surveys, nor have public hearings on the revised plan been held in Ka'u. The current EIS process and subsequent permit hearings will permit a wider and more systematic sampling of updated resident concerns.

4.3.4.5 Particularly Impacted Groups

Based on the foregoing analysis of Planning Commission testimony, it may be observed that the central theme for both supporters and opponents was survival, according to each individual's vision of Ka'u's future. While both supporters and opponents recognized the external forces for change, the supporters wanted to participate in these forces; the opponents wanted to retain separation.

Those who supported the project generally believed that -- in order to survive -- Ka'u must be part of the island, state and global economic mainstream. They say jobs and the resort industry as solutions to their failing regional economy.

Those who opposed the project saw themselves as fighting for the survival of native Hawaiian resources and local lifestyle (and/or of a "rural" environment which they deliberately chose). They saw the development as threatening something which is already fragile.

There may be some cultural correlates to these views. For example, while native Hawaiians appeared deeply divided over this project, Hawaiian opponents had a set of interests shared by no other group -- the preservation of an undeveloped coastline perceived as a need for continuation of some form of traditional lifestyles. Some immigrant Filipinos (who were little represented at the hearing) have a basic interest in acquiring more opportunities in the mainstream wage economy in order to further their long-term goals (Anderson, 1984) of accumulating money needed to bring more of their extended family to Hawaii.

2.3 PROTECTED SPECIES

2.3.1 Terrestrial Species

2.3.1.1 Existing Conditions

The threatened, endangered or otherwise protected terrestrial species of wildlife occurring or possibly occurring at the Resort include the following: Hawaiian duck (Koloa) (*Anas wyvilliana*), Hawaiian coot ('Alae-ke' oke'o) (*Fulica americana alai*), Hawaiian black-necked stilt (Ae'o) (*Himantopus mexicanus knudseni*), Hawaiian hawk ('Io) (*Buteo solitarus*) and Hawaiian hoary bat ('Ope'ape'a) (*Lasiurus cinereus semotus*). There are no threatened or endangered vascular plants, as listed by the U.S. Fish and Wildlife Service, known in the proposed project area. As noted previously, a new species of liverwort (bryophyte), *Riccia hawaiiensis*, was found in the coastal zone of the project site. None of the above listed bird or mammal species were sighted during the flora and fauna surveys conducted for this EIS. It is noted that Payton and Scott (1985) did not report the Hawaiian duck or Hawaiian coot at the Punalu'u coastal ponds. The species listed are protected under the federal Endangered Species Act of 1973 and the State of Hawaii Endangered Species Rules and Regulations.

The bird species frequenting the Resort area are migratory and have a range that could periodically include the general vicinity of the Resort. Conditions on the survey days and/or the time of the surveys may have been responsible for the lack of bird sightings during the surveys conducted for this EIS. Other species may not reside at Punalu'u or may only use Punalu'u occasionally. Discussions with State Department of Land and Natural Resources wildlife management personnel have indicated that the Hawaiian stilt is seen occasionally at Punalu'u, but probably does not reside there due to the lack of suitable habitat.

It is possible that the proposed changes to the coastal pond habitats, i.e., landscape buffers, possible establishment of islets in the larger ponds and restriction of vehicles from the coastal areas, would improve the habitat to the extent that the Hawaiian stilt, Hawaiian duck and Hawaiian coot frequent the area on a more regular basis and possibly use the area for nesting and breeding purposes. At present, none of these species is known to breed in the Resort area.

It is likely that the Hawaiian hoary bat would be sighted at dusk or nighttime rather than during the day light hours, although individuals were not sighted at dusk during the survey conducted for this EIS. Very little is known about the changes in the nature of social and recreational experiences along the coast, but the park expansion will provide increased park area and facilities for visitors and residents alike.

(6) Historic, archaeological and cultural resources: This was another focal point for project opposition in past hearings. Opponents felt the area's many significant sites of native Hawaiian origin should be preserved as they are today. They questioned whether non-Hawaiians could properly interpret their meaning. Also, objections have been raised to the necessity of driving through the Village Center to reach the Church, since this was felt to change the aesthetic or spiritual nature of visits to the Church.

When supporters addressed the issue of archaeological and cultural resources, they felt the project would give them an opportunity to share such resources with visitors. It may also be noted that the applicant has worked with the Church congregation and has agreed to provide vehicular and pedestrian access routes to the cemetery similar to the existing route.

(7) Infrastructure: Some opponents of the project objected that it could bring major socio-economic changes. Concern was expressed that prices and taxes might rise. Some residents asked whether an influx of new employees would strain the housing supply. Some thought that community services in Ka'u, especially the hospital and schools, could not keep up with the increased demand.

(8) Lifestyle changes: The last four issues have broader implications for some residents. Some have described themselves as "urban refugees" who moved to Ka'u to get away from resorts and/or other urban activities. They felt the proposed project would destroy the very environment they find desirable. Others, including long-term residents of Ka'u, have discussed Punalu'u Park as central to their social life, and food-gathering activities along the coastline as a basic element in their lifestyle.

(9) Setbacks: Some opponents of the resort urged that its buildings should be moved upland. Their proposals responded to particular concerns. As a result, different persons concluded that the resort should be moved to different extents. No consensus emerged as to how far the resort should be moved: away from the shoreline, back from the bluffs, or even mauka of the highway.

Comment: Several of the plan changes relate to concerns about proximity to the coast. As previously noted, there will be a public access provided for along virtually the entire coastal frontage of the project. The multi-family residential units to be built on the southern side of the resort will be located at least 300 feet back from the shoreline, further than the hotel life history of the Hawaiian hoary bat, the type of habitat it prefers and/or its range. However, there are indications from resort development on the Kona coast (Brunner, 1984) that the bat is not restricted from foraging in an area simply because of urbanization.

2.3.1.2 Impacts on Terrestrial Species

Impacts on the endangered and threatened terrestrial species could be caused by changes to existing habitats and increased human activity in the Resort area. As indicated above, it is possible that the changes to be made to the coastal pond areas as well as the enlargement of the ponds and retention basins in the golf course, could increase the attractiveness of these habitats to the resident and migratory water birds that frequent the Resort area. Also, as noted previously, the establishment of landscape buffers around the coastal ponds and the implementation of the Environmental Protection Plan are expected to result in positive impacts to the wildlife in general and specifically the endangered and threatened species of birds frequenting the area. Adverse impacts could be caused by increased human activity in and around the habitats used by the endangered and threatened species.

Increased night lighting of the beach and shoreline areas could also adversely impact the birds frequenting the area. However, it is known that birds tend to become acclimated to noises and other human activities that they learn will not harm them.

2.3.1.3 Mitigation Measures

As noted, the establishment of landscape buffers and implementation of the Environmental Protection Plan are measures that have been designed to mitigate potential adverse impacts. In addition, the placement of signs and displays describing the importance of the habitats to the ecology of the area and the need to protect those habitats would also provide a measure of protection for the endangered and threatened species. Similarly, restricting vehicular traffic on the coastal pond and shoreline areas, maintaining the vegetative cover at the margins of the coastal ponds, the possible construction of islets in the larger ponds and control of the Water hyacynth in the Punalu'u spring would act as additional mitigation measures. Should uncontrolled human pedestrian access to the coastal pond margins and shoreline areas appear to be detrimental to the plants and animals inhabiting these areas, it is possible that specially marked pathways and trails would be established to ensure that highly sensitive areas are adequately protected.

derstood to mean that C. Brewer was closing the road. This is a County road and C. Brewer will not recommend its closing. Also, the revised project design provides for increased parking at the beach park and near Ninole Cove. This plan does not allow unrestricted vehicular access along the shoreline, in part to protect the coastline from the negative effects of off-road vehicles driving along the shore. However, it does permit beachgoers and picnickers to unload their vehicles near their destination. In addition, a new shoreline access road and parking area east of Ninole Cove will be provided, thereby allowing direct shoreline access on the west side of the project site.

Pedestrian access along the entire shoreline is provided for between Ninole Cove and Punalu'u Beach Park.

The revised plan calls only for multi-family residential units on the lower elevations, rather than a hotel. The number of people to be warned or, in the worst case, evacuated in case of major storms or tsunamis is hence reduced from that found in the previous plan.

(5) <u>Public use of the beach park and coastal area</u>: Objections were made to further tourist-oriented development near the black sand beach, which is the only easily accessible sandy beach in Ka'u and a social gathering place for many residents.

At issue was a sense that the current nature of residents' social/recreational experiences would be changed with others present. In hearings, residents frequently referred to the cultural significance of the area's resources and to the area's value as a place for local people to enjoy through a wide range of activities -- e.g., fishing, picnicking, camping, and informal community gatherings. The sense of solitary wilderness on the coastline south of the park will be changed by the presence of buildings and landscaping. It was felt that having more people in the area would mean not only more intensive use of coastal resources, but also that local people would no longer feel comfortable there because newcomers would not understand their ways. Some witnesses said the significance of natural resources such as o'opu and limu was not just physical, but cultural -- they are symbols of being local. (See Section 7. below, for further discussion of recreational aspects of these concerns).

<u>Comment</u>: The new project design includes the dedication of an additional 2.5 acres of land including 600 feet of additional shoreline frontage to that now in the Punalu'u Beach Park. The park's size will increase to over eight acres. The visual impacts on the coastal area between the park and Ninole Cove have been reduced (see discussion of "Setbacks" issue below). These design changes do not eliminate resident concerns about the

2.3.2 Marine and Aquatic Species

2.3.2.1 Existing Conditions

The threatened, endangered or otherwise protected species of marine and aquatic species occurring at Punalu'u in the nearshore water areas include the green turtle (Chelonia mydas) and Hawaiian hawksbill turtle (Eretmochelys imbricata). Species occurring in the offshore waters include Spinner dolphin (Stenella longirostris), Spotted dolphin (Stenella attenuata), Pilot whale (Globicephala macrorhynchus), Melon-headed whale (Peponocephala electra), False killer whale (Pseudorca crassidens), humpback whale (Megaptera novaeangliae) and a number of beaked whales (Mesoplodon sp.). Also, there have been occasional sightings of Hawaiian monk seals (Monachus schauinslandi) along the east coast of the Big Island. The above listed species are protected under the federal Endangered Species Act of 1973, the Marine Mammal Protection Act of 1972 and the State of Hawaii Endangered Species Rules and Regulations.

Of the above listed species, only the green and hawksbill turtles were sighted at Punalu'u during the botanical, faunal and marine surveys conducted for this EIS.

The threatened green turtle utilizes the Punalu'u coastline for foraging and resting. Breeding and nesting occurs almost exclusively in the Northwestern Hawaiian Islands. The number of reproductively active females is estimated at just 750 for the entire Hawaiian population. Tag-recapture studies conducted near the project site have shown that the green turtles grow faster along the Ka'u coastline than anywhere else in the Hawaiian Islands. Green turtles are herbiverous and appear to favor Pterocladia capillacea, a red algae that grows on the rocks and along the shoreline of Punalu'u Harbor. National Marine Fisheries Service biologists theorize that the nutrient rich basal groundwaters that naturally flow into Punalu'u Harbor facilitate the growth of the algae, thereby providing a readily available food supply for the green turtles.

Hawksbill turtles tend to feed on a variety of sponges and ascidians in the nearshore environment and breed offshore of Punalu'u during the months of February through May. In the immediate vicinity of the Resort, hawksbill turtles nest at the black sand beach, Horseshoe Beach and Koloa Beach. Nesting occurs at night during the months of June through January. Nesting in other areas in the vicinity of Punalu'u, but outside the project boundaries, include Kawa Beach and Kamehame Beach, the latter being an apparent favored site by the turtles. Together, these areas comprise the majority of known nesting habitat for hawksbills in the Hawaiian Islands.

(2) Developer credibility: Supporters acknowledged Brewer's long-term relationship with the community and felt the project is being planned responsibly. Some expressed concerns about particular project characteristics (e.g., public access), but felt Brewer would abide by subsequent agreements.

Opponents, however, felt Brewer had previously exploited the community and the environment for financial gain and would continue to do so. Some said that Ninole Cove was filled with sediment because of modifications to the natural drainage system by C. Brewer operations. Others felt that, whereas C. Brewer may feel some responsibility to Ka'u, its corporate owner would seek economic gain despite community losses because it is a foreign company. Some concern was expressed that future resort operators would not abide by agreements between C. Brewer and the community unless these were spelled out in detail.

Comment: Since the above opinions were expressed, C. Brewer has become a Hawaii-based company once again. Also, the current design involves no dredging of Ninole Cove. Accordingly, questions of past or future responsibility for the Cove (State owned) do not bear on the project described in this document.

(3) Environmental concerns: In addition to the specific concerns with resources noted below, a broad sense emerged that the coastal ecosystem is fragile. One issue was the possible effect of artificial lighting on newly hatched turtles. Another was the concern that fish populations might decline with increased use of the beach.

Comment: The new design provides a landscape buffer and warnings to pedestrians. The intent of this design revision is to provide protection for turtle hatchery areas from risks due to lights and human interference.

(4) Public access: There was substantial concern that the project will cut off access in and out of the area -- to the beaches, the Church, and other community gathering places. Some of this concern was based on the idea that current access roads would be closed to the public, endangering public safety in the event of tidal waves or other disasters.

A particular focus of objection was the proposal to not allow vehicles to drive directly on or along the shoreline. Some witnesses felt that such vehicular access is important for effective use of fishing, food-gathering, and recreational resources along the entire shoreline (see Section 5.1 and 7. below).

Comments: Based on the Master Plan, C. Brewer had suggested that the existing County road along the black sand beach (leading to the park and other private lands) was not essential for access to the Punalu'u Beach Park. This was misun-

Hawaiian legend relates that there was a time when stormy weather prevented the men from diving for freshwater near Ninole. There were two supernatural turtles, a mother and father, who came out of the water and the mother deposited into the sand an "egg" which looked like a piece of kauila wood. From the egg hatched a daughter turtle named Kauila. Out of the water, Kauila would assume human form and played with the children. The people loved Kauila because she would watch over the children as they fished. A painting of Kauila hangs in the Ka'u Center of History and Culture at the Resort.

The offshore species listed above are wide ranging and appear to use the Hawaiian Island coastlines for feeding and resting.

2.3.2.2 Impacts on Marine and Aquatic Species

Impacts on the protected turtles could be caused by changes in water quality, such as increased nutrient loading and increased sedimentation; increased human usage of the shoreline and offshore water areas; and increased lighting on the shoreline, beaches and backshore areas.

As indicated in the "Impacts on Nearshore Marine Environment" section (Section 2.5.1.2), the existing Punalu'u Harbor water quality characteristics could be altered by increased nutrient loading due to increased use of treated sewage effluent for golf course irrigation purposes and increased surface water runoff. However, these two potential adverse impact factors are not expected to have a significant effect on the turtle habitat due to the planned drainage system improvements which will divert runoff water to retention basins and eliminate, except for extraordinary heavy rainfall, present direct discharges into the nearshore waters; and due to the fact that increased nutrient loading, if it were to occur, may be a beneficial effect by encouraging the growth of the green turtle's food supply, *Pterocladia capillacea*. As noted previously, the proposed project does not include any modifications to the shoreline.

Impacts to the turtles from increased human usage could have both positive and negative effects. On the positive side, it is possible that, because of the Environmental Protection Plan (Appendix H) and increased educational programs regarding the ecological sensitivity of the marine and terrestrial environments, both residents and visitors would become more aware of the need to protect and preserve the turtles and other marine organisms, thereby ensuring greater protection to the species. Similarly, increased human usage may discourage the illegal taking of turtles simply by greater numbers of people being around. However, it is also possible that increased human usage

Balancing these potential negative concerns are both the family/mental health impacts of unemployment and also the evidence that Ka'u currently has some problems which might be aided by decreased isolation. Confirmed child abuse/neglect cases jumped from two in 1983 to 14 in 1985 (unpublished data obtained from Hawaii State Department of Social Services and Housing), although this partially reflects an islandwide trend for greater reporting. Additionally, State Health Department workers attribute high teen drug use and pregnancy rates in Ka'u in part to the area's isolation and lack of preventive agencies (personal communication, David Wrigley, Chief, Mental Health Service, Big Island). Finally, the availability of more forms of employment may contribute to mental health by providing more opportunities for a good fit between occupational and individual temperaments.

4.3.4.4 Project Specific Community Issues and Concerns

Community issues and concerns may be studied because (1) to the extent that they reflect controversy and polarization, they are themselves a social impact of the proposed project; (2) certain issues are hard to quantify, and the purpose of disclosing impacts may be best served simply by documenting these concerns in the impact statement.

Community attitudes and issues constantly change. The EIS process and associated public hearings both affect attitudes and provide a cumulative record of concerns and issues. The views of some 30 Big Island residents were expressed at a Planning Commission hearing on January 29, 1986. Additionally, 20 Ka'u residents wrote responses in late 1986 to an earlier DEIS (PBR HAWAII, 1987, Chapter XII). Many specific points were raised. These may be grouped into nine broad categories for purposes of analysis.

Revisions in the project design that respond to particular concerns, along with changes in circumstances in the past year, are noted when appropriate.

(1) <u>Need for project because of jobs and diversification of economic base</u>: Generally, people who supported this project did so because they felt that Ka'u is dying (economically and socially). They felt that the sugar industry's future is questionable; the young people must move away; and there are no other proposals in the foreseeable future which offer as much as the proposed Resort expansion.

Those who supported the project for these reasons assumed that Ka'u residents would be the primary beneficiaries of employment opportunities. They saw no threat to the established agricultural industry, mainly because they believed that sugar is already threatened by forces outside of the area.

of the beach and shoreline areas would drive the turtles from Punalu'u and/or increase the incidence of turtle molestation. Based on discussions with National Marine Fisheries Service and U.S. Fish and Wildlife Service biologists, it is believed that increased human usage would have a positive effect if accompanied with increased educational programs and environmental awareness.

Increased night lighting of the shoreline and beach areas could have adverse impacts on the nesting and subsequent hatching of turtles. Numerous scientific studies have indicated that hatchlings become disoriented in bright lights and tend to crawl toward those lights rather than towards the ocean. Experiences in Florida and elsewhere have shown that hatchlings will crawl towards automobile lights along highways and are consequently killed. Similarly, night lighting tends to discourage the turtles from coming ashore to lay their eggs.

Impacts to the offshore species (whales and dolphins) are not expected to occur due to the lack of planned development activities in the marine environment at Punalu'u.

2.3.2.3 Mitigation Measures

The primary mitigation measure to be employed to protect the turtles occurring at Punalu'u will be the implementation of the Environmental Protection Plan (Appendix H). The educational programs specified in the Plan would increase the public's knowledge regarding the sensitive nature of the species habitats and the need to protect and preserve those habitats along with the plants and animals themselves. As noted previously, interpretive displays will be erected at key points within the Resort, informing the public about the turtles and other protected species and their habitats, their characteristics and other pertinent protection elements. In addition, the provisions within the Environmental Protection Plan specifying the restriction of vehicles along the shoreline will provide additional protection and mitigation of potential adverse impacts. To minimize potential adverse impacts to the turtles caused by night lighting, street lights will be placed along the makai sides of the streets and the lights will be back-shielded to prevent direct lighting of the shoreline and beaches. Also, Resort hotels and other structures will be restricted from shining lights directly on the shoreline and beaches and lighting will be kept to minimum levels, incorporating data from other areas such as Florida, given necessary safety and security considerations.

Additional enhancement measures that would be taken by CBP, to the extent possible, would be the continued surveillance of Kamehame and Kawa beaches; the possible establishment, through the Environmental Protection Plan, of walking "turtle watching tours" to Kamehame and/or Kawa beaches; predator control, e.g. placing fences around sensitive areas and/or live trapping of predator species (such as feral dogs and mongoose); and implemenreported crime rate following the Resort's opening in the 1970's. Increased population is expected to produce slight but not dramatic increases in Ka'u crime rates.

Linkages between tourism and crime have been comprehensively reviewed in other resort social impact assessments (Community Resources (1984a, 1984b). Academic statistical analyses produce contradictory conclusions, although there is some consistency in finding a relationship between tourism and increased rates of robbery and rape, as well as juvenile delinquency in places with "street scenes" (e.g., Lahaina, Kailua-Kona). For the Big Island's current tourism center, Kona crime rates are high compared to islandwide crime rates, but they increased less rapidly than in other parts of the island during the 1970's, when tourism growth was greatest.

Interviews with police officers in various parts of rural Hawaii produced a consensus view that on site crime at destination resorts is minimal. Off site, the major crime impact is likely to involve increased petty thefts from visitors at beach parks or other tourist attractions. No increase in resident victimization has been observed near resort areas.

Family and Mental Health Issues: In addition to concerns stemming from the nature of resort employment (see Section 4.2.2.2 above), indirect impacts can occur when population growth for any reason outstrips provision of housing and other needed social infrastructure. In interviews conducted in 1986 (Community Resources, 1986), various Kona social service agency workers blamed that area's housing shortage for increased child abuse caseloads and various other family problems, along with some types of mental health problems (e.g., alcohol/drug abuse). Newcomers from the Mainland tend to have less of a social support network than long time residents and are therefore more likely to internalize stress and develop classic psychiatric symptoms.

Increased female labor force participation could conceivably result in child care dilemmas and initial pressures on family budgets for expenditures such as additional vehicles. These outcomes are speculative, since there is some evidence that many families may already have developed the resources needed for women to work. For example, 1980 Census data indicate that the proportion of occupied Ka'u households with two or more cars (61 percent) is identical to the countywide proportion (60 percent). And the proportion of Ka'u workers who carpooled was substantially higher than the countywide proportion (42 percent vs. 22 percent, based on totals excluding pedestrians or persons working at home). Child care was a particular concern in the early studies on Kohala resort development; however, in later years it was little mentioned in surveys on perceived tourism impact in the region, and Kohala has had one of the state's lowest reported rates of child neglect as of the early 1980's (Community Resources, 1984a).

tation of the Environmental Protection Plan. Chemical and/or poison predator control is not planned.

2.3.3 <u>Summary of Protected Species</u>

Punalu'u is the known habitat for several species of terrestrial and marine threatened, endangered or otherwise protected species. As such, a key tenet of the proposed Resort planning has been the protection of these species and their habitats. To effect this protection, CBP has worked with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, State Department of Land and Natural Resources and cognizant private groups and individuals to draft an Environmental Protection Plan (Appendix H) that will provide the framework and guidelines for the required protection. In addition, an educational program consisting of interpretive displays and handout materials will be developed to explain the environmentally sensitive nature of the area and the need to protect and preserve the natural habitats and species found at Punalu'u. The mitigation measures described previously, such as the establishment of landscape buffers around coastal ponds and restricting the amount of light that will be allowed to shine on the coastal area, have also been designed to provide the level of protection required. It is noted that CBP believes that the natural attributes of the project site add to the attractiveness of the Resort and should be protected for both the residents of and visitors to the Resort.

2.4 COASTAL PONDS

2.4.1 <u>Physical Characteristics/Water Quality</u>

2.4.1.1 Existing Conditions

To determine the existing conditions, probable impacts and mitigation measures required to minimize potential adverse effects on the coastal ponds at Punalu'u, two biological field surveys of the coastal ponds and nearshore areas were conducted. The first survey was conducted in October 1984 and the second in August 1986. The information presented herein has been drawn from those two surveys, as well as published literature regarding coastal and anchialine ponds in Hawaii and potential environmental impacts that could result from Resort and/or golf course operations and maintenance procedures. The complete results of the surveys are given in Appendix C.

There are three major coastal ponds at Punalu'u Resort, none of which are classified as "anchialine ponds" (Figure IV-19). [Note: anchialine ponds are generally described as highly motivated and skilled seasonal workers can temporarily match or exceed the year round wage earner average if they are working on a quota system, most earn much less, often barely above minimum wage.

Furthermore, it may be noted that the current policy choice is not between resort jobs and some other higher paying economic activity, but between resort jobs and few or no additional ones (other than some possible limited expansion of seasonal macadamia picking). Given both the current Ka'u 11 percent unemployment rate and the dim prospects for future new agricultural jobs, it should be recalled that numerous studies have established a clear relationship between unemployment and such social impacts as increased divorce rates, parent-child problems, worsened physical health, and psychiatric symptoms. (Some standard references include Bakke, 1934; Gordus, Jarley, and Ferman, 1981; Brenner, 1973; Dooley and Catalano, 1980. Frank, 1981, used Hawaii data to establish a relationship between economic problems and mental health problems in this state.)

Each form of employment has particular advantages and disadvantages in a social as well as an economic sense. Resort employment is generally far less strenuous than agricultural work and involves more opportunities for human interactions with both co-workers and guests. However, hotel and other resort related jobs are subject to seasonal fluctuations and/or split working hours. These have some implications for personal and family life, as previously discussed in Section 4.3.2.

To some extent, the perceived "quality" of resort work will depend on availability of alternatives and personal expectations. At present, Ka'u dependence on agricultural jobs has resulted in relatively satisfactory employment conditions for long time male residents but high female unemployment and limited opportunities for recent immigrants. Should agriculture wither and Ka'u become dependent on service work alone, the opposite situation could occur. Should neither sector be active and healthy, the region will undergo social and economic crisis, accompanied by substantial outmigration. To the extent that both agricultural and service sectors can flourish, residents will have a greater selection of job opportunities to match individual needs and skills.

4.3.4.3 Indicators of Social Cohesion

Crime: According to Ka'u police (personal communication, Sgt. Robert Gomes, August 14, 1986), the area currently has an extremely low crime rate (see Section 6.3 below). Existing Punalu'u Resort condominiums have suffered occasional burglaries but are not considered significant crime generators, although there was a brief elevation in Ka'u's small (less than 100 square meters), shallow ponds (less than 1 meter deep) with an absence of surface connections to the sea, but contain saline water and undergo tidal fluctuations. They also harbor a distinctive biota, which includes opae'ula shrimp (Halocaridina rubra and Metabateus lohena). Classification as anchialine requires that both the physical and biological attributes be present]. A fourth pond area (Dry Mauka Pond on Figure IV-19) was dry during field surveys conducted in 1984 and 1986. One of the three ponds (Pond No. 1) has a direct connection to the ocean through a small, apparently natural, discharge stream channel. The estimated low tide discharge flow ranges between about 4.5 cfs and 20 cfs and is seasonal. The other two major ponds are fed by large subsurface springs (basal ground water) and an inland extension of the ocean water table which produce brackish waters with a discernible density gradient. Two small ephemeral or temporary (transient) ponds (located on State-owned property) with surface areas of approximately 20 to 30 square meters (at a +2.6-foot high tide) also occur in the back-beach areas of Ninole Cove (west of Pond No. 2), having apparently been recently excavated by storm waves (Brewer, Appendix C, Section 2). The coastal ponds and wetland areas of the Resort are under the regulatory jurisdiction of the U. S. Army Corps of Engineers per the provisions of the Rivers and Harbors Act of 3 March 1899 and related water quality and wildlife habitat protection legislation.

The dry mauka pond (see Figure IV-19) adjacent to the proposed relocated 8th golf hole is heavily vegetated by numerous wetland plants (see Section 2.1.4), but only intermittently contains standing water. Pond No. 1, on the makai side of the proposed 8th and 9th golf holes (directly connected to the ocean), is fed by numerous springs of clear, low salinity water that provide exceptional underwater visibility. The shoreline of the pond is lined with various wetland plants. The bottom of the pond is covered, in most areas, with several centimeters of decaying organic matter. The second pond (Pond No. 2), located immediately landward of Ninole Cove on State-owned property, has been modified by flash flooding since 1978 and by storm wave inundation in 1986. Analysis of the wetland vegetation map provided in the Wetlands and Wetland Vegetation of Hawaii (Elliot and Hall, 1977) study, indicates that the pond and surrounding vegetation bear little resemblance to that reported in the aforementioned study. Biological diversity in this pond is low.

Water quality values obtained in the coastal ponds suggest one of relatively uniform physical characteristics, though salinity data indicate a small but distinct gradient. Surface waters of the larger pond (Pond No. 1) demonstrated a temperature range of 19.5 to 21.6 degrees C.; bottom waters ranged from 19.5 to 22.0 degrees C. Salinities ranged from 0.1 to 1.9 parts per thousand (ppt) in surface waters; bottom waters were between 0.05 to 3.9 parts per thousand (ppt). Dissolved

TABLE IV-48

AVERAGE STATEWIDE AND HAWAII COUNTY EMPLOYMENT AND ANNUAL WAGES
FOR INDUSTRIES ASSOCIATED WITH RESORTS AND PLANTATION AGRICULTURE, 1985

	STATEWIDE				HAWAII COUNTY			
	Average Employment		Avg. Annual Wage		Average Employment		Avg. Annual Wage	
	no.	% of total	dollars	% of total	no.	% of total	dollars	% of total
TOTAL PRIVATE SECTOR	343,400	100.0%	$16,070	100.0%	27,963	100.0%	$13,896	100.0%
Selected Resort-Related Industries								
"Hotels, rooming houses, etc."	28,947	8.4%	$13,601*	84.5%*	3,931	14.1%	$12,056*	86.8%*
"Eating and drinking places"	40,171	11.7%	$ 7,496*	46.6%*	2,657	9.5%	$ 6,561*	47.2%*
"Other retail trade"	56,036	16.3%	$13,029	81.1%	4,889	17.5%	$11,672	84.0%
"Transportation"	23,439	6.8%	$19,508	121.4%	1,266	4.5%	$17,092	123.0%
Selected Plantation-Related Industries								
"Agriculture, forestry, fisheries:"								
-- Sugar	3,079	0.9%	$18,258	113.6%	181	0.6%	$22,200	159.8%
-- Pineapple	2,056	0.6%	$16,157	100.5%	N/A	N/A	N/A	N/A
-- Other Crops	3,061	0.9%	$13,095	81.5%	2,221	7.9%	$13,985	100.6%
"Manufacturing:"								
-- Sugar Mills	2,706	0.8%	$20,759	129.2%	662	2.4%	$23,284	167.6%
-- Pineapple canning	2,016	0.6%	$14,577	90.7%	N/A	N/A	N/A	N/A
-- Other Food Processing	4,914	1.4%	$16,867	105.0%	1,306	4.7%	$15,486	111.4%

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* Wage figures do not include tips/gratuities.

Source: Hawaii State Department of Labor and Industrial Relations, 1986, pp. 2, 3, 10.

oxygen values were similar with all samples demonstrating values between 67 to 69 percent of saturation.

Water temperatures of the smaller pond (Pond No. 2) were similar to those of Pond No. 1. Surface and bottom water salinities ranged from 0.8 to 1.5 ppt in surface waters, to 1.1 to 6.6 ppt in bottom waters, respectively. These data suggest that fresh water springs heavily influence portions of the pond. Surface water dissolved oxygen values were higher than Pond No. 1 and are probably the result of high photosynthetic rates associated with the dense growths of filamentous green algae which occur throughout the pond. Except in areas of noticeable spring water discharges, a large portion of the surface area of Pond No. 2 (perhaps 80 percent) demonstrated a noticeable greenish turbidity in October 1984 surveys. The turbid waters were absent in August 1986 surveys, which may indicate the effect of recent storm wave "flushing." Pond No. 2 is also distinguished by a thick (to 50 cm) anaerobic benthic algal mat or "ooze" which appears to be devoid of macrofauna (Brewer, Appendix C, Section 2).

The third major pond (Pond No. 3, Punalu'u Lagoon) is located immediately makai of the Punalu'u Black Sand Restaurant complex. This pond has undergone major manmade "improvements" (artificial shoreline in places; manmade islands) and although physically anchialine in character, it harbors little in the way of characteristic anchialine pond flora and fauna. The pond is also moderately eutrophic; especially in less well-flushed mauka regions and provides habitat for about a dozen domesticated ducks and geese (whose waste products probably contribute to the pond's eutrophic character).

The chemical properties of coastal spring, pond, and nearshore waters at Punalu'u are shown in Table IV-9. The offshore ocean "control" sample indicates below normal salinity (33.5 ppt versus the 35-36 ppt normally associated with true ocean waters) and pH (8.3 versus 8.4), as would be expected considering the influence of freshwater discharges along the coastline. Fresh and brackish water discharges, whether from ponds or the single coastal spring, demonstrated (relative to the ocean water samples) elevated levels of nitrogen (as nitrate and total N), phosphorus (as orthophosphate and total P), and chlorophyll a (except for the spring water discharge). The significance of these data in relation to other coastal areas on the south coast of Hawaii Island is unknown inasmuch as water quality data for comparable south coast locations are unavailable.

Perhaps the major impact of inmigrant workers will come from their sheer numbers. The projected year 2005 Ka'u population figures suggest an average annual growth rate ranging between three and four percent each year -- much higher than the Ka'u growth rate for the 1970's but actually lower than the estimated rate for the early 1980's, which in turn implies that some of the projected "inmigration" may occur with or without the Resort.

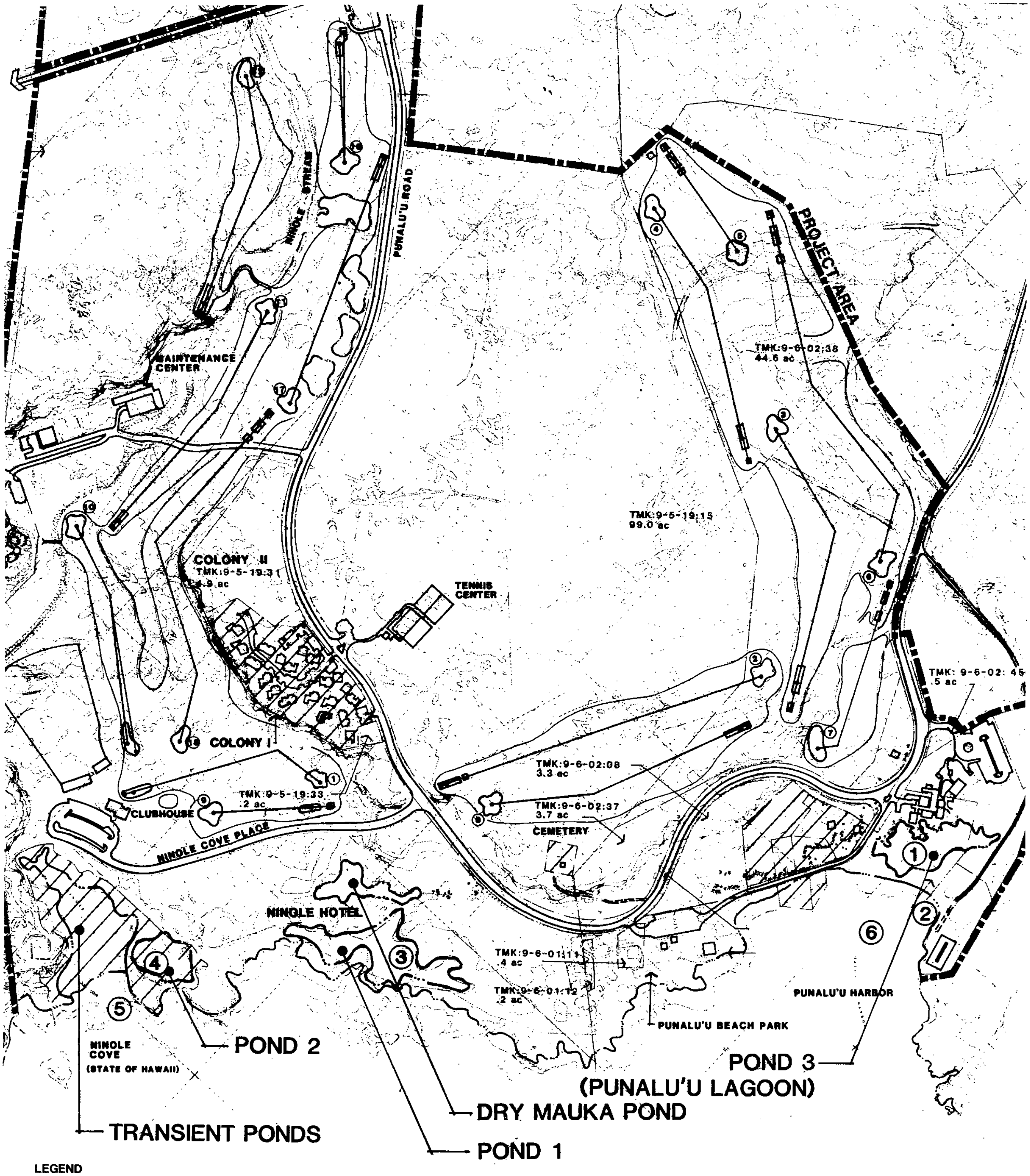
If the population growth greatly outpaces provision of housing and other public facilities, it could produce the sort of negative family and mental health impacts discussed in the Section 4.3.4.3. Conversely, however, population growth can provide an economic and political justification for meeting some of the major Ka'u community needs documented in Section 4.3.2 -- i.e., improved medical services, expanded police and fire protection, more educational opportunities, shopping centers, etc.

4.3.4.2 Economic and Social Quality of Resort Employment

The economic quality of resort related employment (particularly in relation to agricultural jobs) has been a topic of frequent debate in Hawaii. Table IV-48 provides 1984 data on average employment and wages for various types of jobs associated with destination resorts (although not all such jobs are necessarily located in resorts), as well as sugar and pineapple plantation jobs.

As the table indicates, average wages for hotel jobs are slightly below the statewide average for all private sector jobs, and average wages for some associated resort-like activities (retail or food service) are much lower. Particularly in higher quality hotels and restaurants, tips are often believed to result in much higher income than is indicated by reported wage data, but there is little hard evidence which can either prove or disprove this contention. [A recent survey of Kohala Resort workers (Community Resources, Inc. and Datametric Research, 1987) did establish that the median household income for resort workers matched that of the overall West Hawaii population. The study also showed a majority of all workers, including management, were Hawaii born.]

While sugar wages are relatively high on average, few people in Hawaii now work in sugar, and the future of that industry is highly uncertain. According to information provided by personnel directors at Ka'u Agribusiness and Mac Farms of Hawaii, year round macadamia employees earn an average wage between $7.50 and $8.00 per hour, below sugar workers but greater than many resort workers. However, 75 to 80 percent of the peak macadamia workforce consists of seasonal workers. While a few



LEGEND

PROJECT BOUNDARY

OTHER OWNERS

① WATER QUALITY STATIONS

COASTAL POND SURVEY AREAS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

pbr

FIGURE IV-19

(of whom about 24 percent would be visitors). However, their visibility within the wider Ka'u community would be limited, since most would remain on site at the Resort. Evidence gathered by interviewing car rental agencies and activities desks at various other Big Island and rural Oahu resorts (Community Resources, 1984b) suggests that only about 15 percent of the visitor population leaves a resort destination on any given day for sightseeing purposes, and most of this sightseeing involves islandwide trips rather than forays into nearby communities.

In addition to jobs, visitors may be sources of either irritation for residents or improved social life and amenities for residents. A review of published literature on resident-visitor interaction both in Hawaii (Knox, 1979; Liu and Var, 1984) and elsewhere (UNESCO, 1976; Knox,1978; Graburn, 1983) suggests that resident attitudes toward tourists usually have less to do with economic dependence than with factors such as age, perceived visitor respect for local culture, displaced political resentments over loss of local control, and competition for resources. In the latter regard, resolution of resident concerns over the sharing of the recreational resource at the black sand beach (Section 4.3.4.4) may be particularly important.

<u>Effects of Resort Residents</u>: The population analyses suggest a total year 2005 Ka'u resident population (excluding visitors) ranging from 7,980 to 9,700, of whom nine to ten percent would be Resort residents. Since many of these would be part-time residents, they are unlikely to have a pronounced effect on area politics or community affairs.

<u>Effects of Inmigrating Workers</u>: The most serious possible negative impacts would occur if inmigrants received jobs while many longtime Ka'u residents did not. This is considered unlikely, due to hotel operators' preference for well established residents who are less likely to turn over their jobs. However, highly motivated inmigrants with more resort experience may end up supervising longtime residents in initial work phases.

Some social adjustment problems could occur if newcomers have radically different cultural backgrounds or values than most current residents. The nature and location of future housing may be a factor in determining whether this occurs. Based on experience at other resort areas in Hawaii, dormitory style housing may be less acceptable to local residents or Filipino immigrants than to young Mainland transients or recent Southeast Asian immigrants. The latter groups are less likely to seek unionization, so hotel management-union relationship could also influence the ultimate composition of the inmigrant population. However, it should be noted that the major available labor supply outside Ka'u is in Puna and Hilo, where the population is reasonably compatible with current Ka'u social characteristics.

Effects of Resort Employment may be either transitional (adjustment to change) or long-term (inherent in the work). The major adjustment problems reportedly experienced in Kohala in the late 1960's and early 1970's involved plantation wives' initial entry into the labor force and their subsequent changed self images (Cottington, 1969; Hawaii State Department of Planning and Economic Development, 1972). According to largely anecdotal evidence, women's self confidence improved, but child care suffered and husbands felt threatened - resulting in wife abuse, divorce, and mental health problems. However, a follow up study by Smith (1972) found that such problems had been few and confined to already shakey marriages, and a year long study of family and psychiatric impacts when tourism was introduced to the Oahu plantation community of Kahuku encountered no such problems at all (Young and Kinzie, 1973). Today, the resort workforce typically contains a higher proportion of males, and some adjustment may be required for men who are having the initial experience of dealing with female colleagues and, in some cases, supervisors. Males may also experience some initial difficulties in adjusting to "service" work.

More enduring problems may be associated with the evening and weekend shift work often required in resort settings but rare in Ka'u today. These shifts can present logistical problems for families with children, and they may reduce the amount of time which husbands and wives can spend at home together. Other long-term effects include some tendency in rural resort areas for different ethnic groups to prefer "front-of-the-house" or "back-of-the-house" jobs, which have different implications for wages, tips, and other benefits. Additionally, national hotel chains typically rotate top management to different outlets throughout the country or world, so that the most powerful individuals in any hotel are usually perceived as "outsiders."

All of these potential employment related impacts must be weighed against the impacts of unemployment noted in Section 4.2.2.2. Additionally, there are positive implications for social structure in providing a diversification of both employment types and employers. At present, Ka'u has one dominant employer -- C. Brewer. While some of the initial workers of the expanded Resort may also be Brewer employees, the long-term development of the Resort will result in numerous additional and independent employers (i.e., hotel operators, store owners, concessionaires, etc.). Consequently, community leadership and economic power will be less concentrated in a single corporation.

Effects of Visitor Population: Based on the analyses in Section 4.3.3.1.1, Ka'u's future de facto population on project build-out in the year 2005 would be, for the lower range scenario, slightly in excess of 9,830 (of whom about 19 percent would be visitors) - and, for the higher-range scenario, 12,810

TABLE IV-9

Spring, Pond and Coastal Water Quality
Punalu'u-Ninole Cove Region

September 2, 1986

STATION #:	1	2	3	4	5	6	7*
PARAMETER**							
Ammonium (mg N/1)	0.006	0.006	0.008	0.009	0.016	0.024	0.028
Nitrite (mg N/1)	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Nitrate (mg N/1)	0.001	0.322	0.190	0.148	0.112	0.112	0.021
Total N (mg N/1)	0.530	0.494	0.318	0.290	0.170	0.140	0.196
Orthophosphate (mg P/1)	0.006	0.076	0.057	0.054	0.036	0.038	0.018
Total P (mg P/1)	0.065	0.089	0.077	0.074	0.057	0.047	0.020
Salinity (R.I.)	0	0	0	1.5	22.5	23.5	33.5
Turbidity (NTU)	1.79	0.63	0.30	0.32	0.76	0.42	0.25
pH	8.40	8.06	7.85	8.31	8.43	8.39	8.30
Non-Filterable Residue (mg/1)	3.9	<0.1	0.4	0.5	4.8	2.6	7.0
Chlorophyll a (ug/1)	16.6	0.043	1.29	3.69	0.955	1.22	0.309

* Station 1 = "restaurant" pond (#3)
2 = Spring at Punalu'u Harbor boat-launching ramp
3 = Pond #1
4 = Pond #2 (Ninole Cove)
5 = Nearshore water, Ninole Cove (50 ft. offshore)
6 = Nearshore water, Punalu'u Harbor (50 ft. offshore)
7 = Offshore control (approximately 2,000 ft. offshore)

** All samples collected at depth of approximately 10 cm.

Ka'u Home Prices: Considering the prices of residential homes listed for sale in the Ka'u district in 1986, households with annual incomes of $11,000 or less would have difficulty purchasing market priced housing in the district, as would some of the households earning between $11,000 and $22,500.

Conclusion: For planning purposes, it is concluded that 30 percent to 50 percent of resort employee households in the district would have insufficient income to participate freely as purchasers of residential real estate in the marketplace. Thus, the Resort's expansion could support about 250 to 550 new Ka'u households that could be expected to have difficulty purchasing market-priced housing, as shown in Table IV-47.

TABLE IV-47

Projected Affordable Housing Required by Development at Punalu'u Resort for the Ka'u District

	At project completion	
	Low	High
Total housing requirement(1)	824	1,109
Share in affordable housing range:		
At 30%	247	333
At 50%	412	555

(1) From Table IV-45.

4.3.4 Qualitative Social Impacts

4.3.4.1 Social Structure

As discussed in Section 4.3.1, Ka'u's social structure in recent years has been largely tied to plantation life, although some changes have begun to occur with increased population growth outside the plantation communities. Project related implications for social structure involve both direct effects of working in a service (rather than an agricultural) setting and also indirect effects from population growth in three different components (visitors, resort residents, and inmigrants attracted by job opportunities).

However, comparison of the nearshore water quality at Punalu'u to the State Water Quality Standards for open, seasonally "wet," coastal waters (Table IV-10) indicates that the normal baseline quality exceeds most of the standards with the following exceptions: total phosphorus (at the offshore "control" station), total nitrogen (station 6), non-filterable residue, and turbidity (stations 6 and 7). These elevated nutrient levels appear to result from upland nitrogen fixing trees and shrubs such as Kiawe and Koa-haole (Kay, et al., 1977) as well as upland sugar lands fertilization and possibly the use of treated sewage effluent for golf course irrigation. [Note: The water quality measurements given in Tables IV-9, IV-10 and IV-11 are based on one-time sampling. This sampling is thought to adequately represent and characterize the water quality of the Punalu'u area to the extent required at present. It is recognized that fluctuations and variations in nutrient levels will occur over any given period of time. As specified in the Environmental Protection Plan (Appendix H), water quality monitoring will be performed prior to construction and operation of new Resort facilities. These measurements will provide the detailed baseline information required to detect variations that may be attributable to future Resort operations.]

As noted above, elements that probably contribute to the elevated nutrient levels of the coastal ponds and nearshore waters include upland trees and shrubs, fertilization of upland sugar lands and the use of treated sewage for Resort and golf course irrigation purposes. Of these, only the latter could be controlled by CBP. As such, the following discussion is provided to disclose potential impacts that might result from continued and increased use of treated sewage for golf course and landscape areas irrigation. It is noted that the disposal of treated sewage, following storage in holding ponds along the 17th fairway is generally considered by appropriate health and regulatory agencies to be an environmentally acceptable and benign method of treated wastewater disposal. Other disposal methods, such as injection into ground waters could "contaminate" potable water supplies and would not permit additional natural treatment processes to occur.

The existing Punalu'u Resort golf course presently receives an average of 20,000 gallons per day of secondary treated domestic sewage for irrigation purposes. Wastewater treatment beyond secondary treatment is not necessary. The wastewater, after secondary treatment, will not contain any complex organic compounds, which usually require advanced levels of treatment. The secondary effluent will contain soluble ions of nitrogen and phosphorus. These two elements and potash are the major ingredients in lawn fertilizers. By using secondary effluent for irrigation the amount of commercial fertilizer

4.3.3.2.3 Housing Affordability

The subsections below address housing affordability for the direct, indirect and induced employee households anticipated to require new housing in the district.

Household Income: Results of the Hawaii State Department of Health's Health Surveillance Survey suggest that about 15 percent of hotel industry employees are members of households earning $11,000 or less per year and about 45 percent are members of households earning $22,500 or less per year, in 1986 dollars. Assuming mortgage payments equivalent to 28 percent of gross household income and a 30-year loan at 9.5 percent interest with 10 percent down, these households could only afford to purchase homes priced at less than about $33,600 and $68,700, respectively, as shown in Table IV-46.

TABLE IV-46

Resort Employee Housing Affordability Considerations in the Ka'u District

(1986 dollars)

Household income(1)			Residential home listings(3)	
Income	Cumulative percent distribution	Maximum affordable home price(2)	Number	Cumulative percent distribution
To $11,000	15%	$ 33,600	7	10%
$11,001 - $22,500	45	68,700	23	43
$22,501 - $28,000	65	85,500	13	62
$28,001 - $39,500	85	120,600	10	77
$39,501+	100	120,600	16	100

(1) Based on household income data for 308 hotel industry employees sampled in 1983 by the Hawaii State Department of Health's Health Surveillance Survey. Maximum income ranges adjusted to 1986 dollars, assuming a 4% annual rate of increase.

(2) Assuming mortgage payments equivalent to 28% of gross income and a 30-year loan at 9.5% interest, with a 10% down payment.

(3) Residential homes in Ka'u with one or more bedrooms listed for sale between January and December 1986.

required to maintain a healthy golf course is reduced. Potash (potassium) may be applied periodically to balance the nutrients, as will chemically produced nitrogen and phosphorus to provide the level of nutrients required by the golf course grasses, trees and shrubs.

TABLE IV-10

Summary of Water Quality Data - Nearshore Waters*

STATION #:	5***	6	7	Class AA State Water Quality Standard - Open Coastal Waters **
PARAMETER**				
Nitrate + Nitrite (ug/1)	112.0	112.0	21.0	5.0
Ammonium (ug/1)	16.0	24.0	28.0	3.5
Total N (ug/1)	170.0	140.0	196.0	150.0
Orthophosphate (ug/1)	36.0	38.0	18.0	7.0
Total Phosphorus (ug/1)	57.0	47.0	20.0	20.0
Chlorophyll a (ug/1)	0.955	1.22	0.309	0.3
Turbidity (NTU)	0.76	0.42	0.25	0.50
Non-Filterable Residue (mg/1)	4.8	2.6	7.0	20.0
pH	8.43	8.39	8.3	8.1 ± 0.5

* For comparative purposes field data expressed as mg/1 have been converted to ug/1 to correspond to State Water Quality designations.

** For seasonally wet open coastal waters ("wet" criteria apply when open coastal waters receive more than three million gallons per day of fresh water discharges per shoreline mile).

*** 5 = Ninole Cove; 6 = Punalu'u Harbor; 7 = Offshore Control.

Range of sales prices:	$1,500 to $248,000
Average sold price:	$8,400
Number of sales:	129 lots

There has been significant home development at Hawaii Ocean View Estates, which is now estimated to have a resident population of about 400 to 500 persons in 1986, according to study by Community Resources, Inc.

Other growth opportunities: The most logical areas for possible growth within the district appear to be on the large tracts of land that are located close to existing urban areas and infrastructural systems. Preliminary studies by C. Brewer Properties and Phillips Brandt Reddick & Associates indicate that nearly 800 additional homesites could be developed on lands within urban districted or urban expansion lands near to existing communities in the district. These lands are owned by C. Brewer Properties and its affiliates, and other private landowners. The potential new homesites are estimated as shown below:

Potential New Homesites in Ka'u
by Land Ownership

	Ownership		
	C. Brewer and affiliates	Others	Total
Pahala area	278	0	278
Na'alehu area	307	160	467
Waiohinu	0	15	15
Other(1)	0	20	20
Total	585	195	780

(1) Waiohinu to South Point Road.

Source: C. Brewer Properties and Phillips Brandt Reddick & Associates

C. Brewer Properties intends to use its lands and cause sufficient housing to be developed in the district, as required by the Resort's demands which are not satisfied by alternatives or the development of residential projects by others in the area. In conclusion, it appears that there is sufficient and appropriate land within the Ka'u district to accommodate the population growth that could be expected to occur as a result of the Resort's further development.

TABLE IV-11

Comparison of Pond Water Quality to Primary, Secondary and Tertiary Treated Sewage and Well Water

PARAMETER:	Total N (ug/1)	Total P (ug/1)	Turbidity (NTU)	Non-Filterable Residue (mg/1)
Primary STP	24,000	8,000	6.6	86.0
Secondary STP	17,000	7,000	5.4	37.0
Tertiary STP	100-1,000	<2,000	>0.5	<1.0
Punalu'u STP	8,600	10,530	15.5	20.0
Punalu'u Pond #1	318.0	77.0	0.30	0.4
Punalu'u Pond #2	290.0	74.0	0.32	0.5
Punalu'u Pond #3	530.0	65.0	1.79	3.9
Parker Well #4	1,162.0	89.0	--	--
Parker Well #5	1,200.0	80.0	--	--
Parker Well #6	879.0	104.0	(tidally affected ground water)	

Sources: Young and Chan, 1970; Gakstatter, et al., 1978; Eckenfelder, 1970; Kay, et al., 1977; and Brewer Analytical Labs, November 1987.

Because the wastewater is sprayed to water the golf course, chlorination is presently used to destroy harmful bacteria and viruses. Chlorine is the only chemical presently used and will continue to be the only chemical used at the wastewater treatment plant. Chlorination destroys about 80 to 90 percent of the harmful microorganisms. The remainder are destroyed by direct contact with ultra-violet radiation (sunlight) and action of microorganisms in the soil as the wastewater percolates through the topsoil of the golf course.

For comparative purposes the concentrations of total nitrogen, total phosphorus and turbidity and non-filterable residues characteristic of primary, secondary and tertiary treated sewage are depicted in Table IV-11 along with the values reported in the three coastal ponds which could, presumably, receive some small portion of the applied treated effluent. Table IV-11 also shows the quality of three wells in west Hawaii, two of which (Nos. 4 and 5) are rated as "exceptional quality" (Kay, et al., 1977).

Housing stock: In 1985, there were an estimated 1,647 housing units in the district, as noted by the County of Hawaii in its General Plan (Preliminary Draft dated May 1986). Prices of these existing housing units are substantially lower than those elsewhere on the island, but the stock tends to be relatively old and there is very little sales activity. According to MLS and Real Estate Data Index (REDI) records, residential home sales activity in the district from July 1, 1985 through June 30, 1986 is summarized as follows:

Range of sales prices:	\$22,500 to \$182,500
Average sold price:	\$54,900
Number of sales:	20 units

Vacant lots: The region has an abundance of inexpensive vacant lots, the majority of which are located in subdivisions that are substandard with respect to the provision of water, electricity and other public utilities and services. The County General Plan (Preliminary Draft) notes 17,281 lots in the region as of 1985, of which 15,450 are vacant. This inventory represents almost four times more lots than resident population, with more than 13,000 lots located in the "substandard" subdivisions, as noted below:

Major Substandard Lot Subdivisions
in the Ka'u District

Hawaii Ocean View Estates	10,400
Hawaii Ocean View Ranchos(1)	1,200
Mark Twain	705
Green Sands	318
Kula Kai View Estates(1)	154
Kona Garden Estates(2)	243
Kona South(2)	144
Kiolakaa Homesites	134
Total	13,298

(1) Three-acre lots.
(2) Three to 20+ - acre lots.

Because of the predominance of these "substandard" lots, average lot sales prices in the district tend to be very low. Ka'u vacant lot sales activity between July 1, 1985 and June 30, 1986, as reported by the MLS and REDI, is summarized as follows:

As compared with the "Parker series" wells, the quality of the coastal pond waters is such that they would meet the requirements for drinking water with respect to total nitrogen and total phosphorus and (although not shown) ammonia-nitrogen and nitrate-nitrite as well) (Kay, et al., 1977). It is noted, however, that State Potable Water Standards require N (as nitrate) to be 10 ug/l (0.01 ug/l) or less. The pH values for the coastal ponds and spring are higher than anticipated but probably reflect buffering as a result of sea water influence.

Nitrate-nitrogen is typically high in Hawaiian ground waters, principally as a result of nitrogen-fixing trees and shrubs such as Kiawe and Koa-haole (Kay, et al., 1977). It is noted in Kay, et al., (1977), relative to the South Kohala coast, "The nitrogen is significantly derived from nitrogen-fixation plants, such as Kiawe (Prosopis pallida), which is plentiful and is known to produce nitrate. No other source of nitrogen exists in the area except for the small quantity of sewage treatment effluent." Although Ka'u and the South Kohala Coast differ climatically (20 inches of rain annually versus 30 inches annually in Ka'u) and the amount of agricultural activity upland from Punalu'u, as with the South Kohala coast, the only other source of nitrogen other than the small amount of treated sewage effluent (20,000 gpd or 0.07 percent of ground water outflow) and upland Kiawe and Koa haole trees at Punalu'u is the fertilization of upland sugar fields.

With the exception of the eutrophic pond (Station 1, Table IV-9) where the majority of the nitrate-nitrogen is in an organic form (in algal protoplasm), the water quality data indicate that for the coastal spring discharge (Station 2) and Ponds No. 1 and No. 2 (Stations 3 and 4, Table IV-9), between 51 and 65 percent of the total nitrogen is in a soluble form. A similar pattern is demonstrated with respect to soluble versus insoluble phosphorus; orthophosphate accounting for between 73 and 85 percent of total phosphorus. These data indicate that ground waters provide an important and sustained source of nutrients (soluble nitrogen and phosphorus) to the nearshore marine environment at Punalu'u.

Lau (in Kay, et al., 1977), notes that for the South Kohala coast, ground water discharge into the ocean definitely supplies an important and sustained source of nitrogen for the nearshore coastal water. Nitrogen concentrations in coastal spring waters was found to be over 400 percent greater than coastal water. Similarly, a continuous enrichment of phosphorous in the coastal water takes place in the ground water discharge as the average concentration in the ground waters was found to be about 100 percent higher than in the coastal water (Kay, et al., 1977).

TABLE IV-45

Projected Additional Housing Unit Demand
for Direct Operational Employees
in the Ka'u District

Employee labor supply category	At project completion Low	High
In-migrants to Ka'u:		
Managerial or specialty(1)	152	199
Other(2)	201	431
Subtotal	353	630
Ka'u natural increase(2)	471	479
Total	824	1,109

(1) Projected at 1.0 managerial or supervisory employee per household, as shown in Table IV-41.

(2) Projected at 1.5 other employees per household based on total nonmanagerial or supervisory in-migrant employees and Ka'u natural increase employees as shown in Table IV-41; commuters and currently unemployed assumed to be already housed in region.

4.3.3.2.2 New Housing Opportunities in Ka'u

The Ka'u district represents a relatively isolated and small residential real estate market that includes small towns, a portion of the Volcano community, a few lot subdivisions and large areas of underutilized land, as described previously in Section 4.2.1.2. There are limited existing opportunities for immediate new housing in the district, but ample opportunities to accommodate growth, as explained in the subsections below.

Chlorophyll a, non-filterable residue, and turbidity data also support the qualitative observations cited in the baseline environment study which indicated the eutrophic character of the "restaurant pond" (Punalu'u Lagoon) and the enriched environment of Pond No. 2 (Ninole Pond) as contrasted with Pond No. 1 (Table IV-9). The restaurant pond (Pond No. 3) demonstrated a chlorophyll a level nearly thirteen (13) times the titer of Pond No. 1; Pond No. 2 had nearly three (3) times the chlorophyll a titer as Pond No. 1. The chlorophyll a data also lend additional support to the high degree of flushing which was reported in the baseline survey.

2.4.1.2 Impacts on Coastal Pond Physical Characteristics/Water Quality

Impacts on the coastal ponds at Punalu'u Resort could be caused by increased surface runoff drainage into the ponds; increased nutrient loading due to continued and increased use of treated sewage effluent for golf course and landscape irrigation; continued use of biocides and fertilizers on the golf course and landscape areas; pond maintenance and cleaning operations; increased public use of the ponds; and increased sedimentation due to surface water runoff and/or fugitive dust.

The Resort Master Plan calls for Pond No. 1 and the dry mauka pond to be reconnected and integrated into the relocated 8th and 9th golf holes. The ponds would have a landscape buffer on the golf course side to prevent ready access to the ponds thereby preventing golfers and others from entering or otherwise disturbing the ponds. In addition, pending approval by appropriate state and federal agencies, the dry mauka pond would be reconnected to Pond No. 1 by removal of the narrow man-made rock and earthen barrier that currently separates the two ponds. This connection would create approximately one-acre of additional wetland and pond habitat. No other modification or reconfiguring of these two ponds, other than debris and overgrowth removal, is planned.

Pending approval by appropriate state and federal agencies, Pond No. 3 (Punalu'u Lagoon) would be cleaned and cleared of debris and overgrowth that has accumulated in the pond and the pond shoreline would be stabilized as part of the proposed project. This work would be designed to restore the pond to a more natural condition and to integrate the pond into the Punalu'u Black Sand Restaurant and Inn complex.

Based on calculations and analyses performed for this EIS (see Notes at conclusion of this section), increased use of treated sewage for golf course and landscaped areas irrigation is not expected to adversely affect the physical characteristics or water quality of the coastal ponds. This is due to natural

- The historically soft market conditions among condominiums in visitor rental pools in the Hilo area, where occupancies have averaged about 50 percent in recent years and many units have been converted to office or other uses.

- The development of new units at Punalu'u, where investor returns could be supported in part by this additional rental market segment.

Between 17 and 180 construction workers could be seeking housing in the district at any given time during the development of the Resort, as shown previously in Table IV-43.

Operational Employees

Inmigrants to Ka'u: The demand for additional housing in the Ka'u district is projected to be less than the number of direct employees of the Resort who are expected to move to the district, because households could include more than one Resort employee. Personnel brought in to fill managerial or specialty positions may be expected to be principally heads of households; thus each managerial level inmigrant is projected to generate demand for one additional home. On the other hand, experience has shown that many nonmanagerial and nonspecialty employees share housing. Thus nonmanagerial and nonspecialty employees in need of new housing are projected to generate housing unit demand at a ratio of one housing unit per 1.5 employees.

Ka'u Natural Increase: The approximately 750 new labor force members projected to be available for work at the Resort through natural population increase within the district, as shown previously in Table IV-29, are also assumed to form new households and thus to require housing. Housing unit demand for this group is also estimated at a ratio of 1.5 employees per household.

Summary: Including the requirements attributed to both inmigrants to Ka'u and natural increase and new household formation among Ka'u residents, the demand for housing directly attributable to the Resort's expansion is projected to amount to about 820 to 1,110 units at project completion, as shown in Table IV-45.

flushing of the ponds that presently occurs or will occur following the previously noted modifications as well as the circulation patterns within Punalu'u Harbor.

As noted previously, present golf course irrigation practices at Punalu'u Resort include the use of secondary treated domestic wastewater effluent supplemented with potable water as required. The treated wastewater effluent is pumped from the treatment plant to storage ponds located along the 17th fairway and withdrawn from the ponds for irrigation purposes. At present, a total of approximately 800,000 gallons of water per day (gpd) is required to irrigate the entire golf course, of which approximately 20,000 gallons is treated wastewater. That is, all of the wastewater presently generated at the Resort (20,000 gpd), plus potable water (780,000 gpd), is presently used to irrigate the golf course. The ultimate predicted wastewater volume when the Resort is fully developed and occupied is 779,200 gallons per day. This volume is slightly less (208 gallons) than what is presently being applied so there will be no excess. The existing storage ponds have sufficient capacity to store approximately three days of wastewater. Irrigation occurs five or six days per week, depending on the amount of rainfall received and other golf course maintenance operations and, as noted above, the treated wastewater is supplemented with potable water to provide adequate irrigation water quantities. Residence time for treated wastewater in the storage ponds is between two to three days, depending on application rates and requirements. The golf course irrigation system is presently capable of applying 600,000 to 700,000 gallons per day to the areas makai of the Belt Highway. Areas mauka of the highway are irrigated with potable water from the Resort storage tanks. This practice will be continued for the foreseeable future. In addition, the new 8th and 9th golf holes in the coastal area would be irrigated with potable water.

The storage ponds have adequate capacity to handle peak flows. Wastewater flow varies throughout the day. It is never constant. Flows are generally very low, or non-existent, in the early morning hours. Peaks or surges in flow are experienced during breakfast, lunch, and dinner hours. The dinner hour peak is usually the highest of the day. By definition, the average flow is the total volume of wastewater generated in a day. For engineering purposes, the average flow is determined from a year's flow records. The peak flow or surge usually lasts for one or two hours and the design peak flow is defined as the total volume of wastewater generated during the period of the surge divided by the surge time interval in time units of days. The peak flow is a design criterion used to provide adequate hydraulic capacity in sewer pipes and treatment of plant tanks.

The golf course is planted primarily with common Bermuda grass (Cynodon dactylon) and with several species of other grasses, trees and shrubs planted along and/or in the fair-subsections below, the Resort could be expected to generate additional housing demand in Ka'u and elsewhere on the island through mechanisms which are not accounted for here. These would include housing demand attributable to:

- Persons supported by the indirect and induced spending by the Resort's visitors or in the construction of its facilities. Such persons could be employed either within or outside of the Ka'u district.

- Persons moving to the island or the district as a result of employment opportunities created through job turnover, when on-Resort or direct off-site employment opportunities draw labor from existing locations of employment on the island or in the district. Because of the small existing employment base in Ka'u and the Resort's relative isolation from the island's other employment centers this is expected to be a relatively small group.

- Persons moving to the island as a result of opportunities created by the Resort's direct construction or visitor expenditures, who settle outside of the Ka'u district.

Construction Employees

Direct construction employment tends to be short-term and therefore does not generate the long-term housing demands that are associated with operational employment. With the generous housing subsidy allowances typically paid to construction workers, some of the demand for residential housing by construction employees is expected to be absorbed by units available in short-term rental markets in Ka'u and the surrounding region, including units that are developed at Punalu'u. While there are likely to be substantial rental units in the Hilo and Kona areas, due to the long commuting distance to Ka'u from these areas, however, this short-term rental market could include developer provided housing from temporary or permanent on site units.

The housing for subsidized construction workers could tend to encourage rent increases in surrounding areas. The effect on long-term renters would be indirect because units in short-term rental markets are different from those rented on long-term leases. However, the strong demand and potentially high earnings from short-term rentals supported by the construction workers could induce more property owners to keep their units in short-term rather than long-term rental use. This effect could be mitigated by:

ways. Volcanic soils, of varying thickness, underlie the golf course and surrounding areas.

Existing basal ground water quality measurements (Mink, 1981 and USGS, 1973) are listed in Table IV-1. As shown, in general, the lower level water supplies are not suitable for potable or irrigation purposes because of elevated levels of chloride and other salts. Also, as noted previously, USGS and other surveys have indicated basal ground water outflows at the Resort (between Punalu'u and Ninole) to be in excess of 30 million gallons per day. Assuming that the full capacity of the golf course wastewater effluent irrigation system were in use, i.e., 700,000 gpd and that potable water would not be required to supplement the wastewater quantity, the total amount of wastewater that would be applied to the golf course would be approximately 2 percent of the total basal ground water outflow (70,000 gpd / 30,000,000 gpd = 2.33%). Generally, under dry weather conditions, the quantity of wastewater effluent that would enter the ground water stream would be significantly less than that applied due to absorption by the soil and vegetation, transpiration and evaporation (Mink, 1981).

The use of treated and untreated wastewater effluent for sugarcane and golf course irrigation purposes in Hawaii has been examined in detail over the past 20 years (Young, et al., 1967; Chun, et al., 1972; Peterson and Hargis, 1971; Tenorio, et al., 1969; Quan, et al., 1970; Tenorio, et al., 1970; Lau, 1972; Dugan, et al., 1975; Dugan, et al., 1976; Handley and Eckern, 1981; Chang, et al., 1977; and Aguilar, 1987). In general, it has been found that the controlled use of wastewater effluent for irrigation purposes is an environmentally sound and economical method for the disposal of treated wastewaters and is preferred over the use of potable water supplies from a conservation standpoint (DLNR Letter of December 31, 1986). After a seven-year study of secondary effluent irrigation of grassland and sugarcane, no detrimental effects were found on vegetation or public health in a Hawaiian Oxisol soil (Dugan, 1980). It is noted that Dugan et. al. (1975) used predominately the Lahaina silty clay series on Oahu as their study soil and that the combination of soil and grass in a five-foot lysimeter removed all detectable levels of total nitrogen and phosphates. Nitrogen, however, was not effectively removed from depths shallower than five feet. The implications of these results are not fully understood with respect to Punalu'u, given the quality of the basal ground water, i.e., high naturally occurring nutrient levels, and the application of fertilizers on the golf course to supplement the treated sewage effluent application and different soil types. Treated wastewater effluent does not appear to satisfy all of the nutrient requirements of the golf course grasses and landscaping and must, therefore, be supplemented with chemical fertilizers. As noted in Section 1.2.1, the only naturally occurring soil type within the project boundaries is classified as D290 and top soil

TABLE IV-44

Projected Total Population Impact
for the Island of Hawaii

(Average daily population)

	At project completion	
	Low	High
On-Resort(1)	2,469	3,596
Off-Resort:		
Employees:		
Construction(2)	17	180
Managerial and supervisory operational(3)	46	60
Other(4)	45	97
Subtotal employees	108	337
Dependents:		
Of construction employees(5)	4	45
Of managerial and supervisory operational employees(6)	92	120
Of other employees(7)	45	97
Subtotal dependents	141	262
Subtotal off-Resort	249	599
Total	2,718	4,195

(1) Including Resort residents and visitors, as shown in Table IV-43.
(2) As shown in Table IV-43.
(3) Estimated as 30% of managerial and supervisory positions created.
(4) Estimated as 15% of nonmanagerial and nonsupervisory employees.
(5) Estimated as 0.25 additional household members per construction employee.
(6) Estimated as two additional persons per employee.
(7) Estimated as one additional person per employee.

has been brought in for the golf course. Dry weather condition measurements taken immediately following watering of the golf course with the treated sewage effluent indicate that water penetration and the grass root zone are up to about two inches in depth, indicating that possibly none of the irrigation water reaches the basal ground water supply, even with daily watering. It would appear, based on these measurements that a significant portion, if not all, of the nutrients bound in the sewage effluent as well as those in the chemical fertilizers is absorbed by the soils and plants. The biostimulatory effects of increased nutrient loading on the coastal ponds and nearshore marine environment, if they occur, appear to be positive in that algal growth is encouraged and that this appears to aid in the production of food for the herbivorous fish and turtles that inhabit the coastal ponds and nearshore waters. Further, due to the relatively strong currents and wave actions along the Punalu'u coastline, should excess nutrients enter the ocean waters, they would be dispersed throughout the harbor and rapidly carried out to sea to add to the oceanic food chain (see Section 2.5.2 below).

Handley and Eckern (1981) found that California grass (paragrass) (Brachiaria mutica) irrigated with effluent from secondary treated domestic sewage showed excellent response as a means for disposal of large amounts of water, effective removal of nitrogen and high production of fodder. Even with the highest effluent irrigation rates, nitrate nitrogen levels in the percolate remained less than the 10 mg/l recommended maximum for potable water (Handley, 1981).

Nitrogen, as organic nitrogen, ammonia, nitrate and nitrites, are a major concern due to potential toxicity and also its potential stimulation of aquatic growth. The ultimate removal of nitrogen from the effluent depends on the type of crop as well as soil type. Lau, et al. (1975) found Bermuda grass, with periodic cutting, to be more effective than sugar cane in protecting ground water supplies and removing nitrogen.

Similarly, mineralized phosphorus occuring in secondary treated wastewater effluent could cause eutrofication of surface waters. Studies have shown that although higher concentrations of phosphorus are found in soil water samples of effluent irrigated sites as compared to control sites, those concentrations were less than 1 mg/l. Dugan, et al. (1975) reported that the phosphorus concentration in effluent applied to an Oxisol with Bermuda grass cover decreased to 0.03 mg/l or less regardless of applied concentration.

Pathogens and bacteria of sanitary significance are removed from the wastewater during secondary treatment. Chang and Young (1977) found that the volcanic soils at the Kaneohe Marine Corps Air Station Klipper Golf Course (Oahu) were effec-

In summary, new development at the Resort is projected to generate population growth at the Resort by visitors and residents at the Resort's facilities, and in the community by the in-migrant operational employees and their accompanying household members. Total projected population impact is projected to range from about 3,500 to 5,700 persons at project completion, as also shown in the table.

4.3.3.1.2 Island of Hawaii

Net population impact of the Resort would be greater in Ka'u than the island as a whole. Considering the employment experiences of other resorts and the growing labor pool of resort-experienced personnel on the island, most of the in-migrants to Ka'u are expected to already be residents of the island. Operational employees who move to the island in association with their employment at Punalu'u are assumed to represent about 30 percent of managerial and supervisory employees and 15 percent of other employees. In comparison, resort developments in the North Kona and South Kohala districts of the island have drawn 18 percent to 20 percent of their operational employees from off-island. Punalu'u is expected to attract relatively fewer off-island employees than the Kona and Kohala resorts due to its more rural nature and remote location. In addition, construction workers temporarily resident on the island are assumed to represent 20 to 50 percent of the average annual construction labor force, as discussed previously. Thus persons attracted to the island because of employment or proprietary opportunities created by Punalu'u's expansion are expected to number about 110 to 340 persons over the life of the project, as shown in Table IV-44.

Including dependents of these employees, and the on-Resort visitors and residents noted previously, the total impact of the Resort's expansion on the island of Hawaii is estimated to be about 2,700 to 4,200 persons, as also shown in Table IV-44.

4.3.3.2 Projected Housing Impacts

4.3.3.2.1 Employee Housing Requirements (Construction and Operational Employees)

This section presents the analysis of the additional housing required to support the employees who are expected to temporarily or permanently move to Ka'u due to the direct construction and operational employment or proprietary opportunities expected to be generated by the Resort, both on- and off-site. In addition to the housing requirements noted in the tive in removing nitrogen, phosphorus and fecal coliforms from the applied secondarily treated wastewater. Further, the quality of the percolate did not present a hazard to the ground water quality and/or adjacent surface waters. Also, it was found that the presence and concentration of aerosolized coliform bacteria in the irrigation spray fallout were not considered a public health hazard to golf course workers, users or nearby residents (Chang and Young, 1977). Lau, et. al. (1975) stated that the absence of enteric viruses in sugar cane and grass percolates sampled over a two-year period suggests that the possibility of contaminating deep water resources is extremely remote.

The use of treated wastewater effluent for golf course irrigation purposes has been studied in some detail by the U.S. Army Corps of Engineers at Waikoloa Beach Resort in the South Kohala District of the Island of Hawaii. To date, it has been found that although nutrient levels in coastal (anchialine) ponds were elevated following use of treated wastewater effluent on the golf course, there was no apparent change in phytoplankton activity or increase in water turbidity (COE, 1985). Brock (1985) noted that negative impacts from similar practices at Mauna Lani Resort golf course were not observable in anchialine ponds surrounded by the golf course and condominium development. These studies also suggest that standard golf course operation and maintenance procedures, i.e., proper applications of fertilizers herbicides and biocides, similarly have no adverse impacts on the ponds or pond organisms even though elevated nutrient levels in the ponds are experienced. Given the limitations and restrictions of their studies, the results of Murdoch and Green (1987) also tend to support previous findings.

In the event of prolonged, intense rainfall, it is probable that present irrigation practices, i.e., watering five or six days per week would continue, as a means of disposing of the treated wastewaters. As a result, it is probable that the nutrient levels of the coastal ponds and nearshore waters would show increases over and above that which may occur as a result of normal or dry weather irrigation practices at completion of the Resort. As noted above, and as shown in the notes and calculations at the conclusion of this section, it is probable that these increased nutrient levels would enter the coastal pond and Punalu'u Harbor circulation patterns and be dispersed out to sea fairly quickly.

Based on the studies performed in Hawaii and elsewhere, present and forecast application rates of treated wastewater at Punalu'u Resort, the level of wastewater treatment; the length of storage time in holding ponds at Punalu'u (which essentially provides tertiary treatment to the wastewaters due to the action of sunlight, additional bacterial action that occurs naturally during the holding period and the mechanical and biological processes taking place within the grass root zone); the relatively

TABLE IV-43

Projected Total Population Impact
for the Ka'u District

(Average daily population)

Population category	At project completion Low	High
On-Resort:		
Visitor(1)	1,771	2,554
Resident(2)	698	1,042
Subtotal	2,469	3,596
Off-Resort(3):		
Operational employees	453	845
Construction employees	17	180
Other household members	609	1,089
Subtotal	1,079	2,114
Total population impact	3,548	5,710

(1) Visitors staying in hotels or in condominium units in transient visitor rental pools, as shown in Table IV-22.

(2) Residents at the Resort's condominium units and single-family homes, representing about 455 to 680 full-time and 243 to 362 part-time residents, based on the assumptions shown in Table IV-21.

(3) Calculated from figures shown in Table IV-42.

small land area of the golf course as compared to the entire watershed area of Punalu'u; and the existing water quality characteristics of the basal ground water, coastal ponds and offshore waters; it appears that continued use of treated wastewater effluent for irrigation of the golf course and landscape areas would not cause adverse impacts to the water or air quality of the Resort area.

In February 1987, at the request of the Hawaii County Council, the Hawaii District office of the State Department of Health tested the nearshore ocean waters off Punalu'u Resort for the effects of sewage pollution, presumably caused by the use of treated sewage effluent for golf course irrigation. Three sampling stations were selected in an area that the Department of Health believed would show the greatest effects of pollution if it were present. The three samples were taken seaward of the black sand beach, one in front of the existing souvenir stands; one near the boat launch ramp; and one in between the first two. Total coliform bacteria, fecal coliform and fecal streptococcus bacteria were measured. The results of this sampling indicated that both total coliform and fecal coliform were less than 2 parts per 100 ml of water sampled and that fecal steptococcus bacteria were less than one part per 100 ml. Based on historical records and samples taken throughout the State, the Punalu'u waters are typical of pristine conditions and showed no indications of sewage pollution. Also, based on the sample results, the District Sanitarian has indicated that the Department would not support the need for further sampling.

Increased public use of the ponds and adjacent shoreline could be caused by improved access to the coastal areas and increased numbers of people visiting the Resort. The relocation of the 8th and 9th golf holes would necessitate a change in the present recreational use of Pond No. 1 (seine-netting of fish, shrimp and prawns) for public safety reasons. Pond No. 1 and the dry mauka pond would be provided with vegetative buffers to limit public access to the golf course and to provide safety measures to minimize "stray ball" incidents. The developers recognize the importance of Pond No. 1 to the local residents and, although a strict non-consumptive conservation program would be desirable versus restricting people from the pond, safety precautions require that public access in that portion of the pond that is on CBP property be restricted. As such, significant impacts on the coastal ponds due to increased numbers of people having improved access to the ponds is not expected.

Increased sedimentation of the coastal ponds due to increased surface water runoff and/or fugitive dust is not expected to be cause significant short- or long-term impacts. As noted previously, the planned improvements to the Resort surface water collection and disposal system; the planned construction of retention basins in the golf course fairways; and the abandonment

	Total On-Island Labor Demand(1)	Percent from Off-Island	Employess Requiring Housing
Low	25	20%	17
High	360	50%	180

(1) As shown on Table IV-26

- Additional Household Members: Inmigrant operational supervisory and managerial employees at the Resort were assumed to be accompanied by two additional household members, while other operational employees were assumed to average one additional household member. Construction workers temporarily resident on the island are assumed to be accompanied by an average of 0.25 additional household members per full-time equivalent worker.

These projections are considered to represent a "maximum impact" scenario because:

- There has been significant population movement to Ka'u between 1980 and 1986 despite the lack of economic growth in the region. Thus, by the time of project completion, the available labor supply in the district may be considerably higher than assumed in this analysis.

- The analysis assumes that none of the Resort residents would be employees of the Resort, whereas most other resorts in the state include some residents who are also employed at the resort.

On-Resort Population Impact: On-resort population is comprised of visitors staying at the hotels and condominiums and residents in condominiums and single-family residences at the Resort. Thus all on-Resort population impact would be located in the Ka'u district. Average daily visitor population was estimated previously in this report to represent about 1,770 to 2,550 persons at project completion, as noted in Table IV-43. On-Resort resident population was projected using the assumptions concerning condominium and single-family home development at the Resort shown previously in Table IV-20 and assumptions about full- and part-time use of the housing units noted in Table IV-21. Thus on-Resort resident population is projected to be between 700 to 1,040 at project completion, as also shown in Table IV-43. Resident population would represent about 26 percent of on-Resort population by 2005.

of the present direct discharge culverts, are measures designed to accommodate future surface water runoff and allow that water to percolate into the basal ground water prior to discharge into the offshore waters. Similarly, fugitive dust during construction activities would be controlled through water spraying and planting of ground cover and vegetation as soon as possible.

2.4.1.3 Mitigation Measures

As noted above, Pond No. 1 and the dry mauka pond would be reconnected and provided with landscape buffers to prevent access by golfers and others. The importance of the ponds as wildlife habitat would be described in appropriately placed displays. Precautions would be taken during the construction period to reduce potential impacts caused by fugitive dust. It is expected that the decrease in human activities in Pond No. 1 would allow the aquatic organisms (plants and animals) inhabiting the Pond to regenerate population levels and possibly increase usage of the pond by resident and migratory water birds.

Pond No. 3 would be cleaned and cleared of debris and the pond shoreline stabilized to improve the water and habitat quality of the pond. It is the developer's intention to maintain the ponds in their natural state to attract and protect wildlife and to add to the overall aesthetics of the Resort. Further, implementation of the Environmental Protection Plan (Appendix H) would provide additional assurance that the coastal pond resources are protected and preserved.

TABLE IV-42

Projected Off-Resort Population Impact
for the Ka'u District

(Average daily population)

In-migrant type	At project completion Low	At project completion High
Managerial and supervisory:		
Operational employees(1)	152	199
Other household members(2)	304	398
Subtotal	456	597
Other:		
Operational employees(1)	301	646
Construction employees(3)	17	180
Other household members(4)	305	691
Subtotal	623	1,517
Total	1,079	2,114

(1) Including direct, indirect and induced employees of Punalu'u Resort, as shown in Table IV-41.

(2) Projected at two additional persons per household.

(3) Assuming 20% to 50% of construction-related workers come from off-island and seek to locate in the Ka'u region while working on the project. Based on estimated low and peak demands of 85 to 360 employees for total on-island labor requirements, as shown in Table IV-26.

(4) Projected at one additional person per operational employee and 0.25 additional persons per construction employee.

PUNALU'U RESORT FINAL EIS

NOTES AND CALCULATIONS REGARDING ENVIRONMENTAL IMPACTS RESULTING FROM USE OF TREATED SEWAGE EFFLUENT FOR GOLF COURSE AND LANDSCAPE IRRIGATION

The information, analyses and projected potential environmental impacts of continued application of secondary treated sewage effluent, fertilizers and biocides on the Punalu'u Resort golf course and landscape areas are based on the basic ecological principals and calculations given below. The principals and calculations have been applied to the biological survey, water quality sampling and physical oceanographic measurements made on-site. The analyses described in the EIS are also integrated and compared with the results and conclusions of other scientific studies as reported in the literature cited in the text of the EIS.

BASIC ECOLOGICAL PRINCIPALS

Reference: Odum, E. P. 1953. Fundamentals of Ecology. Second Edition. W. B. Saunders Company. Philadelphia and London. 546 p.

1. Principals Pertaining to Limiting Factors

A. Liebig's "Law" of the Minimum

To occur and thrive in a given situation, an organism must have essential materials which are necessary for growth and reproduction. These basic requirements vary with the species and with the situation. The essential material available in amounts most closely approaching the critical minimum needed will tend to be the limiting one. That is, the rate of growth is dependent on the nutrient or other conditions present in the minimum quantity in terms of need and availability. Stated in other words, an organism is no stronger than the weakest link in its ecological chain of requirements. This principal was first clearly expressed by Justus Liebig in 1840. Liebig stated that "growth of a plant is dependent on the amount of foodstuff which is presented to it in minimum quantity". Since that time, the principal has been extended to include other factors, such as temperature, time, etc. However, to avoid confusion, the concept of the come from household members who accompany the inmigrant operational employees.

Assuming no migration to the district without the provision of additional jobs by the Resort, about 480 to 890 operational positions supported through expansion of the Resort and agricultural activities in the Ka'u district could be expected to be filled by inmigrants to Ka'u at project completion, as shown previously in Table IV-29. Allocating the existing and projected sources of labor supply to the additional labor demand to be supported at Punalu'u Resort and in agriculture in Ka'u, it is concluded that the expansion of the Resort could account for about 450 to 850 of the 480 to 890 employees expected to inmigrate to Ka'u, as shown in Table IV-41.

The total population impact in Ka'u resulting from the inmigration of employees, however, would also include construction workers temporarily resident in the district and the accompanying dependents of all employees. Thus the impact of the Resort's expansion on off-Resort population in Ka'u is expected to total about 1,100 to 2,100 persons, as shown in Table IV-42. This finding is explained as follows:

- <u>Operational employees</u>: Direct, indirect and induced managerial and supervisory Resort employees who inmigrate to the district are estimated to represent about 152 to 199 persons, while other immigrant Resort employees are estimated to represent about 301 to 646 persons, as explained previously.

- <u>Construction employees</u>: Based on the experience of Mauna Lani Resort and other hotel developments on the island of Hawaii and the expected competing demands for construction labor on the island in future years, between 20 percent and 50 percent of direct construction employees may be expected to come from off-island. The actual amount, however, would be related to the amount and scheduling of other major construction projects in the state. For purposes of projection, at least 20 percent of construction workers at the Resort were assumed to come from off-island labor pools and up to 50 percent during periods of peak manpower requirements. Thus, the range of construction employee population impact shown in Table IV-42 is estimated based on the following assumptions:

minimum has been restricted to chemical materials (oxygen, nitrogen, phosphorus, etc,) necessary for physiological growth and reproduction, as was originally intended by Liebig.

B. Shelford's "Law" of Tolerance

The presence and success of an organism depend upon the completeness of a complex of conditions. Absence or failure of an organism can be controlled by the qualitative or quantitative deficiency or excess with respect to any one of several factors which may approach the limits of tolerance for that organism. That is, not only may too little of something be a limiting factor, as proposed by Liebig, but also too much, as in the case of such factors as heat, light and water. Thus, organisms have an ecological minimum and maximum, with a range in between which represents the limits of tolerance. The concept of the limiting effect of maximum as well as minimum was incorporated into the "law" of tolerance by V. E. Shelford in 1913.

C. Combined Concept of Limiting Factors

The presence and success of an organism or a group of organisms depends on a complex of conditions. Any condition which approaches or exceeds the limits of tolerance is said to be a limiting condition or a limiting factor. By combining the idea of the minimum and the concept of limits of tolerance, the general principal that organisms are controlled in nature by (1) the quantity and variability of materials for which there is a minimum requirement and physical factors which are critical, and (2) the limits of tolerance of the organisms themselves to these and other components of the environment.

D. Application of Minimums and Tolerance to Punalu'u

The water sampling analyses conducted for this EIS have shown that the coastal pond and nearshore waters of Punalu'u have elevated levels of nutrients. The sources of these elevated nutrients presumably results from the massive outflow of basal groundwaters (estimated by U.S.G.S. to be approximately 30 million gallons per day between Punalu'u and Ninole). The groundwaters "pickup" nutrients as they flow from upper elevations to the sea, with naturally occurring nitrogen fixing trees (Kiawe and Koa haole), sugar cane fertilizers and golf course irrigation and fertilization practices contributing. The key factor is that the waters contain at least the minimum nutrient levels required for growth and reproduction of the organisms (plants and animals) inhabiting the coastal ponds and nearshore waters and, given the lack of scientifically reported occurrences, apparently do not contain growth. Particularly prominent examples are medical services, schools, affordable housing, and shopping opportunities.

Similarly, elected officials (personal communications, State Rep. Andrew Levin, August 14, and Councilman James Dahlberg, August 15, 1986) report that Ka'u needs and requests most frequently voiced to them include things like emergency medical services, expanded police and fire service, variety of high school course offerings, recreational facilities, water systems for subdivisions not yet served, and highway improvements leading to both Hilo and Kona.

Islandwide issues and priorities can be documented through both the 1983 County survey and the State's most recent <u>State Plan Survey</u> (SMS Research, 1984). Both found that the major public concerns involved the need for more jobs and an improved Big Island economy. In the statewide survey, Big Island residents were more concerned about these than were residents of other islands. In the County survey, Ka'u residents were as concerned about these issues as were residents in other parts of the island. However, both islandwide and in Ka'u, the importance of public access to recreational areas was underscored by a finding that two-thirds of all respondents would not approve a project bringing jobs and money to the island if the project restricted access to a recreational area.

4.3.3 <u>Quantitative Social Impacts</u>

4.3.3.1 Projected Population Impacts

The development of facilities will increase population at the Resort and elsewhere on the island. On any given day, there will be visitors staying at the Resort's hotels and in residential units that have been put in visitor rental pools. There will also be persons residing during most or parts of each year at multi- or single-family properties at the Resort. In addition, operational and construction employees attracted from off-island will add to the population of the island, and there may be population movement among districts of the island, to Ka'u. This section discusses the off-Resort (employee) and on-Resort population impacts of the Resort's development with respect to the Ka'u region and to the island as a whole.

4.3.3.1.1 Ka'u District

<u>Off-Resort Population Impact</u>: The Punalu'u Resort will impact Ka'u's population by attracting employees for the Resort's construction and operation from off-island and from other districts of the island. Additional population growth will also

nutrients in amounts in excess of the limits of tolerance of the organisms. Based on the rapid flushing of the coastal ponds (see calculations below) and the active circulation and outward movement of nearshore and offshore waters, it appears that excess nutrients, i.e., amounts not required for maximum growth and reproduction by coastal pond and nearshore organisms, are carried out to sea where they are utilized by the offshore organisms. If levels of nutrients in the coastal ponds were below minimum requirements and/or above tolerance levels, adverse effects would be noted in the form of decreased numbers of organisms. These effects would be evidenced by senescence of the ponds or nearshore waters, phytoplankton blooms and a general degradation of the coastal ponds and nearshore waters. Presently reported periodic decreases in limu, shellfish and fish in the ponds and nearshore waters of Punalu'u appear to be caused by human factors, such as overfishing or improper harvesting methods rather than natural causes such as increased nutrient loading due to upland fertilization or golf course operation and maintenance causes. As noted previously, the rapid flushing of the ponds and the circulation patterns of the nearshore and offshore waters indicate that the waters are "free" of contaminants.

CALCULATIONS FOR TOTAL NITROGEN APPLIED VIA TREATED SEWAGE

1. Present Conditions

a. Treated Sewage Effluent Contribution

Effluent Quantity = 20,000 gallons per day (gpd)

Total N of effluent = 8.60 mg/l (see Table IV-11)

Application Rate = six days per week (average) = 312 days per year.

Conversion Factors
1 gal = 3.785 l
1 lb. = 0.2642 gal
1 lb. = 453.6 g

8.60 mg/l ÷ 1000 mg/l = 0.0086 gm/l
20,000 gpd x 3.785 l/gal = 75,700 l/day
0.0086 gm/l x 75,700 l/day = 651.02 gpd ÷ 453.6 gm/lb
= 1.44 lbs./day
1.44 lbs./day x 312 days/yr = 449.28 lbs./yr ÷ 2,240 lbs/ton
= 0.20 tons/yr.

tures. The small but growing part-Hawaiian population consists of a number of inter-related families and is characterized by sharp value disputes over whether to maintain a traditional subsistence-based lifestyle or to attempt greater success in the mainstream wage economy. Hawaii's rural Filipinos are often highly concerned with re-establishing the extended family pattern of their native Philippines, resulting in a dedication to hard work in order to raise funds to import more family members to the area (Anderson, 1984), a pattern very evident in Ka'u.

4.3.1.3 Existing Housing Supply and Characteristics

Census data on housing characteristics (Table IV-16) reflect a number of basic improvements from 1970 to 1980. Two-thirds of the housing units in Ka'u were owner-occupied in 1980, up from just 40 percent in 1970. Median cash rental was just $95, as opposed to $223 for the entire island. Five percent of the district-wide units were vacant and available for rental, although these may have included many Resort units since the percentages of units available for rentals in Pahala and Na'alehu were much smaller. The relatively high overall percentage of vacant units (18.6 percent) in Ka'u appears to reflect the part-time seasonal occupancy in some of the area's newer subdivisions. The 1980 median value of owner-occupied Ka'u housing units was $42,500, well below the median values in South Kona ($102,600), Volcano ($59,200) and the entire island ($70,300). The number of persons per household in Ka'u -- particularly in Na'alehu and Pahala --slightly exceeded the islandwide median in 1980.

4.3.2 <u>Community Issues and Concerns</u>

This section presents a general contextual overview of issues and concerns found among the residents of Ka'u. Project-specific issues are considered "social impacts" and are discussed in Section 4.3.4 of this EIS.

The only recent available opinion poll on community concerns was incorporated in an islandwide planning survey commissioned by the County (Hawaii Opinion, 1983). Published results include responses of a small (74 respondents) sub-sample of Ka'u residents. The overall pattern of these Ka'u responses, particularly in comparison to the islandwide results, indicates deeply ambivalent and/or divided attitudes toward population growth. The survey indicated that Ka'u residents were more likely than other Big Islanders to say the "best thing" about life there was open space and lack of overpopulation. There was a tendency to prefer locating future Big Isle population growth in other areas besides Ka'u. However, repeated responses on various other questions indicate deep dissatisfaction with facilities and services likely to be improved only with population

b. Potable Water Contribution

Quantity Applied = 780,000 gpd

Total N of Potable Water = Average 1.0 mg/l (see Table IV-1)

Application Rate = Six days per week (average) = 312 days/yr

1.0 mg/l ÷ 1000 mg/l = 0.001 gm/l
780,000 gpd x 3.785 l/gal = 2,952,300 l/day
0.0011 gm/l x 2952,300 l/day = 2,952.3 gpd ÷ 453.6 gm/lb = 6.51 lb/day
6.51 lb/day x 312 days/yr = 2,030.68 lb/yr ÷ 2,240 lb/ton = 0.91 ton/yr

c. Combined Present Treated Sewage Effluent Plus Potable Water Contribution

Sewage Effluent Contribution =	1.44 lb/day
Potable Water Contribution =	6.51 lb/day
TOTAL	7.95 lb/day

7.95 lb/day x 312 days/yr = 2,480.4 lb/yr ÷ 2,240 lb/ton = 1.11 ton/yr.

d. Potential Total N Added to Pond No. 1 and Nearshore Waters From Treated Sewage Effluent

Assume all N added to golf course and landscape areas enters basal groundwater stream and flows into Pond No. 1. Based on Pond No. 1 flushing calculations, between 12.93 and 2.91 million gallons per day flow out of Pond No. 1. Therefore, assume same amount of water flows into Pond No. 1.

i. Present Conditions with 20 cfs flow rate

20 cfs = 12.93 million gallons per day

7.95 lb/day N x 453.6 gm/lb = 3,606.12 gm/day
12,930,000 gal/day x 3.785 gal/l = 48,940,050 l/day
3,606.12 gr/day ÷ 48,940,050 l/day = 0.00007 gm/l
0.00007 gm/l x 1000 mg/l = 0.070 mg/l
Therefore, 0.070 mg/l N added to Pond No. 1 per day when flow rate = 20 cfs.

ii. Present Conditions with 4.50 cfs flow rate

4.50 cfs = 2.91 million gallons per day

4.2.3.4 Fiscal Impact Mitigation Measures

Fiscal impacts resulting from the proposed project, i.e., county and state expenditures and revenues, are projected to be positive with revenues being greater than expenditures. As such, measures to mitigate potential adverse impacts do not appear warranted.

4.3 SOCIAL ENVIRONMENT

4.3.1 Social Structure and Lifestyle Existing Conditions

4.3.1.1 Population Characteristics

As previously noted, three out of four 1980 Ka'u residents lived in the district's two plantation communities, where the social structure typically revolves around work and family. As indicated in Table IV-17, 91.2 percent of Ka'u's population lived in family settings as of the last census, and 87 percent of these families were traditional husband/wife--headed households. More than half the families had children under 18 at home, and only 3.9 percent of the families featured children with a single-parent female head. Census data for the District is given in Table IV-15.

4.3.1.2 Lifestyle Characteristics

According to social service agency informants, certain aspects of the Ka'u lifestyle are shared by virtually all residents. The area's isolation from Hilo or Kona and its limited shopping or entertainment facilities results in a quiet way of life which is gratifying to many but stultifying to others. There is a particular concern in the area over teen pregnancies and drug use. Entertainment usually involves visits with friends and/or family outings, with a strong emphasis on utilization of outdoor resources -- hunting, beach visits, coastal food gathering, etc.

However, there are sharp lifestyle variations in other ways, depending on factors such as ethnicity and location. A traditional strong sense of rivalry between the two plantation communities is now reportedly fading, although a sense of social distance remains between these plantation community residents and some of the newer subdivision residents. Such subdivision residents, primarily Caucasians, are often more individualistic and articulate; they are quick to form both ongoing and ad hoc issue-oriented organizations -- in contrast to plantation community residents, who tend to rely on the ILWU or other existing struc-

2,910,000 gal/day x 3.785 gal/l = 11,014,350 l/day
3,606.12 gm/day ÷ 11.014,350 l/day = 0.0003 gm/l
0.0003 gm/l x 1000 mg/l = 0.300 mg/l
Therefore, 0.300 mg/l N added to Pond No. 1 per day when flow rate = 4.50 cfs.

2. Future Conditions

a. <u>Treated Sewage Effluent Contribution</u>

Effluent = 780,000 gpd

Total N = 8.60 mg/l

Application Rate = six days per week = 312 days per year

780,000 gpd x 3.785 l/gal = 2,952,300 l/day
0.0086 gm/l x 2,952,300 l/day = 25,390 gm/day ÷ 453.6 g/lb. = 55.97 lbs./day
55.97 lbs/day x 312 days/yr = 17,462.64 lbs/yr ÷ 2,240 lbs/ton = 7.80 tons/yr.

b. <u>Potable Water Contribution</u>

Quantity Applied = 20,000 gpd

Total N of Potable Water = Average 1.0 mg/l

Application Rate = Six days per week (average) = 312 days/yr

1.0 mg/l ÷ 1000 mg/l = .001 gm/l
20,000 gpd x 3.785 l/gal = 75,700 l/day
0.001 gm/l x 75,700 l/day = 75.7 gm/day ÷ 453.6 gm/lb = 0.17 lb/day
0.17 lb/day x 312 days/yr = 53.04 lb/yr ÷ 2,240 lb/ton = 0.02 ton/yr

c. <u>Combined Future Treated Sewage Effluent Plus Potable Water Contribution</u>

Sewage Effluent Contribution =	55.97 lb/day
Potable Water Contribution	<u>0.17</u> lb/day
TOTAL	56.14 lb/day

56.14 lb/day x 312 days/yr = 17,515.68 lbs/yr ÷ 2,240 lb/ton = 7.82 tons/yr

Like the community colleges, the Department of Education has a mandate to assure that public school vocational offerings and/or adult education courses meet community needs. "Job shadowing" programs, in which high school students may obtain direct exposure to future workplaces, would be one example of school responses to community employment needs. A one- to two-year lead time is usually required to modify existing curricula or introduce new programs.

Alu Like, Inc.: Alu Like, Inc. is a non-profit community based organization which provides a variety of services to Native Hawaiians. The organization administers a JTPA program for Hawaiians, with essentially the same program components as the JTPA program administered by the Employment Service. Alu Like also administers another, related federally funded program, the Native Hawaiian Vocational Education Program (NHVEP). This recently funded program currently has only one activity funded on the Big Island, which is contracted to the community college. The purpose of that activity is to conduct outreach and counseling efforts to increase the numbers of Hawaiian students in community college vocational education programs.

Alu Like's overall vocational educational goals, however, include identification of barriers to employment of Native Hawaiians in several "high demand" industries, including tourism. Program administrators expect that resources will in the future be allocated more toward training programs to meet specific needs in these areas.

As indicated in Appendix I, C. Brewer personnel have initiated preliminary contacts with all the above agencies.

In addition to preparing Ka'u residents for entry-level jobs, the contemplated program may also focus on development of skills for higher-level positions and/or new businesses, as well as removing practical barriers to employment. Two possible strategies suggested would be development of child care facilities and establishment of some form of employee transportation assistance for persons who need it. The latter type of service has been provided by some South Kohala resorts and was recently agreed to by the Kuilima Development Co. on Oahu. Final decisions on such actions would depend on detailed needs assessments to be conducted at a point in time closer to actual resort openings, since needs which do not currently exist may be more prominent at that time or vice versa.

4.2.3.3 Income Impact Mitigation Measures

Income impacts resulting from the proposed project are expected to be positive in that personal and household incomes should increase. As such, mitigation measures to minimize potential adverse impacts do not appear warranted.

d. Potential Total N Added to Pond No. 1 and Nearshore Waters From Treated Sewage Effluent

Assume all N added to golf course and landscape areas enters basal groundwater stream and flows into Pond No. 1. Based on Pond No. 1 flushing calculations, between 12.93 and 2.91 million gallons per day flow out of Pond No. 1. Therefore, assume same amount of water flows into Pond No. 1.

i. Future Conditions with 20 cfs flow rate

20 cfs = 12.93 million gallons per day

56.14 lb/day N x 453.6 gm/lb = 25,465.10 gm/day
12,930,000 gal/day x 3.785 gal/l = 48,940,050 l/day
25,465.10 gm/day ÷ 48,940,050 l/day = 0.0005 gm/l
0.0005 gm/l x 1000 mg/l = 0.500 mg/l
Therefore, 0.500 mg/l N added to Pond No. 1 per day when flow rate = 20 cfs.

ii. Future Conditions with 4.50 cfs flow rate

4.50 cfs = 2.91 million gallons per day

2,910,000 gal/day x 3.785 gal/l = 11,014,350 l/day
25,465.10 gm/day ÷ 11,014,350 l/day = 0.0023 gm/l
0.0023 gm/l x 1000 mg/l = 2.30 mg/l
Therefore, 2.30 mg/l N added to Pond No. 1 per day when flow rate = 4.50 cfs.

Note: (1) State Department of Health Potable Water Systems (Drinking Water) standards for Nitrogen are 10 mg/l which can be increased under certain conditions to 20 mg/l (see Title 11, Department of Health, Chapter 20, Potable Water Systems, Sections 11-200-3(b) and 11-200-3(d)).

Note: (2) The above Total N calculations assume that all of the chemical fertilizers applied to the golf course and landscape areas (see Table IV-12) are taken up by the grasses and plants. If this were not the case, less chemical fertilizers would be applied to assure that the fertilizer is being used by the plants and not percolating into the basal ground water and flowing out to sea. All fertilizers are applied per manufacturer's suggested application instructions.

English (or Japanese) as a second language; and one-time-only occupational skills programs in areas such as food preparation or construction skills; and upgrade training and development of supervisory/managerial skills.

Because numerous agencies on the Big Island already provide such services, the true need is to provide communication and coordination between Ka'u clients and agencies -- with particular attention to solving problems raised by the area's remoteness, either through transportation assistance or encouraging outreach efforts on the part of agencies which do not currently have Ka'u offices. Such efforts could be carried out cost efficiently by a small staff having a thorough understanding of the Ka'u community and good lines of communication with service providers, some of the more important of whom are as follows:

Hawaii Community College: The community college offers a wide range of courses, at various levels of achievement, both at its main campus in Hilo (the primary source of service for the Ka'u district) and also at various locations in West Hawaii. The University administration has recommended that the Community College be incorporated into the University of Hawaii at Hilo as a new "College of Vocational Studies," a decision to be finalized in December 1987.

Resort-related offerings at the Hilo campus include Agriculture (including groundskeeping), Accounting, Data Processing, General Clerical, and Secretarial Science. In West Hawaii, the College currently offers Food Service and Hotel Operations programs.

There is general agreement on the part of the College's administration that expansion of services, especially in West Hawaii, is necessary. While there are not specific plans at this time to expand services, the college is involved in a study which will provide a framework for future expansion. The College expects that the results of this study will be available in December 1987.

State Department of Education: The State Department of Education (DOE) has, at Ka'u High School, the only occupational skills training programs currently offered within the Study Area. Offerings include courses in the Business Occupations, Agricultural Occupations, Construction and Civil Technology, and Mechanical Occupations clusters. (A tourism-relevant course cluster not currently offered at the school is Food Service.) In addition, the school offers employment and guidance counseling for its students. Perhaps as important as its course offerings is its physical facility, which, like the Konawaena High School campus, might be made available to the community college for more advanced vocational skills training programs.

CALCULATIONS FOR POND NO. 1 FLUSHING

1. August 1986 Measurements

   Pond Area = 2.3 Acres x 43,560 sq ft/Ac = 100,188 sq ft

   Depth = Average 2 ft

   100,188 sq ft x 2 ft = 200,376 cu ft

   One pond opening = 10 ft x 2 ft x 1 ft = 20 cu ft

   Measured Outflow = 20 cu ft/sec (cfs)

   20 cfs x 60 sec/min x 60 min/hr = 72,200 cu ft/hr

   200,376 cu ft ÷ 72,200 cu ft/hr = 2.783 hrs. That is, 2.783 hours are required for one complete exchange of pond water to occur, assuming total mixing.

   20 cfs x 0.64632 = 12.93 million gallons per day

2. February 1988 Measurements

   Pond Area = 2.3 Ac x 43,560 sq ft/Ac = 100,188 sq ft

   Pond Depth = Average 2 ft

   100,188 sq ft x 2 ft = 200,376 cu ft

   Two pond openings

   a. 10 ft x 0.5 ft x 1 ft = 5 cu ft
      Measured flow = 0.75 ft/sec
      5 cu ft x 0.75 ft/sec = 3.75 cfs

   b. 3 ft x 0.25 ft x 1 ft = 0.75 cu ft
      Measured flow = 1.0 ft/sec
      0.75 cu ft x 1.0 ft/sec = 0.75 cfs

   Total Outflow = 3.75 cfs + 0.75 cfs = 4.50 cfs

   4.50 cfs x 60 sec/min x 60 min/hr = 16,200 cu ft/hr

   200,376 cfs ÷ 16,200 cu ft/hr = 12.37 hrs. That is, 12.37 hours are required for one complete exchange of pond water to occur, assuming total mixing.

   4.50 cfs x 0.64632 = 2.91 million gallons per day

TABLE IV-41

Projected Off-Resort In-Migrants to
Ka'u due to New Employment in the
District by Industry of Employment

	Industry of employment				Total	
	Punalu'u Resort		Agriculture			
	Low	High	Low	High	Low	High
Total new labor demand(1)	1,517	1,985	100	100	1,617	2,085
Managerial or supervisory employees(2)	152	199	-	-	152	199
Nonmanagerial or supervisory employees:						
Labor demand	1,365	1,786	100	100	1,465	1,886
Less(3):						
Commuters	205	268	15	15	220	283
Current Ka'u unemployment	152	154	10	8	162	162
Ka'u natural increase	707	718	47	36	754	754
Subtotal	301	646	28	41	329	687
Total	453	845	28	41	481	886

(1) Direct, indirect and induced employment expected to be located in the Ka'u district, as projected by Community Resources, Inc. in Table IV-29.

(2) Resort managerial and supervisory operational positions estimated as 10% of total employment, based on statewide samples of hotel and related employment (Department of Health, Health Surveillance Survey, 1970 to 1980, in Bouslog, Employment in the Hotel Industry in Hawaii, 1984; Department of Labor and Industrial Relations).

(3) Totals for each source of labor (columns on far right) are as stated in Community Resources, Inc., Table IV-29. Totals are allocated to the two industries in proportion to their respective shares of the new employment in the district, representing about 94% Resort and 6% agriculture.

2.4.2 Coastal Pond Flora

2.4.2.1 Existing Conditions

Three ponds were surveyed during the course of the field investigations. The fourth pond (dry mauka pond on Figure IV-19) was dry at the time of the surveys in October 1984 and August 1986. Pond No. 1 is fed by numerous springs of clear, cool, low-salinity water that provides exceptional underwater visibility. The pond is directly connected to the ocean through a small, apparently natural, stream channel that has an estimated discharge flow ranging between 4.5 cfs and 20 cfs (at low tide) depending upon seasonal changes to the shoreline. There does not appear to be any inflow from the ocean, although some exchange may take place. The shoreline of Pond No. 1 is lined with various wetland plants (see Section 2.1.4), including the grass *Paspalum* sp. and bullrushes (*Scirpus validus*). Duckweed and floating mats of *Azolla filiculoides* occur along the protected margins of the pond.

Pond No. 2, located on state-owned land, immediately landward of the beach at Ninole Cove, has been drastically modified by flashflooding since the 1977 survey by Elliot and Hall (1977) and by recent (1985 and 1986) storm wave inundation. Although the pond was once apparently connected to Ninole Cove, it is now totally landlocked except for tidal influences and wave-splash across a narrow basaltic isthmus. During the 1984 surveys, an estimated 80 percent of the 50 meter diameter pond surface area was eutrophic. The remaining 20 percent being dominated by clear, low-saline springs. Monotypic stands of an unidentified filamentous green alga dominated most of the pond and formed large decomposing mats on the surface. The 1986 surveys showed generally clear water, though large masses of mucous-like filamentous green algae still dominated large portions of the pond. Storm waves generated by Hurricane Estelle in 1986 may have been responsible for flushing the pond and improving water quality.

The Punalu'u "Lagoon" pond (Pond No. 3), adjacent to the restaurant complex, is a greatly disturbed pond that is generally devoid of flora with the exception of microalgae and leaf litter from the trees lining the sides of the pond. During the 1986 surveys, the pond had a distinctive dark green coloration, due apparently from a microalgae bloom. The microalgae do provide a source of food for the fauna inhabiting the pond.

4.2.3.2 Employment Impact Mitigation Measures

Employee-oriented housing, which represents one of the most crucial management actions for determining the nature and identity of the ultimate workforce, is discussed in Section 4.3.3.2.1. The present section focuses on potential ways to maximize employment of present Ka'u residents. There are two reasons for doing this: (1) possibly to reduce somewhat the level of inmigration anticipated in Table IV-41; and (2) to minimize any potential perceived inequities which may occur should current Ka'u residents not be employed while new Ka'u jobs are going to "outsiders."

C. Brewer has indicated its intent to develop a program for the purpose of maximizing both employment and other economic benefits for longtime Ka'u residents. As currently conceived, it could encompass traditional job training elements; attention to supervisory and entrepreneurial skill development; and also removal of obstacles to employment through actions such as child care and transportation assistance. The company has accepted a draft outline to initiate broad planning over the next several months, with final needs assessment, detailed planning, and program implementation when all approvals and commitments are in place for actual project construction (see Appendix I).

As indicated in Appendix I, one major aspect of the eventual program would involve resident-oriented job training efforts. Most resort operations train their own employees and tend to prefer longtime area residents because of greater stability and less turnover. But it is possible to augment these individual efforts with some limited resort-wide efforts.

Such efforts will be carefully designed with substantial input from both the community and potential operators. They are likely to include a focus on (1) community education and outreach; and (2) effective coordination with current training service providers who may now have limited visibility in Ka'u. A vigorous community education program would insure maximal awareness of upcoming job availability among important resident target groups (e.g., high school students, commuters out of Ka'u, the unemployed and disadvantaged, etc.). Once residents are aware of possibilities, the challenge is to assure that any skill deficits can be overcome with appropriate education or training, and that providers of such training can be effectively plugged into the remote Ka'u community.

In addition to job specific training, the types of efforts needed to improve residents' competitiveness might include such things as remedial education for communication and basic academic skills; counseling on work habits and attitudes;

2.4.2.2 Impacts on Coastal Pond Flora

Impacts on the coastal pond flora could be caused by the proposed modifications to the ponds, i.e., limiting access to Pond No. 1 and the dry mauka pond; the cleaning of Pond No. 3; increased nutrient levels due to increased use of treated sewage effluent for golf course and landscape area irrigation; increased human activities in and around the ponds; and short-term effects due to construction activities near the ponds. Reconnecting the dry mauka pond to Pond No. 1 would permit flushing of both ponds to occur and, most likely, decrease the volume and extent of the floating duckweed and *Azolla filiculoides* mats that currently are found along the protected margins of Pond No. 1. Although this could reduce the attractiveness of the pond to certain species of waterbirds, the increased flushing is expected to increase the water quality of the ponds and, thereby, increase the attractiveness of the pond to invertebrates that comprise part of the diets of the waterbirds. Additionally, reconnecting Pond No. 1 and the dry mauka pond would create an additional one acre of wetland/aquatic habitat. As noted previously, increased nutrient levels that may be experienced in the ponds are not expected to adversely impact the flora of the ponds, due in part to the natural, rapid flushing of the ponds. Decreased human activities in and around the ponds as a result of the vegetative barriers, could increase their attractiveness as waterbird habitats. Increased sedimentation to the ponds could occur as a result of the grading and building construction activities that are planned. As noted previously, little if any silt or fines are found on-site that could cause significant wind blown dust problems. However, increased sedimentation could result in decreased water quality and clarity. Increased sedimentation could also increase the rate of encroachment by the wetland vegetation and possibly the filling of the ponds.

2.4.2.3 Mitigation Measures

The proposed modifications to the ponds, i.e., establishment of vegetation buffers, removal of debris and overgrowth and reconnecting Pond No. 1 and the dry mauka pond, are designed to increase their value as both waterbird and aquatic biota habitats. Improving the flushing of the ponds would reduce the levels of standing algae and microalgae and improve the habitat characteristics of the ponds for marine and brackish water flora. Reconnecting Pond No. 1 and the dry mauka pond would create an additional one acre of wetland/aquatic habitat. Increased nutrient loading of the ponds as a result of the increased use of sewage effluent for golf course irrigation is not expected to adversely impact the ponds, As such, specific mitigation measures are not required. Human activity in and around the ponds would be controlled through the use of landscape buffers around the ponds and implementation of the Environmental

TABLE IV-39

County Government Annual Revenue
and Expenditure Comparison

(In 1986 dollars; millions)

	At project completion	
	Low	High
New revenues	$ 3.5	4.4
New expenditures	1.3	1.7
Net additional revenues	$ 2.2	2.7
Revenue/expenditure ratio(1)	2.7	2.6

(1) New revenues divided by new expenditures.

Source: Peat Marwick Main & Co.

TABLE IV-40

State Government Annual Revenue
and Expenditure Comparison

(In 1986 dollars; millions)

	At project completion	
	Low	High
New revenues	$ 5.2	7.7
New expenditures	1.9	2.8
Net additional revenues	$ 3.3	4.9
Revenue/expenditure ratio(1)	2.7	2.8

(1) New revenues divided by new expenditures.

Source: Peat Marwick Main & Co.

Protection Plan. Sedimentation of the ponds as a result of wind blown dust from construction activities would be controlled through water spraying and/or the use of dust pallatives as required.

2.4.3 Coastal Pond Fauna

2.4.3.1 Existing Conditions

In Pond No. 1, the shoreline of the pond, the discharge channel, and areas of noticeable spring discharges harbored the majority of the pond biota. The floor of the pond is covered with several centimeters of decaying organic material which appears to be unfavorable for most fauna, except Eleotris sandwicensis (o'opu akupa). Small mullet (Mugil cephalus) and juvenile aholehole (Kuhlia sandvicensis) are common throughout the pond, though the latter species is most numerous within stands of Scirpus where water circulation is high. The largest population of juvenile aholehole (several hundred) occurs within the stream discharge channel. A relatively small population of mosquito fish (Gambusia) occurs along some protected grassy shorelines. The marbled blenny, Entomacrodus marmoratus (pao'o) was observed in the stream channel in the 1986 field survey.

Large numbers of the endemic goby, o'opu akupa (Eleotris sandwicensis), are found throughout the pond, though occurring in highest densities in areas of spring discharges and along the pond margin. The highest population density occurs within the stream discharge channel. Significant was the observation that virtually all of the fish observed during the underwater surveys in 1984 were small. This observation was later explained by the presence of a discarded gill net in the narrow embayment located off the main pond. Fishing is likely to be the reason for the absence of larger fish within the pond during the 1984 surveys. A much larger population of o'opu akupa was found in the pond during the 1986 survey period, and the fish were, on the average, considerably larger than those observed in 1984. Similarly, seasonal variations and differences in species diversities and densities would be expected.

Macroinvertebrates were represented by the glass shrimp, Palaemon debilis (opae huna), the palaemonid prawn, Macrobrachium grandimanus (opae oehaa), and the snails Melania sp., Assiminea sp., and Theodoxus cariosa. Palaemon and Macrobrachium appear to be restricted to the bases of grass covered banks and rocky areas along the perimeter of the pond. These areas would presumably confer some degree of protection against predatory fish. Both species occur in very large numbers (perhaps 10 to 20 specimens per linear foot of appropriate shoreline) but are difficult to accurately census because of their cryptic nature and nearly

TABLE IV-38

Projected Annual State Expenditures Attributable to Development at Punalu'u Resort

(In 1986 dollars; millions)

Population and expenditure category	At project completion Low	At project completion High
Population:		
On-Resort visitors	1,771	2,554
On-Resort residents(1)	593	886
Total	2,364	3,440
Expenditures:		
On-Resort visitors(2)	$ .5	.8
On-Resort residents(3)	1.4	2.0
Total expenditures	$ 1.9	2.8

(1) Full-time and part-time residents at the Resort's condominium and single-family homes, less 15% estimated to have already been residents of the state.

(2) Visitors estimated to require $308 per capita in state government expenditures. See Table IV-37.

(3) Residents estimated to require $2,280 per capita in state government expenditures. See Table IV-37.

Source: Peat Marwick Main & Co.

4.2.3 Economic Environment Mitigation Measures

4.2.3.1 Visitor Expenditure Impact Mitigation Measures

Visitor expenditures are expected to be a positive economic environmental impact. As such, mitigation measures to minimize potential adverse effects do not appear warranted. Should future conditions indicate visitor expenditures are causing adverse impacts, appropriate measures would be taken to reverse that indication.

transparent exoskeleton. The gastropod Melania sp. was also a common benthic species associated with the pond margin. Theodoxus is restricted to submerged, sediment free rocks. Pond No. 1 appears subject to intense fishing pressure which may partially explain the fluctuations in populations and species occurences between the 1984 and 1986 surveys. In March 1987 two fishermen were observed using a hand-held seine net adjacent to the stream channel discharge, apparently catching anything and everything they could direct into their net.

The biological diversity of Pond No. 2 was low during both surveys. The goby, Eleotris sandwicensis (o'opu akupa), was the only fish recorded in the pond in the 1984 surveys. This species was restricted to areas demonstrating an absence of a thick benthic organic mat and in areas dominated by spring discharges. Eleotris was not observed during the 1986 surveys; however small populations of juvenile aholehole and Gambusia were observed.

The macroinvertebrate population of Pond No. 2 was limited to the glass shrimp Palaemon debilis and Macrobrachium, which were infrequently recorded within submerged vegetation around the perimeter of the pond, and the mollusks Melania sp., Assiminea sp., and Theodoxus cariosa. The dense mats of floating and submerged algae were colonized with countless Assiminea (greater than 1,000 per square meter). Theodoxus occurred in small numbers on a few large boulders near the narrow pond isthmus.

Surveys of the two "transient" ponds (located immediately west of Pond No. 2) indicated the presence of small Macrobrachium, Gambusia, and in one pond, a single small Eleotris.

The Punalu'u "Lagoon" pond (Pond No. 3), adjacent to the restaurant complex, is a greatly disturbed pond that is inhabited by a dozen or more very large carp (Cyprinus carpio); the topminnow Poecilia, the mosquito-fish Gambusia, and large numbers of toad (Bufo) tadpoles. Two very large prawns were observed but poor water visibility prevented an accurate identification. Their size (rostrum to tail approximately 20 cm) suggests that they are either Macrobrachium lar or Macrobrachium rosenbergii, both being recently introduced exotic species.

2.4.3.2 Impacts on Coastal Pond Fauna

Impacts on the coastal pond fauna could result from the planned vegetation buffers and cleaning activities; decreased human activity in and around the ponds; construction activities in the vicinity of the ponds; and increased nutrient loading of the ponds due to the continued use of treated sewage effluent for golf course and landscape irrigation.

TABLE IV-37

State of Hawaii Per Capita Government Expenditures

1986

Function	Expenditures (000s)(1)	Service population(2)	1986 annual expenditure Per resident	Per visitor
General government	$ 194,000	1,062,300	$ 182.62	-
Public safety	93,000	1,176,700	79.03	79.03
Highways	105,000	1,176,700	89.23	89.23
Natural resources	21,000	1,176,700	17.85	17.85
Health and sanitation	84,000	1,176,700	71.39	71.39
Hospitals and institutions	121,000	1,062,300	113.90	-
Public welfare	322,000	1,062,300	303.12	-
Education	773,000	1,062,300	727.67	-
Recreation	17,000	1,176,700	14.45	14.45
Utilities and other enterprises	90,000	1,062,300	84.72	-
Debt service	262,000	1,062,300	246.63	-
Retirement and pension	141,000	1,062,300	132.73	-
Employees' health and hospital insurance	1,000	1,062,300	.94	-
Unemployment compensation	63,000	1,062,300	59.31	-
Grants-in-aid to counties	18,000	1,062,300	16.94	-
Urban redevelopment and housing	95,000	1,062,300	89.43	-
Cash capital improvements	42,000	1,176,700	35.69	35.69
Miscellaneous	13,000	1,062,300	12.24	-
Total	$ 2,455,000		2,277.89	307.64

(1) State operating expenditures for fiscal year ended June 30, 1986 (Tax Foundation of Hawaii, Government in Hawaii, 1986).

(2) Resident or de facto population estimates for the state as of July 1986.

Source: Peat Marwick Main & Co.

In general, the impacts on the coastal ponds are expected to be positive. The dry mauka pond would be connected to Pond No. 1, thereby creating a larger pond and, hence, greater habitat opportunities for both the marine/brackish water species inhabiting the ponds as well as the waterbirds that frequent the Resort area. The proposed cleaning and restabilization of Pond No. 3 (Punalu'u Lagoon) is also expected to result in positive effects on the biota of the pond. The present condition, in which exotic species of fish and prawns are allowed to inhabit the pond, greatly decreases the opportunities for typical Hawaiian coastal pond organisms to become established. Also, the present eutrophic nature of the pond contributes to the unattractiveness of the pond as a habitat for these organisms. Improved landscaping around the pond, using both native and introduced strand and wetland plants, is also expected to increase the value of the pond as a habitat for aquatic and terrestrial species.

As noted in Section 2.4.1.2, adverse impacts on the ponds as a result of the continued use of treated sewage effluent for golf course and landscape irrigation are not expected.

Decreased human activity in and around the ponds could have a positive effect on the ponds by increasing their attractiveness as wildlife habitats. Implementation of the Environmental Protection Plan, the placement of signs and interpretive displays and the establishment of landscape buffers around Pond No. 1, are expected to provide additional measures to ensure that the ponds remain attractive as wildlife habitats. It is recognized that the placement of landscape buffers around Pond No. 1 and the dry mauka pond and restricting their use for recreational/subsistence fishing may place some hardships on people utilizing the pond as a supplemental source of seafood.

2.4.3.3 Mitigation Measures

The proposed changes to the pond configurations and conditions are expected to result in positive impacts to the wildlife of the Resort area and, as such, do not appear to require measures to mitigate potential adverse impacts. Implementation of the Environmental Protection Plan and the establishment of interpretive displays explaining the ecological importance of the coastal ponds are also mitigative measures designed to protect the ponds and the wildlife inhabiting or using the ponds. Restricting vehicles in the coastal pond areas would also provide protection to the ponds.

TABLE IV-36

Projected Annual County Government Expenditures
Attributable to Development
at Punalu'u Resort

(In 1986 dollars; millions)

Population and expenditure category	At project completion Low	At project completion High
Population:		
On-Resort visitors(1)	1,771	2,554
On-Resort residents(1)	698	1,042
Off-Resort residents(2)	519	782
Total population	2,988	4,378
Expenditures:		
On-Resort visitors(3)	$ .6	.8
On-Resort residents(4)	.4	.5
Off-Resort residents(4)	0.3	.4
Total expenditures	$ 1.3	1.7

(1) See Table IV-43.

(2) Resort operational employees and their dependents who move to the island because of new employment opportunities at Punalu'u, as shown in Table IV-44.

(3) Visitors estimated to require $316 per capita in county government expenditures. See Table IV-35.

(4) Residents estimated to require $526 per capita in county government expenditures. See Table IV-35.

Source: Peat Marwick Main & Co.

2.4.4 Summary of Coastal Ponds

The proposed modifications to the coastal ponds are expected to result in positive impacts to the flora and fauna of the ponds. It is the developer's intention to maintain the ponds in their natural state to attract and protect wildlife and to add to the overall aesthetic appeal of the Resort. Implementation of the Environmental Protection Plan and the establishment of interpretive displays are expected to provide additional measures to assure that the coastal pond resources are protected and preserved.

2.5 NEARSHORE MARINE ENVIRONMENT

2.5.1 Nearshore Marine Environment Water Quality

2.5.1.1 Existing Conditions

The entire Punalu'u Harbor and Ninole Cove shoreline is significantly influenced by intertidal and subtidal freshwater springs and at least one major surface water discharge from a large, spring-fed, coastal pond. Collectively, these discharges account for the wide variation in the physical and chemical properties of the nearshore waters and the relatively low diversity of nearshore marine organisms encountered in most areas. The waters within Punalu'u Harbor are classified as Class AA waters under the State Water Quality Standards.

Nearshore waters in Punalu'u Harbor demonstrate a distinct thermal and salinity gradient as a result of the abundance of freshwater springs which discharge into the ocean within the intertidal zone and from freshets emanating from subtidal pahoehoe flows. Cold ground waters float atop the denser ocean waters and freely mix by wind and wave action. These discharges create a cold, low saline, surface water layer that ranges from approximately 0.3 to 1.0 meter deep. Surface water temperatures in Punalu'u Harbor were extremely variable and ranged from 19.2 to 21.1 degrees C (Appendix C). By contrast, bottom temperatures in the same locations ranged from 24.3 to 27.1 degrees C. The degree of thermal stratification is best exemplified in the salinity data. Surface waters ranged from 6.4 to 12.5 parts per thousand (ppt); mid-water or bottom samples ranged from 18.1 to 22.0 ppt. Dissolved oxygen values indicate that the deeper waters are more highly oxygenated. Nutrient levels recorded in Punalu'u Harbor are shown in Tables IV-9 and IV-10.

Water quality in the Ninole Cove area demonstrated a similar pattern as that of Punalu'u Harbor with surface water temperatures of 19.0 to 20.0 degrees C, and bottom temperatures

More recent per expenditure estimates are not available and there is little evidence to suggest that 1987 expenditures would be significantly different on a per capita basis from 1984 expenditures.

Based on these county government outlays, public expenditures by the county on behalf of the Resort's residents or visitors and employee inmigrants to the county could be expected to total about $1.3 million to $1.7 million per year at project completion, in 1986 dollars, as shown in Table IV-36.

State

A similar analysis of state government expenditures and the relevant populations for the various services indicates that expenditures in 1986 totaled about $2,280 per resident and $308 per visitor, as shown in Table IV-37.

As in county expenditures, the 1984 figures are the most recent available and are considered valid indicators of current per capita government expenditures. State government expenditures are projected to total between $1.9 million and $2.8 million per year at project completion, as shown in Table IV-38.

4.2.2.6.3 Revenue/Expenditure Analysis (County and State)

The net fiscal impacts of the Resort's development to the county and state are estimated by comparison of the projected government revenues and expenditures.

County

Comparison of projected public revenues and expenditures indicates that the county may expect to net about $2.2 million to $2.7 million per year at project completion, in 1986 dollars, as shown in Table IV-39. The analysis also indicates that additional county revenues generated by the Resort would be 2.6 to 2.7 times the expenditures incurred by the county at project completion, as also shown in Table IV-39.

State

Net fiscal benefits to the state are projected to range from $3.3 million to $4.9 million per year at project completion, in 1986 dollars, as shown in Table IV-40. The analysis also indicates that additional state revenues generated by the Resort would be about 2.7 to 2.8 times the expenditures incurred at project completion, as also shown in Table IV-40.

of 25.9 to 26.0 degrees C. Salinity values ranged from 4.5 to 5.9 ppt in the surface water mass to 18.7 to 27.4 ppt in the benthic water mass. Nutrient levels recorded in Ninole Cove are shown in Table IV-9.

2.5.1.2 Impacts on Nearshore Marine Environment Water Quality

Impacts on the nearshore marine environment water quality could be caused by continued use of treated sewage effluent for golf course and landscape areas irrigation; use of biocides and fertilizers on the golf course and landscape areas; increased human activities in the nearshore and marine environment; and increased surface water runoff.

The continued use of treated sewage effluent for irrigation of golf course and landscape areas is not expected to produce adverse effects on the nearshore marine environment due to (1) the estimated increase in the quantity of effluent to be applied, following secondary treatment and storage in the ponds on the 17th fairway, is relatively small, i.e., approximately two percent compared to the overall receiving water inflow of basal ground waters; and, (2) nearshore water currents and tidal flushing would prevent any significant deterioration of water quality (See Section 2.5.2 below). It is estimated that, at completion of the Resort, the average wastewater flow would be approximately 0.80 million gallons per day (mgd). Present average flow is approximately 0.02 mgd. The ultimate average wastewater flow per day would not completely satisfy the irrigation requirements for the golf course and would require potable water to supplement the irrigation demand.

The degree of dilution and dispersion of waste waters applied to the golf course that would occur in the nearshore and offshore waters are sufficient to negate potential significant increases of nutrients, if they were to occur at all. As noted previously, it is theorized that the elevated nutrient levels of the ground waters flowing naturally into Punalu'u Harbor (estimated to be about 30 mgd) and the nearshore environment are most likely the major contributing factor aiding the growth of Pterocladia capillacea, the red algae food source apparently preferred by the green turtles inhabiting the harbor. Also, as noted previously, secondary treatment of the sewage effluent, followed by storage in the ponds on the 17th fairway, followed by waterspraying on the golf course, essentially provides tertiary treatment to the sewage when the mechanical and biological processes taking place within the grass root zone are considered as part of the treatment system. That is, any possible pathogens or other constituents that could cause adverse effects on humans and/or organisms living in the nearshore marine environment are removed. Further, as shown by studies performed on the Big Island (Brock, 1985; Maciolek and Brock, 1974; Maciolek, 1987; Lee, 1987), the use of treated sewage for golf course irrigation purposes does not appear to cause adverse impacts on the measures and (4) cash capital improvements. Residents necessitate public costs in all the aforementioned areas, and also in education, retirement and pension funds, public welfare and other government functions.

County

The various county government expenditures for fiscal year 1984 were analyzed with respect to the relevant population served by each of the government functions. This analysis indicates that county government expenditures in 1986 totaled about $526 per resident and $316 per visitor, as shown in Table IV-35.

TABLE IV-35

County of Hawaii Per Capita Government Expenditures

Fiscal year 1986

Function	Expenditures (000s)(1)	Service population(2)	1986 annual expenditure Per resident	Per visitor
General government	$ 8,818	110,100	$ 80.09	-
Public safety	23,917	118,200	202.34	202.34
Highways	4,264	118,200	36.07	36.07
Health and sanitation	2,573	118,200	21.77	21.77
Public welfare	2,445	110,100	22.21	-
Education	270	110,100	2.45	-
Recreation	5,409	118,200	45.76	45.76
Interest	4,102	110,100	-	-
Bond redemption	1,643	110,100	-	-
Retirement and pension	9,232	110,100	83.85	-
Mass transit	655	110,100	5.95	-
Cash capital improvements	1,181	118,200	9.99	9.99
Miscellaneous	1,672	110,100	15.19	-
Total	$ 66,181		525.67	315.93

(1) County operating expenditures for fiscal year ended June 30, 1986 (Tax Foundation of Hawaii, Government in Hawaii, 1986).

(2) Resident or de facto population estimates for the county as of June 30, 1986.

Source: Peat Marwick Main & Co.

receiving waters (coastal ponds) even though there are increases in the nutrient levels of the receiving waters. Additionally, the previously noted Department of Health water sampling results indicate that the use of treated sewage effluent on the golf course does not affect the sanitary quality of the receiving waters.

The use of biocides and fertilizers on the golf course and landscape areas similarly does not appear to be a factor that could adversely affect the nearshore or offshore receiving waters.

Based on the analyses performed regarding the potential impacts of fertilizers and biocides used at Punalu'u on the nearshore marine environment (Appendix G), it has been determined that in light of the large nutrient subsidies presently entering the coastal ponds and nearshore marine environment from basal groundwaters, it is unlikely that additional nutrient enrichment from shoreside fertilization would have significant impacts. Similarly, the relatively small quantities of biocides used, the availability of retention basins in the golf course and adherence to manufacturer's application instructions indicate impacts to the marine environment from the biocides used would not occur. Table IV-12 identifies the fertilizers and biocides used at Punalu'u.

It is noted that all of the pesticides used at Punalu'u are in Toxicity Categories III and IV, indicating unrestricted use and all degrade fairly rapidly. Analyses of the fate of fertilizers and pesticides used at the Westin Mauna Kea golf course (Murdoch and Green, 1987) indicate that in the event that surface runoff of fertilizers or pesticides did occur, they would likely be sufficiently diluted by runoff from undeveloped areas to be insignificant. Given similar golf course operations and maintenance procedures at Punalu'u, the use of the same types of fertilizers and biocides, and large undeveloped drainage areas upland of the Resort, it would appear that it is unlikely that any of the chemicals would be found in the waters offshore of Punalu'u in sufficient concentrations to cause adverse impacts.

Increased human activities in the nearshore marine environment are also not expected to cause adverse impacts. Increased human usage can be expected due to improved access to the beach and shoreline areas and increased numbers of people (residents and visitors) using the area for sunbathing, fishing, swimming, camping and picnicking activities. The proposed water play area of the Resort is designed to be the primary water contact area for visitors to the Resort, thereby potentially reducing the number of visitors that would be using the beach and shoreline park facilities. It is expected that the low biological diversity and densities that are presently found in the

TABLE IV-34

Projected Annual Revenues to the State Government
Attributable to Development at Punalu'u Resort

(In 1986 dollars; millions)

Population and revenue category	At project completion Low	At project completion High
Population:		
On-Resort visitors	1,771	2,554
On-Resort residents(1):		
Full-time	387	578
Part-time	207	308
Subtotal	594	886
Total	2,365	3,440
Revenues:		
Visitors - general excise tax(2)	$ 4.5	6.5
On-Resort residents:		
General excise tax(3)	0.3	0.5
Individual income and other taxes(4)	0.4	0.7
Hotel room tax(5)	1.4	1.9
Total	$ 6.6	9.6

(1) Residents of the Resort's condominium and single-family homes, less 15% estimated to have already been residents of the state.

(2) Based on 4% of direct, indirect and induced visitor expenditures.

(3) Based on 4% of selected household budget items. Household incomes assumed to be $60,000 for full-time residents and $120,000 for part-time residents based on a survey of resort developers and real estate brokers at other resorts.

(4) Estimated at $980 per year per on-Resort full-time resident, based on 1984 average per capita state tax collections and expected relative income level of Punalu'u resident households.

(5) Based on 75% hotel occupancy with an average achieved room rate of $80 and 50% occupancy of condominium units kept in visitor rental pools, with an average achieved unit rate of $90. State revenues calculated at 5% of gross transient accommodations room revenues.

Sources: State of Hawaii, Department of Planning and Economic Development, The State of Hawaii Data Book, 1984, 1985; and Tax Foundation of Hawaii, Government in Hawaii; A Handbook of Financial Statistics, 1985.

TABLE IV-12
PUNALU'U RESORT FERTILIZERS AND BIOCIDES

LOCATION	TOTAL AREA	MATERIAL	APPLICATION FREQUENCY	APPL. RATE	TOTAL N/YEAR
Fertilizers					
Golf Course Fairways, Roughs, Fringes & Tees	105.0 Ac	DC 168 (18-5-5)	4 times/ year	250#/ Ac	9.45 Tons
Greens	3.4 Ac	Ferromec (15-0-0, 6Fe, 4S)	6 times/ year	300gal/ Appl.	0.46 Tons
Greens	3.4 Ac	Blade Bright (16-4-4)	26 times/ year	520#/ Ac	3.68 Tons
General Land-scape areas & Colony I Grounds	70.0 Ac	14-4-4	7.5 times/ year	250#/ Ac	9.19 Tons
		TOTAL N PER YEAR			22.78 Tons
Treated Sewage					
All Areas at present	178.4 Ac	Treated Sewage	6 Days/ Week	8.60mg/l 20,000 gal/Day	1.44# /Day .225 Tons/Yr
All Areas at proj. completion	178.4 Ac	Treated Sewage	6 Days/ Week	8.60mg/l 780,000 gal/day	55.97# /Day 8.73 Tons/Yr
Insecticides					
All Areas	178.4 Ac	Diazinon AG 500	12 times/ year	.33gal/ Appl.	4 gals/ year
Fungicides					
All Areas	178.4 Ac	Tersan	26 times/ year	1.7#/ Appl.	44 #/ year
Herbicides					
All Areas	178.4 Ac	Roundup	As Needed	---	90gal/ year
Fairways, Roughs, Fringes & Tees	105.0 Ac	Weed Hoe	Every 12 Days	160 oz/ 200 gal/ 4 Ac	570 gal/ year
Greens	3.4 Ac	Weed Hoe	Every 10 Days	48 oz/ 100 gal.	

State

Tax revenues to the state would be generated by the state's five percent tax on gross visitor room receipts, four percent general excise tax on direct, indirect and induced expenditures by the Resort's visitors and also on expenditures by the Resort's part- and full-time residents who were not already state residents. Resort residents who are already state residents are estimated as 15 percent of total Resort residents, based on the share of Hawaii resident resort condominium unit buyers on the islands of Hawaii and Maui, which ranges from 15 percent to 26 percent of buyers.

In addition, the Resort's full-time residents who were not already state residents would pay individual income taxes and other state taxes such as liquor, tobacco, fuel, inheritance, estate and conveyances taxes. According to state tax receipts in fiscal year 1984, individual income and other taxes paid by residents averaged about $552 per resident, in 1986 dollars. However, the average full-time resident household is expected to earn about $60,000, or $24,000 per capita, whereas average per capita income in the state in 1985 was estimated to be $13,542, as reported by the Bank of Hawaii. Thus payments of state individual income, liquor, fuel and similar taxes by full-time residents at Punalu'u are estimated to represent 1.8 times the statewide average, or about $980 per capita per year. Therefore individual income and other tax revenues from the Resort's residents are estimated to represent $0.4 million to $0.7 million per year, as shown in Table IV-34.

Accounting for the amount of visitor expenditures and number of full- and part-time residents that could be attracted to the state by the Resort, total tax revenues to the state are expected to range between $6.6 million and $9.6 million per year at project completion, in 1986 dollars, as also shown in Table IV-34.

4.2.2.6.2 Expenditures (County and State)

The visitors and the part- and full-time residents that could be expected to live at the Resort condominium and single-family units would also necessitate additional expenditures of public resources. County expenditures on behalf of residents would also increase in proportion to the number of employees coming from off-island to work in the operations of the new Resort.

Visitors are seen to necessitate public costs in terms of (1) public safety (such as increased needs for police and fire protection), (2) development and upkeep of highways, recreational facilities and natural resources, (3) health and sanitation nearshore areas would remain due to natural physical processes, i.e., wave action and continued fishing pressures. Additional information regarding the potential impacts due to recreational activities is presented in Section 7.

Increased human activities in the nearshore marine environment are also not expected to cause adverse impacts. Increased human usage can be expected due to improved access to the beach and shoreline areas and increased numbers of people (residents and visitors) using the area for sunbathing, fishing, swimming, camping and picnicking activities. The proposed water play area of the Resort is designed to be the primary water contact area for visitors to the Resort, thereby potentially reducing the number of visitors that would be using the beach and shoreline park facilities. It is expected that the low biological diversity and densities that are presently found in the nearshore areas would remain due to natural physical processes, i.e., wave action and continued fishing pressures. Additional information regarding the potential impacts due to recreational activities is presented in Section 7.

Increased surface runoff is also not expected to cause adverse impacts on the nearshore marine environment due to the proposed changes in the Resort drainage system. As noted previously, the two existing drainage culverts that discharge surface runoff waters directly into the nearshore and coastal pond areas would be abandoned and replaced with retention basins in the golf course. The retention basins would be designed to contain surface water runoff and allow that runoff to percolate through and be filtered by the soils and underlying lava rock formations prior to seepage into the offshore receiving waters. The retention basins would be cleaned of oil and grease, debris and sediments by golf course maintenance personnel and disposed of in accordance with applicable regulations. Direct discharge of surface runoff water into the ocean and/or coastal ponds would not occur except in the case of extraordinary intense rainfall over extended periods of time.

The reconnecting of Pond No. 1 to the dry mauka pond is expected to improve the habitat value of the dry mauka pond without adversely impacting the receiving waters.

2.5.1.3 Mitigation Measures

Mitigation measures designed to minimize potential adverse impacts to the water quality of the nearshore marine environment include the abandonment of the existing culverts that discharge surface water runoff directly into the ocean or coastal ponds and the creation of retention basins to hold surface water runoff; the development of the water play area as the primary water contact and "beach" area for the Resort; and the implemen-

TABLE IV-33

Projected Annual Real Property Tax Revenues
Attributable to Development at Punalu'u Resort

(In 1986 dollars; millions)

Source of property tax revenue	At project completion Low	At project completion High
Hotel units(1)	$ .87	1.21
Multifamily units(2)	2.46	3.03
Single-family units(3)	.04	.05
Single-family lots(4)	.04	.04
Commercial space(5)	.04	.04
Total revenues	$ 3.45	4.37

(1) Based on estimated value of $130,000 per room and a combined land and building tax rate of $9.00 per $1,000 assessed value.

(2) Based on estimated average value of $220,000 per unit if only 1,224 units are developed and $180,000 per unit if higher density projects with up to 1,836 units are developed, and a combined land and building tax rate of $9.00 per $1,000 assessed value.

(3) Based on estimated value of $250,000 per house and lot and a combined land and building tax rate of $8.50 per $1,000 assessed value.

(4) Based on estimated value of $85,000 per lot and a tax rate of $8.50 per $1,000 assessed value.

(5) Based on estimated value of $60.00 per net leasable square foot and a combined land and building tax rate of $9.00 per $1,000 assessed value.

tation of the Environmental Protection Plan previously described. The potential for adverse impacts due to increased nutrient loading resulting from the continued use of treated sewage effluent on the golf course and landscape areas does not appear to be significant and, therefore, specific mitigation measures do not appear warranted. Should future studies and conditions indicate that adverse impacts are being experienced, appropriate mitigation measures would be taken.

2.5.2 Physical Oceanography

2.5.2.1 Existing Conditions

In general, the physical oceanography of the Ka'u coastline is characterized by vertical or near vertical, rocky cliffs that are exposed to storm waves, especially summer southerly ocean swells and waves; few "beach" areas; a generally southwestward flowing surface current that reverses on ebbing tides; and rapidly descending bottom topography. The Punalu'u area is one of the few "beaches" occuring along the coast. Punalu'u Harbor provides some protection against southeasterly and easterly swells and waves, but is subjected to southerly and southwesterly swells and waves. As indicated previously, Hurricane Estelle caused the scouring of the Punalu'u Harbor and Ninole Cove shorelines and altered, to some extent, the coastal ponds along the Resort shoreline.

To define and describe the nearshore and offshore current and circulation patterns, current measurements were made in August and September 1986 using current drift drogues and fluorescein dye. The complete results of these measurements are included in Appendix F.

The nearshore current and circulation pattern in Punalu'u Harbor is primarily wave driven. Waves breaking on the shallow shoal area on the west side of the harbor result in a mass transport of water shoreward over the shoal which is relieved by a clockwise flow along the beach and out the deeper channel on the northeast side of the harbor. This circulation pattern is the result of several factors. First, the prevailing waves from the east and south approach so as to make a breaker angle favorable to the clockwise flow. Secondly, the waves break at a greater distance offshore at the west side of the harbor than on the east side, thus producing a greater wave setup on the west side, and this water surface elevation differential caused by wave setup is also favorable to a clockwise circulation pattern. Thirdly, the deeper water on the east side of the harbor provides an easier path for the return flow seaward than does the shoal area on the west side.

above. In addition, household income includes income generated through the multiplier effects of indirect and induced visitor expenditures.

The DBED reports that the multiplier effects of visitor expenditures throughout the community have declined in recent years, but that each $1.00 spent by visitors in 1985 is estimated to have generated $0.71 in total income to households in the state. Assuming a similar multiplier effect for the expected expenditures of visitors to the Resort, it is projected that the Resort could contribute between $41 million and $60 million per year in total household income to the state at project completion, in 1986 dollars, as also shown in Table IV-32.

4.2.2.6 Fiscal Impacts

This section describes the expected fiscal impacts of the proposed developments in terms of additional revenues and expenditures to the County of Hawaii and the State of Hawaii.

4.2.2.6.1 Revenues (County and State)

Development at Punalu'u Resort would bring additional tax revenues to the county and state government. County revenues would be principally in the form of real property taxes on the new facilities. Revenues to the state would be composed principally of general and specific excise taxes, personal income taxes and the recently passed five percent tax on transient accommodations. The following sections project the additional revenues that could be generated for the county and state governments as a result of the Resort's development.

<u>County</u>

Real property in the county is currently taxed at $10.00 per $1,000 of assessed value for land and $8.50 per $1,000 of assessed value for buildings, for all uses with the exception of unimproved residential land which is taxed at $8.50 per $1,000 assessed value.

Based on these rates, the hotel, new condominium, single-family and commercial facilities envisioned at the Resort could be expected to generate between $3.5 million and $4.4 million per year at project completion, in 1986 dollars, as shown in Table IV-33. The majority of these revenues would be attributable to the property value of the hotels and condominium units.

The study area is directly exposed to the prevailing tradewind generated waves and south swell, as well as to some portion of northerly and southwesterly waves, thus the wave induced circulation system within the harbor is like the typically prevailing condition. No variation in the current speed or circulation pattern within the harbor as a function of tide was observed during the field investigations, in spite of the fact that the tide range (about 2+ feet) was relatively large by Hawaii standards. Because there is generally always some wave action in the study area, the circulation within the harbor should generally be good, with the current speed varying as a function of the incident breaker heights. The current setting out the channel moves rapidly seaward and is entrained by the offshore coastal currents. The current speed along the beach is typically about 15 cm/sec (0.25 knots), increasing to 30 cm/sec or greater (0.5 knots) as it flows out the channel. This circulation system within the harbor results in good flushing and a rapid turnover of the nearshore harbor waters.

The salinity measurements also supported the hypothesis of rapid mixing of the nearshore waters with the coastal water. The lowered surface salinity caused by fresh water inflow along the shore could not be traced very far outside of the small embayment which forms Punalu'u Harbor.

The nearshore current and circulation system in the vicinity of Ninole Cove is also wave driven. The orientation of the shoreline and direct exposure to the prevailing incident wave approach, and the small islands and shoal areas offshore, most of which are awash at high tide, results in considerable surf along the shore the majority of the time. During the field investigations, current drogues and dye patches moved along the shore and out a rip current through the surf beside the larger of the offshore islands. After moving through the nearshore breakers the drogues moved rapidly seaward, and curved south as they became entrained by the southward flowing flood tide coastal currents. There was considerable wave action in the vicinity of Ninole Cove during the three days of field investigations, despite the fact that the tradewinds were light to moderate, thus it seems likely that there is generally sufficient wave action to result in good circulation and flushing of the nearshore waters in this area.

The offshore coastal currents were found to vary in both speed and direction with the tide. During the flood tide there was strong surface flow to the southwest at 10 to 15 cm/sec (0.25 knots), and a weaker 5 cm/sec (0.1 knots) subsurface flow also to the southwest. The surface flow is presumably partially wind driven by the prevailing tradewinds from the northeast. The ebb tide flow as weaker, generally setting to the southeast through southwest on the surface with speeds of 5 to 15 cm/sec (0.1 to 0.25 knots). The subsurface flow was easterly, also at speeds of

TABLE IV-32

Projected Annual Personal and Household Income From Direct Employment for the State of Hawaii

(In 1986 dollars; millions)(1)

Type of employment	At project completion Low	At project completion High
Construction(2)	$ 4.2	5.6
Hotel and resort(3)	12.9	18.1
Commercial(4)	3.1	3.2
Total personal income	$ 20.2	26.9
Total household income(5)	$ 41.4	59.6

(1) 1984 State of Hawaii, Department of Labor and Industrial Relations data updated to 1986 dollars, based on Consumer Price Index changes.

(2) Average annual wage of $24,734, reflecting 30% of the workers from off-island and an average income of $29,152 for construction workers throughout the state and $22,840 for construction workers in the county of Hawaii (State of Hawaii, Department of Labor and Industrial Relations, 1985, pages 2 and 10).

(3) Excluding tips. Hotel, resort residential and resort administration employment wages projected at the county of Hawaii hotel industry average of $13,196 (State of Hawaii, Department of Labor and Industrial Relations, 1985, page 10).

(4) Commercial sector wages projected at $9,704, based on average wages in retail industries on the island, industry classifications (State of Hawaii, Department of Labor and Industrial Relations, 1985, page 10; State of Hawaii, Department of Planning and Economic Development, 1983, page 215).

(5) Based on State of Hawaii, Department of Planning and Economic Development estimate of $0.71 total household income for each $1.00 spent by visitors to the state in 1985.

Sources: State of Hawaii, Department of Labor and Industrial Relations, Employment and Payrolls in Hawaii: 1984, 1985; and First Hawaiian Bank, Economic Indicators, May/June 1984 and 1986.

5 to 15 cm/sec. The ebb tide currents were particularly weak seaward of Ninole Cove, and an onshore (west) set to the currents was measured. During both flood and ebb tide the current flow in Punalu'u Harbor was seaward out the channel on the east side at speeds up to 45 cm/sec (0.9 knots) where it merged with the coastal current. A generalized circulation pattern for the study area is shown on Figure IV-20.

In general, because of the fairly rapid currents and inshore wave action, launching and retrieving boats at the boat ramp is hazardous and time consuming. It is estimated that the ramp is closed to operations approximately one-third of any given year due to high surf conditions.

2.5.2.2 Impacts on Physical Oceanography

Impacts on the physical oceanographic characteristics of the Punalu'u area could be caused by increased human usage of the nearshore and offshore waters.

Increased human usage of Punalu'u Harbor and/or the beach areas fronting the Resort is not expected to alter the present physical oceanographic characteristics of the Harbor. Any increased actions that might occur would be relatively minor and would occur on the surface waters, thereby not affecting the bottom topography or the physical configuration of the harbor. As indicated previously, the proposed action does not include any modifications to the shoreline or offshore areas.

2.5.2.3 Mitigation Measures

Due to the lack of expected impacts to the physical oceanographic characteristics of the Resort area, mitigation measures do not appear warranted. Should future conditions warrant appropriate mitigation measures would be taken.

2.5.3 Intertidal Zone Physical and Biological Characteristics

2.5.3.1 Existing Conditions

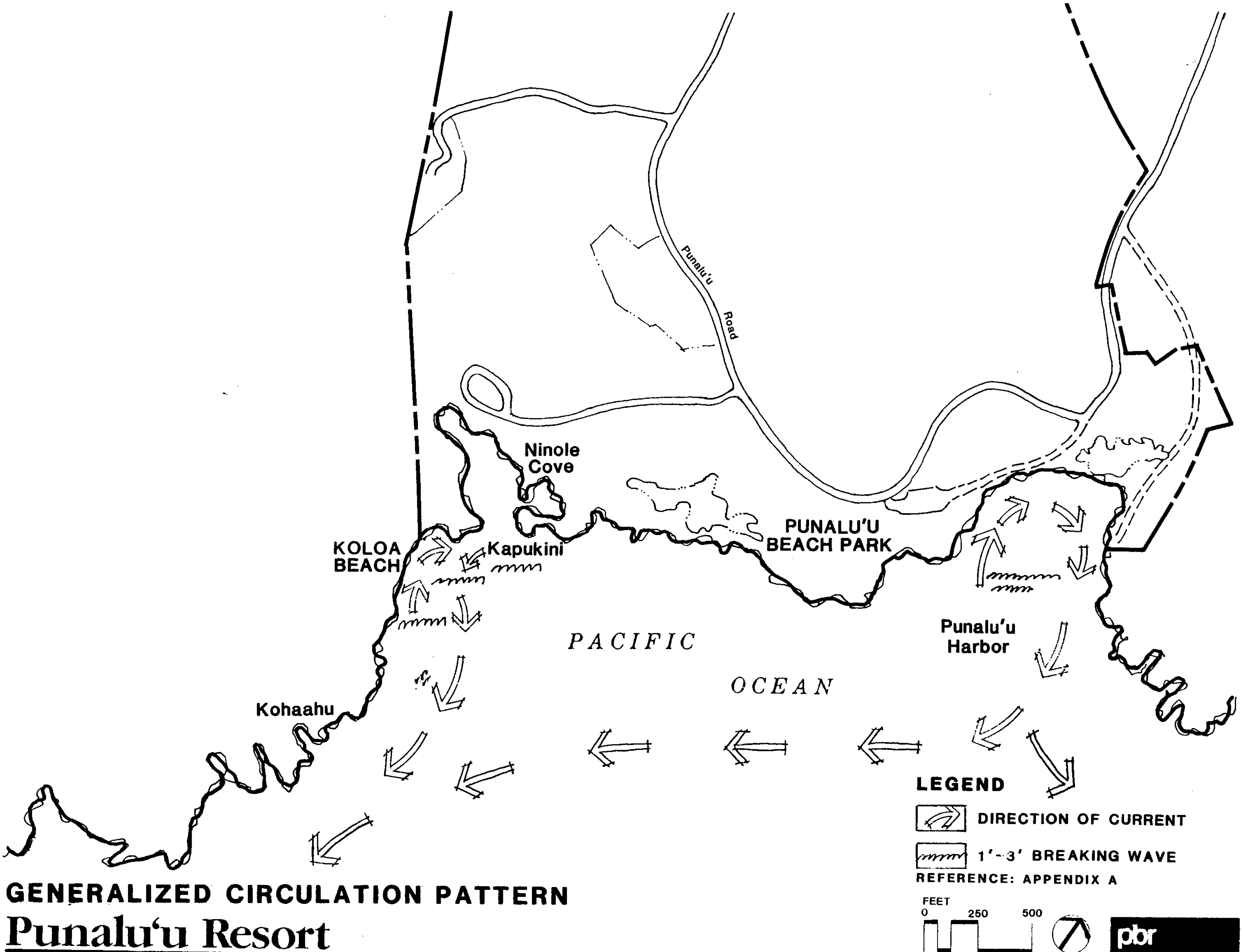
The intertidal zone encompassing the shoreline from Punalu'u Harbor to Ninole Cove consists of: (1) biologically depauperate crescent-shaped black sand beaches and beach berms; and (2) wave dominated exposed basaltic rocks, tidepools, and headlands of low to moderate biological diversity. Intertidal and subtidal freshwater springs, a large point-source surface discharge of cool, low saline, water from a coastal pond (Pond No. 1) and periodic storm wave action appear responsible for the

Table IV-31

Labor Force Status of Women by Family Situation:
County of Hawaii and Various Parts of Study Area, 1980

	COUNTY OF HAWAII		KA'U DIVISION		SOUTH KONA DIVISION		VOLCANO (ENUM. DIST. 351)	
	(no.)	(%)	(no.)	(%)	(no.)	(%)	(no.)	(%)
TOTAL POTENTIAL FEMALE LABOR FORCE (aged 16+)	33,610	100.00	1,232	100.00	2,302	100.00	388	100.00
in labor force (incl. military)	17,013	50.61	534	43.34	1,124	48.82	164	42.26
not in labor force	16,147	48.04	698	56.65	908	39.44	224	57.73
Breakdown by Family Status:								
With Own Children Under 6 Years	6,679	100.00	242	100.0	438	100.0	72	100.00
in labor force	3,244	48.57	83	34.29	198	45.20	28	38.88
not in labor force	3,435	51.42	159	65.70	240	54.79	44	61.11
With Own Children 6 to 17 Years	5,661	100.00	236	100.00	255	100.00	78	100.00
in labor force	3,864	68.25	194	82.20	147	57.64	52	66.66
not in labor force	1,797	31.74	42	17.79	108	42.35	26	33.33
Other Women 16 Years and Over	21,270	100.00	754	100.0	1,717	100.00	238	100.00
in labor force	9,905	46.56	257	34.08	779	53.07	84	35.29
not in labor force	11,365	53.43	497	65.91	560	32.61	154	64.70

Source: U.S. Bureau of the Census, 1980, Summary Tape File 3-A.



GENERALIZED CIRCULATION PATTERN

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE IV-20

(2) <u>Mothers of Young Children</u>: Table IV-31 shows that labor force participation rates among women with children aged six or younger are lower than among mothers of older children. While this may be partially due to parental choice, the particularly low Ka'u rate for mothers of young children (coupled with the particularly high rate for mothers of older children) strongly suggests that some women may be prevented from desired entry into the labor force by lack of child care. Absolute numbers of such mothers were small in 1980 but are likely to increase in the future.

4.2.2.5 Income Impact

4.2.2.5.1 Resident Income

The Resort could be expected to have a significant positive impact on personal and household income for residents of the island and state. The Resort would generate resident income as employee wages, salaries and fringe benefits and as income to proprietors as described in the following paragraphs.

4.2.2.5.2 Personal Income

Personal income is defined as the wages and salaries paid to the direct construction and operational employees of the Resort. Personal income is projected on the basis of average industry wages and salaries for the various types of employment anticipated and on the projected future employment demands.

Personal income paid to Hawaii residents may be expected to range between $20 million and $27 million per year at project completion, in 1986 dollars, as shown in Table IV-32.

4.2.2.5.3 Household Income

The dispersion of indirect and induced employment effects among many industries make it difficult to project the total income benefits of the Resort's development. However, estimation of total household income effects based on visitor expenditure levels permits a perspective on the statewide income benefits that would result from the Resort's further development.

Total household income generated by visitor expenditures at the Resort would include the fringe benefits and proprietor's income paid by establishments that sell goods and services directly to visitors as well as the wages and salaries noted

It is a frequent pattern in Hawaii's visitor industry for new hotels to attract skilled workers seeking promotions and better pay. In later years, however, more Ka'u residents will have begun working their way up the career ladder, so that intra-resort transfers will account for a higher proportion of supervisory and mid-management jobs.

(3) Off-Island Inmigrants Competing for Entry Level Positions are expected to be relatively few in Ka'u, since this area lacks the glamour and international reputation of West Maui or West Hawaii. While the latter areas have witnessed some influx of young Mainland transients during periods of labor shortages, it would appear more likely that any off-island inmigrants to Ka'u would consist largely of immigrants from the Philippines or other Asian countries who are informed of job opportunities by family or friends already in Ka'u. Interviews conducted by Community Resources, Inc. (social impact consultants for this analysis) with social service agencies on Oahu suggest these normally would be primarily Filipinos, who comprise the largest immigrant group and have the greatest extent of pre-existing family ties on the Neighbor Islands. Other Asian immigrant groups would probably be a labor source in the near future only if a conscious effort were made to recruit groups from Oahu.

"Hidden Unemployment" in Ka'u

Individuals who have ceased actively seeking employment because of repeated frustrations or lack of opportunity are not counted among the unemployed by most government statistics. Rather, they constitute the "hidden unemployed" and represent some portion of those adults not in the labor force. Individuals not interested in work -- perhaps because of independent or illicit incomes -- would not be in this category. However, persons who simply lack job opportunities or face some other barrier would be so designated. At least two groups may be identified.

(1) Educationally Disadvantaged residents (e.g., school dropouts and/or non-English speakers) represent one such target group. In an area with historically limited job possibilities, it is possible that deficits are as much or more related to work habits, attitudes, and self image as to academic abilities. Exact numbers of such individuals would be difficult to establish. Given the low absolute size of the current Ka'u labor force, these numbers may not be high. However, the social value of additional employment opportunities may rest in part with meeting the needs of this group.

low to moderate diversity which characterizes most of the intertidal zone. The effect of recent (1986) storm wave action is pronounced throughout the intertidal zone. Although all species recorded during 1984 field surveys were recorded during 1986 surveys, overall population densities of intertidal invertebrates and macroalgae were very low in 1986 (Brewer, Appendix C).

Sandy beaches and beach berms in the Punalu'u Harbor-Ninole Cove area had no distinct resident macro-flora or macro-fauna.

Exposed rocky shorelines and embayments demonstrate intertidal zonation patterns not unlike other exposed coastlines in Hawaii, except in areas dominated by a surface freshwater layer. Exposed rocky shores directly influenced by wave action generally exhibited the most distinct intertidal zonation patterns.

Typical "indicator" splash zone invertebrates include Nerita picea (pipipi), Littorina pintado (pupu kolea), and Littorina scabra.

The upper intertidal zone is distinguished by a dense band of the red seaweed (limu) Ahnfeltia concinna ('aki'aki) except in small coves and embayments dominated by freshwater. The false opihi, Siphonaria normalis, the shingle urchin, Colobocentrotus atratus, and two species of grapsid crabs are the representative and dominant macro-faunal elements of this zone.

The lower intertidal zone is characterized by a variety of encrusting and fleshy red and green algae (limu), with Ulva fasciata (palahalaha) the most abundant species during the 1984 field surveys. The Black foot limpet, Cellana exarata (opihi), is the representative species of this zone, occuring in very large numbers on many wave exposed basalt headlands. Other, more wave protected areas are noticeably devoid of opihi, indicating frequent harvesting by local seafood enthusiasts. Examination of the harvest of one opihi fisherman, during the October 1984 survey, indicated well over one hundred adult opihi. These were collected in less than one hour.

The rocky intertidal zone of wave protected inshore coves, inlets, and embayments subject to massive freshwater spring or surface water discharges are devoid of most intertidal species, including the red algae Ahnfeltia concinna. Ahnfeltia represents an excellent "indicator species" for such zones, inasmuch as the absence of this species generally indicates the absence of almost all other intertidal species.

One unusual feature observed in a small, protected, rocky cove was a dense aggregation of the small (one-half inch) mussel, Brachidontes cerebristriatus. This species has formed a families. An expanded employment basis could continue to attract the latter two groups and also reduce out-migration.

Table IV-30

Ka'u High School Class of 1985 Seniors' Plans for Work or School

WORK PLANS	Undecided	No Plan to Work	Work Full-Time	Work Part-Time	Entering Military
(Sample = 48, out of 59 graduates)	50%	6%	15%	15%	15%

SCHOOL PLANS	Undecided	No School Plans	4-Year School	2-Year School	Private Occup'l	"Some Type"
(Sample = 48)	46%	15%	17%	17%	2%	4%

[Note: Questions about work and school plans were asked separately and results were not cross-tabulated. Thus, percentages in the two different rows cannot be added or otherwise related to one another.]

Source: Hawaii State Department of Education, Student Personnel Services Survey. Unpublished figures provided to Community Resources, Inc. by Nan Yuen, Educational Specialist for Guidance and Counseling.

Inmigrants/Commuters

(1) Returning Ka'u Residents, especially young people, would constitute a particularly socially-compatible set of "outsiders." At least some could find housing with family or friends, easing any initial housing shortages due to inmigration. It is possible that some outreach effort might be needed to ensure their awareness of job opportunities, although it is likely that natural communication networks would provide this awareness. However, at the present time it is difficult to assess the number of former residents interested in returning to the area.

(2) Skilled Resort Employees from Elsewhere (primarily on-island but also some from off-island) will likely be imported to fill initial managerial and supervisory jobs at the resort.

near confluent monotypic "carpet" occupying approximately fifty square meters of rocky substratum. This aggregation is unusual, inasmuch as it is apparently flourishing in an embayment which appears to be continuously bathed in a fast flowing (estimated 20 cubic feet per second), low saline (1.4 ppt) stream from the large coastal pond (Pond No. 1 - Figure IV-19). This species was not observed elsewhere along the shoreline.

Nearly all tide pools in the area are dominated by cool, low saline spring waters which limit opportunities for successful biological colonization and growth. However, one relatively high isolated tide pool harbored approximately 30 juvenile manini (Acanthurus triostegus) and several unidentified juvenile angelfish.

2.5.3.2 Impacts on Intertidal Zone

Impacts on the intertidal zone could be caused by increased human activities in the zone; increased nutrient loading due to the continued use of treated sewage effluent for golf course irrigation; increased surface water runoff; and abandonment of the present surface runoff water culverts that discharge into the zone.

Increased human usage of the shoreline is expected due to improved access as a result of realigning Punalu'u Road and increasing the Punalu'u Beach Park automobile parking area. At present the park is used by residents and visitors for sunbathing, picnicking, camping and fishing. These activities are expected to continue. The proposed water play area of the Resort is designed to be the primary water contact and "beach" for the Resort, thereby potentially reducing the number of visitors that would be using the shoreline park. It is expected that the low nearshore and offshore biological diversity and densities would remain due to natural physical processes and continued fishing pressures.

Increased nutrient loading due to the continued use of treated sewage effluent could adversely affect the intertidal zone. As noted previously, it has been estimated that about 30 mgd of basal groundwater naturally flows into the ocean in the Punalu'u area. The nutrient levels of these waters are elevated due to the naturally occuring vegetation in the upper elevations, i.e., nitrogen fixing plants such as Koa-haole and Kiawe, and possibly, agricultural activities. Also, as previously noted, the Resort generated sewage receives secondary treatment, followed by at least two-days storage in the ponds adjacent to the 17th fairway. As a result of the chemical treatment and storage, the effluent that is sprayed onto the golf course has essentially received tertiary treatment and is free of pathogens. State Department of Health sampling in Punalu'u Harbor indicated lation model projects continuation of this trend in Hawaii. According to the 1980 Census, the female labor rate in Ka'u was just 43.3 percent, compared to 51.3 percent islandwide. (It might also be noted that Ka'u's high unemployment in 1980 was primarily among female participants. Ka'u male unemployment was 7.6 percent versus an islandwide male rate of 7.2 percent, but Ka'u female unemployment was 16.1 percent versus an islandwide female rate of just 6.7 percent). Especially in their early start-up stages, rural area Hawaiian resorts have often hired somewhat more women than men. Thus, it may be expected that the proposed project would not only address the high female unemployment in Ka'u, but also accelerate the statewide trend of attracting more women into the labor force.

- Future high school graduates from Ka'u High School will average about 90 per year in 2005, as compared to recent class sizes of 50 to 70, according to Hawaii State Department of Education projections (personal communication, Ed Matsushige, Information Specialist, Information System Services Branch, Office of Business Services, August 13, 1986). These projections are based in part on the proposed resort expansion.

  While many high school graduates will replace retiring current workers, there will be a net surplus of potential new labor force entrants. Increased job availability in the region will keep some in the area who might otherwise leave (and/or attract them home after outside schooling). Although community informants frequently refer to young people leaving Ka'u in search of work, it is difficult to predict with certainty how many already remain and how many additional would remain if given the sort of employment opportunities afforded by resorts. Table IV-30 shows results of a survey of seniors graduating from Ka'u High in 1985. While results are obscured by the high proportion who were "undecided" about either work or school plans, it may be noted that (a) only 21 percent clearly ruled out immediate work ("no plans to work" or "entering military") and (b) only 17 percent evidenced a clear desire to attend a four-year college, which might overqualify them for the great majority of resort (or, for that matter, agricultural) jobs.

- Continued population growth in Ka'u will augment the base from which the labor force is drawn. As discussed in Section 4.2.1.2, there has been apparent recent population growth even without new economic opportunities -- some retirees, some persons attracted by inexpensive subdivision land, and some immigrants joining their extremely low levels of coliform and streptococcus bacteria and noted that future sampling was not necessary. The majority of studies performed in Hawaii and elsewhere indicate that the use of treated sewage effluent for golf course irrigation is an environmentally acceptable and economical method of disposal. A few studies (Aguilar, 1987) have indicated that in those instances where soil conditions are such that the degree of nutrient uptake is less than that desired, there could possibly be short- and long-term adverse effects. However, sufficient data do not exist to accurately predict long-term effects. It is expected, given the volume of basal ground water discharge, the physical oceanographic characteristics of Punalu'u Harbor, the type of soil conditions that have been in place since construction and establishment of the golf course and the relatively low level of sewage effluent to be applied to the golf course as compared to the basal groundwater outflow, that adverse impacts due to the continued use of treated sewage effluent for golf course irrigation would not occur, either in the short- or long-term. Implementation of the Environmental Protection Plan and the water quality monitoring requirements contained in the plan would assure adequate monitoring of the intertidal zone and allow corrective measures to be taken if they are required.

Increased surface water runoff directly into the intertidal zone would not occur as a result of the proposed project. The two stormwater culverts that presently directly discharge into the intertidal zone or coastal ponds would be abandoned and replaced by retention basins within the golf course, thereby providing some filtration for the stormwaters prior to their introduction into the intertidal zone waters. During periods of extended and intense rainfall it is possible that the retention basins would overflow and rainwaters would directly enter the offshore waters. Oil and grease are expected to accumulate in the retention basins which would be periodically cleaned by golf course maintenance personnel. Adverse impacts to the intertidal zone are not expected as a result of stormwater runoff. Positive impacts would result from the abandonment of the two drainage culverts that discharge directly into the ocean.

2.5.3.3 Mitigation Measures

Mitigation measures designed to minimize adverse impacts to the intertidal zone include development of the water play area as the primary water contact and "beach" area for the Resort; adherence to environmental protection and permit requirements during the reconnection of Pond No. 1 and the dry mauka pond; implementation of the Environmental Protection Plan and the placement of signs and interpretive displays explaining the importance of the zone to the ecology of the area; and redirecting stormwater runoff to golf course retention basins and the abandonment of drainage culverts that presently discharge directly into the ocean.

there are approximately 370 Ka'u residents employed as macadamia nut pickers in Ka'u or Honomalino, of whom two-thirds are seasonal. If wages and working hours prove comparable for hotel work, many of these people could be expected to seek less demanding indoor work if the opportunity were present. However, the exact extent of job transfers is uncertain; many of the current workers are immigrant Filipinos who are more accustomed to agricultural than to service employment, although such preferences may shift over time.

Except for a few positions requiring mechanical or administrative talent, resort jobs generally do not demand the same skills as sugar plantation jobs, and they generally pay less. Therefore, the Ka'u Agribusiness personnel officer (personal communication, Claire Barton, August 8, 1986) does not anticipate much job switching from the sugar plantation. However, South Hawaii agricultural managers recently have expressed concern over a developing islandwide labor shortage which may also have some impact on Ka'u (personal communications, Mr. Barton, Ka'u Agribusiness, and Charles Young, Mac Farms of Hawaii, October 26, 1987).

Should long-term economic conditions result in a sugar plantation closure, the resort could provide alternative employment for those not ready to retire. For the near future, however, no such closing is anticipated.

(3) <u>Commuters from Ka'u</u> may in some instances prefer to work closer to home. The 1980 Census data indicate that 9.8 percent of Ka'u's labor force commuted 30 minutes or more one way to work, and 6.1 percent commuted 45 minutes or more. These percentages did not exceed the comparable islandwide figures (15.0 and 6.0 percent, respectively) but they would nonetheless suggest that up to 120 Ka'u residents might be available for new types of work within their own district.

(4) <u>Part-time or temporary workers</u> in Ka'u may well be attracted to full-time jobs or additional part-time jobs. According to the 1980 Census, 40.1 percent of employed Ka'u residents (slightly more than the islandwide figure of 37.6 percent) either worked fewer than 40 weeks in 1979, or usually worked fewer than 35 hours per week, or both. Some of these Ka'u residents with less than full-time employment may have been seasonal macadamia nut pickers previously discussed.

(5) <u>Projected Natural Growth in Labor Force</u> (both size and participation rates) is expected to add to Ka'u's labor force in the future. The most significant components would be:

- <u>Increased female labor force participation rates</u>: Women have been increasing their labor participation rates nationwide, and the State of Hawaii's economic and popu-

2.5.4 Punalu'u Harbor Physical and Biological Characteristics

2.5.4.1 Existing Conditions

Punalu'u Harbor is fringed on its landward margin with approximately 200 meters of a crescent-shaped, steeply sloping black sand beach. The east and west sides of the bay are composed largely of aa lava flows, rocks, and headlands with numerous small vertical to near-vertical cliffs. A 0.3 to 1.0 meter thick layer of freshwater dominates virtually all of the inshore reaches of the bay. Vertical mixing of water masses was apparent in all areas surveyed.

The floor of the bay is generally shallow and irregular and is characterized by undulating lava bedrock and massive deposits of basalt boulders, cobbles and wave deposited limestone materials which occur shoreward to the lower intertidal zone. Vertical relief is provided by large boulders, widely scattered coral heads and undulating pahoehoe flows which reach to within approximately one meter of the surface in several areas and account for numerous inshore wave breaks. Major inshore or offshore sand deposits are uncommon, though small accumulations of basaltic and coralline sands are evident in several wave protected troughs or depressions between undulating lava outcrops. Lava flows, boulders and rocks are often totally devoid of any macroscopic biological growth, suggesting that the entire bay is subject to frequent and rather severe wave action and scouring. Significant differences were evident in the abundance and density of represented benthic flora and fauna between the 1984 and 1986 field surveys; an effect attributed to frequent and severe wave action (See Appendix C).

Four species of corals were identified within the harbor. *Pocillopora meandrina* and *Porites lobata*, the dominant corals of most wave exposed shallow coastlines in Hawaii, are of generally infrequent occurrence and represented colonies are, with few exceptions, small and irregular in shape. The former species demonstrated several color variations which is typical for the species. *Porites* growth forms ranged from small, scattered, and irregular shaped vegetative growth forms, to a few massive coral heads covering as much as one square meter of substratum. However, vegetative growth forms deposited by storm wave action were the most common. Less common species included *Pocillopora damicornis* (robust form) and very small colonies of *Pocillopora ligulata*.

Twenty (20) species of marine algae (limu) were identified within the intertidal and subtidal zones of Punalu'u Harbor (Appendix C). None of the species was particularly abundant, except for occasional large patches of *Ahnfeltia* which were observed during the 1984 surveys in the intertidal zone on the

- Depending on factors external to the analysis in Table IV-29 (e.g., housing, family ties, etc.), some of the 480 to 885 needed "inmigrants" might actually already have inmigrated to Ka'u prior to resort openings.

- If housing shortages persist or worsen, some of the "inmigrants" may instead be additional commuters.

- Should the sugar plantation ever close, younger plantation workers may shift to resort work and further reduce the expected inmigration.

These qualifying statements are intended to make the point that resort employment will not have a simple relationship with the size of the future Ka'u labor force or the number of inmigrating workers. The resort will interact with other factors (particularly housing) in ways that cannot be completely predicted at the present time. The foregoing analysis has focused on what would appear to be fairly maximal impacts, but other scenarios are also possible.

4.2.2.4 Potential Sources of Labor Supply

There are three broad categories -- each with several subcategories -- of possible labor sources for the new resort activities: (1) labor force participants living in or near Ka'u who can be expected to seek work without special outreach efforts ("natural" labor supply); (2) inmigrants and/or commuters to the area; and (3) growth in the Ka'u labor force due to special mitigation efforts -- i.e., "hidden Ka'u unemployment."

"Natural" Labor Force Participants

(1) Unemployed residents who are actively seeking work are numerous in East and South Hawaii. According to unpublished estimates provided by the Hawaii State Department of Labor and Industrial Relations, the average number of job-seeking unemployed residents in Ka'u for 1986 was 215, representing a 10.8 percent unemployment rate. Even assuming that 3.0 percent would be "normal" unemployment (job switchers, etc.), this leaves an average 1986 surplus labor pool of 162 unemployed job-seekers.

Arguably, some unemployed residents of upper Puna (Census Tract 210) and South Kona (tracts 213 and 214) would be willing to commute to Punalu'u without desiring to live in Ka'u. According to the State estimates for 1986, there were 527 unemployed in upper Puna and 229 in South Kona.

(2) Job switchers would be persons changing current Ka'u positions for new resort jobs. Although they would meet resort labor needs, such individuals would displace any labor shortages to other sectors of the regional economy. At present,

southwestern, ocean side of the harbor. The presence of numerous species of "reef-building" coralline algae throughout the inshore reaches of the harbor (Porolithon, Neogoniolithon, Lithophyllum, and Hydrolithon), are evidence of the impact of occasional storm wave action in this region. Although occasionally found in shallow, wave or water current-dominated inshore areas, these species are normally associated with deepwater offshore reef crests, margins and slopes.

Echinoderms account for the majority of the marine life in the harbor with sea urchins accounting for the greatest number of species (Appendix C). The boring urchins Echinometra mathaei and Echinometra oblongata dominated many boulders and cobbles. The Black urchin, Diadema paucispinum (wana), was occasionally found in densities of up to 16 per square meter in 1984 but was not observed in 1986 surveys. The more conspicuous deep water urchins included the brilliant reddish-orange slate-pencil urchin, Heterocentrotus mammilatus, and the short-spined or collector urchin, Tripneustes gratilla.

Twenty-four (24) species of fish were identified during the October 1984 surveys of Punalu'u Harbor, indicating a rather low species diversity compared to other, more protected, coastlines (Appendix C). The Hawaiian dascyllus, Dascyllus albisella ('alo'ilo'i), was the most abundant species and was always associated with scattered outcrops of Pocillopora. The Hawaiian sergeant, Abudefduf abdominalis (mamo), and the convict tang, Acanthurus triostegus (manini), were second and third, respectively, in abundance. The overall fish population within the harbor was very low, and is undoubtedly the result of the low salinity of the harbor waters and the low density and abundance of coral. Surveys conducted in August 1986 recorded twenty (20) species of fish with the Fantail filefish, Pervagor spilosoma ('o'ili-'uwi'uwi), manini and various related surgeon fishes dominating the fish fauna. The Hawaiian dascyllus, which dominated the 1984 fish survey, was not observed during the 1986 surveys. Corals were greatly reduced in abundance between 1984 and 1986 and are the preferred habitat for this species (Brewer, Appendix C, Section 2).

As noted above in Section 2.3.2 Punalu'u Harbor is known to be the most concentrated resident foraging site in Hawaii for the threatened Hawaiian green turtle (Chelonia mydas). Although nesting is restricted to French Frigate Shoals, Punalu'u is a popular feeding area for the species. At least four (4) turtles were observed during high tide, mid-day, hours during field surveys on August 16, 1986.

The Hawaiian hawksbill turtle (Eretmochelys imbricata) is an endangered species which is known to nest in the Ka'u area. Known nesting sites in Ka'u include Punalu'u Beach, Kamehame Point, Horseshoe Beach, and the beach at Kawa (see Naughton, J.

Table IV-29

Comparison of Future Additional Ka'u Labor Demand vs. Supply

				Inmigrants	
		Low	High	Low	High
New Demand					
A. Ka'u Resort Employment (1):					
-- Direct		1302	1699		
-- 20% Indirect/Induced	+	215	286		
-- Total	=	1517	1985		
B. Highly Skilled Jobs:					
-- 10% to Inmigrants	-			152	199
-- 90% Remainder to be Filled	=	1365	1786		
C. Future New Agricultural Jobs:					
-- No. of Jobs	+	100	100		
-- Total, w/ Resort	=	1465	1886		
D. Voluntary Commuters to Ka'u					
-- 15% Previous Total	-	220	283		
-- 85% Remainder to be Filled	=	1245	1603		
New Supply					
E. Available 1986 Unemployed		162	162		
F. Future Growth in CLF					
0.97 x (2554 - 1777)	+	754	754		
G. Total (E + F)	=	916	916		
Needed Inmigration (or Involuntary Commuting)					
H. Shortfall for Less Skilled Positions (D - G)				+ 329	687
I. Total (B + H)				= 481	886

(1) Based on numbers shown on Table IV-28

(NMFS) Letter of August 6, 1986 to L. Uyehara, C. Brewer Properties, Inc. and Section 2.3.2 of this Final EIS). Punalu'u and Horseshoe Beach are within the proposed project area while Kamehame is immediately north and Kawa is immediately south of the resort. Two hawksbill turtles were observed during field surveys in Punalu'u Bay on August 16, 1986. The green turtle forages on the red algae, Pterocladia capillacea, which is relatively common in shallow subtidal areas adjacent to the western flank of Punalu'u harbor. The Hawksbill turtle feeds on various sponges and ascidians found in the nearshore waters.

2.5.4.2 Impacts on Punalu'u Harbor

Impacts on Punalu'u Harbor could be caused by increased human activities in the harbor and increased nutrient loading of the harbor waters.

Increased human activities in the harbor are expected to be caused by an increase in the numbers of people swimming and fishing in the harbor and an increase in the number of boats using the launch ramp facilities. Punalu'u black sand beach is one of few swimming beaches in Ka'u District and, as such, is popular with both residents and visitors as a swimming area although the beach is not considered "safe" by the County Department of Parks and Recreation. Strong seaward currents, generally strong wave and surge actions close to or on the beach and the inflow of cold basal ground water tend to limit swimming activities by those unfamiliar with the local conditions. As noted previously, the water play area of the proposed Resort is designed to be the primary water contact area and "beach" for residents and guests of the Resort. It is expected that with improved and enlarged Punalu'u Beach Park parking facilities and improved access to the black sand beach area, increased numbers of residents would be using the black sand beach area for swimming. It is unlikely, due the low diversity and densities of nearshore marine life and beach area, that adverse impacts to Punalu'u Harbor would result from increased swimming activities. Similarly, it appears unlikely, given resident's knowledge regarding the protected status of the turtles inhabiting Punalu'u Harbor and the interpretive displays that would be located in the beach park and near the black sand beach, that residents or visitors would harass or otherwise bother the green or hawksbill turtles. However, it is also possible that some residents and/or visitors would ignore warning and informational signs and continue to harass or illegally take turtles. Increased human activities resulting from increased use of the boat launch ramp are similarly not expected to cause adverse impacts on the marine life or water quality aspects of Punalu'u Harbor. Generally, boats enter and leave the harbor as quickly as possible, although on especially busy days there are waiting periods during launching and retrieval operations. The waiting periods could

(5) The State Department of Labor and Industrial Relations' estimated Ka'u civilian labor force of 1,777 was accepted for 1986.

Scenario Outcome

Based only on natural increase from the assumed 1986 civilian Ka'u population of 4,538, the sex-age cohort analysis led to a projected year 2006 population of 5,149. This growth rate (averaging about 0.6 percent per year) is lower than that actually observed in Ka'u from 1970 to 1980.

The analysis also produced an estimated year 2006 Ka'u resident labor force of 2,554 (1,384 male and 1,170 female), as compared to the 1986 figure of 1,777.

These year 2006 figures were then incorporated with preceding assumptions into the future demand/supply analysis shown in Table IV-29.

This table indicates a need to import (through inmigration or involuntary commuting), for the lower range of estimated resort employment, a total 481 additional workers above the number expected from natural increase alone. For the higher range, the figure is 886.

These are illustrative and probably maximal figures. They are also subject to the following explanatory statements:

- Mitigation measures, as described later in this section and in Appendix I, could increase expected labor force participation rates, leading to future availability of more than the 916 indicated new workers from natural increase (births over deaths) of the Ka'u population.

- However, without resort development, at least some of the additional 916 Ka'u workers might outmigrate.

- Housing availability would also be a factor for the actual future residence in Ka'u of both the estimated "available" 916 workers (some of whom might have to outmigrate as existing households become overcrowded) and the potential 480 to 885 "inmigrants" (who could not otherwise move to the area).

result in the discharge of engine oil and grease in the water. The strong seaward moving current adjacent to the east side of the harbor could be expected to disperse these materials out to sea such that they would not build up in any one area to the detriment of the marine life. The recreational aspects of increased usage of the harbor are discussed in Section 7. Continued and/or increased fishing pressure could adversely affect the stocks of fish, shellfish and limu in the harbor unless conservation measures are followed by the fishermen.

As has been described previously (Section 2.5.1), increased nutrient loading due to Resort development and/or operations is not expected to occur. The continued use of treated sewage effluent for golf course irrigation and the use of biocides and fertilizers on the golf course and landscape areas are not expected to adversely affect Punalu'u Harbor waters.

2.5.4.3 Mitigation Measures

To mitigate potential adverse impacts resulting from increased human activities in Punalu'u Harbor, interpretive displays and signs describing the ecological importance of the harbor waters and marine life would be erected as part of the overall Resort Environmental Protection Plan (Appendix H). Continued and/or increased fishing within the harbor are not expected to adversely affect the existing stocks of fish and limu providing the fishermen adhere to the conservation measures that would be described in the interpretive displays. The existing low diversity and densities of marine life are due in part to strong wave and surge action along with existing fishing pressures. Maintenance of existing stocks is dependent upon self-policing actions and consideration of future fishing and gathering requirements. Mitigation of adverse impacts due to increased nutrient loading does not appear warranted at this time. Should future conditions indicate that mitigation measures are warranted (as a result of the water quality monitoring program described in the Environmental Protection Plan), appropriate measures would be taken.

2.5.5 <u>Ninole Cove Physical and Biological Characteristics</u>

2.5.5.1 Existing Conditions

Ninole Cove has been subjected to major physical changes in recent years as a result of a major flashflood event(s) which completely filled in and destroyed more than 1.5 acres of the former embayment. An elevated beach berm and steeply sloping beach represent the existing landward boundary of the cove, a site approximately 150 meters seaward of its former location.

15 percent of all workers commuting 30 minutes or more to work but only 6 percent commuting 45 minutes or more (i.e., the time required to commute from East Hawaii past Volcano or the population centers of South Kona).

Assumptions About Future Additional Ka'u Labor Supply

(1) Pockets of "hidden unemployment" will not be considered in the initial analysis.

(2) A 3.0 percent unemployment rate will constitute full employment, and any unemployment over this rate will constitute available labor supply. Thus, as discussed in Section 4.2.1.3, the assumed available 1986 Ka'u labor supply would be 162 persons. And assumed increases in overall future labor supply would be just 97 percent of the total growth.

(3) Despite evidence of substantial Ka'u population growth in the early 1980's which is not related to new employment opportunities -- but rather to factors such as inexpensive land, retirement, and immigrants joining their families -- future growth in population and labor force will be limited for this analysis to that projected from natural increase after 1986. This amounts to assuming either that no further inmigration will occur or else that it will consist of persons disinterested in future resort or agricultural jobs. It also amounts to assuming a 20-year population growth rate substantially below that estimated for the early 1980's.

(4) To project natural increase in Ka'u population and labor force, Community Resources, Inc. conducted a sex-age cohort analysis (refined from previous applications) incorporating these further assumptions:

- Statewide projected sex- and age-specific mortality and fertility rates were taken from official State population/employment forecast model (Hawaii State Department of Planning and Economic Development, 1986), thus ignoring Ka'u's large family sizes.

- State-wide future sex- and age-specific labor force participation rates from the State's population/employment forecast model were used.

- The assumed initial 1986 population was the State estimate of 4,612 (minus the 1980 military population of 74 equals an assumed 4,538 civilian population). Numbers in each age-sex cohort were based on observed proportions from the 1980 Census.

The Ninole Cove area is surrounded by steep aa bluffs on the west side and a lower undulating aa headland on the east side. A somewhat crescent-shaped and rather steep black sand beach berm creates the present landward limit of the cove. Virtually all of the cove is dominated by a cool layer of surface freshwater which limits biological colonization in both intertidal and subtidal zones. Black sand, brown (apparently terrigenous sediments), and white to grayish-white coralline materials dominate the subtidal zone to a point approximately 45 meters seaward of the beach. The sandy inshore zone terminates in a narrow (15 meters wide) transition zone of scattered small boulders, rocks and cobbles. The physiography seaward of the transition zone is dominated by undulating pahoehoe flows which extended well past the seaward terminus of the cove. With the exception of a few boulders, the pahoehoe flows create the only vertical relief in the cove. The pahoehoe occassionally extends to within a meter of the surface and is responsible for several inshore wave zones. The entire bay is one of exceptionally low biological diversity.

Small nodular growths of Pocillopora meandrina and fragments of wave deposited Porites lobata comprised the coral community. Macroalgae were nearly absent, with only small cropped growths of Chaetomorpha and Enteromorpha observed in more protected areas. With the exception of small stands of Ahnfeltia on the seaward-most headlands, virtually all of the macroscopic plant life was represented by broken fragments of wave deposited coralline-algae. Broken thalli of Pterocladia were seen in several locations, the result of wave deposition from larger beds subsequently located outside and immediately south of the cove.

Macroinvertebrates were similarly low in both population size and diversity.

The fish fauna was composed of only seven species. Twenty-eight (28) individual fish were counted during a thirty minute reconnaissance dive in the cove and eleven (11) of these were observed in the immediate vicinity of a "cleaning station" attended by the cleaner wrasse, Labroides phthirophagus.

2.5.5.2 Impacts on Ninole Cove

Impacts on Ninole Cove could be caused by increased human activities immediately offshore and increased nutrient loading of the cove and immediately offshore area.

Increased human activities within and around Ninole Cove are expected to result from increased shoreline fishing and increased swimming that could occur as a result of increased numbers of people visiting the Resort. It is expected that increased swimming would be primarily by residents of the area

In truth, any such analysis must be considered highly tentative, since it will depend on a chain of assumptions (which is why it is labelled a "scenario"). The assumptions which follow are conservative in that they probably tend to over estimate needed workers from outside Ka'u. This conservatism is considered appropriate because it leads to a statement of maximal impacts for population and housing in later sections.

Assumptions About Future Additional Ka'u Labor Demand

(1) All direct jobs created by new resort activities will be located in Ka'u (either on site or at tourist attractions such as the Volcanoes National Park). In fact, some direct jobs could well be in Hilo or Kona, such as those created by visitor expenditures for transportation.

(2) Twenty percent of indirect/induced jobs will be located in Ka'u.

(3) The number of needed workers will equal the number of estimated full-time equivalent jobs (although many residents of rural Hawaii resort areas work more than one job and a recent survey of Kohala luxury resort workers (Community Resources, Inc. and Datametric Research, 1987) suggest the number of workers required equals about 92 percent of the number of jobs).

(4) Ten percent of all future resort related Ka'u jobs will be considered as inherently requiring inmigrants who possess managerial or entrepreneurial skills currently in short supply within the community. [Note: This is a particularly conservative assumption which is subject to mitigation through job training efforts discussed in Section 4.2.3 and Appendix I. These efforts are intended to reduce the 10 percent by as much as practical.]

(5) The number of sugar plantation jobs/workers will remain constant from now through the year 2006.

(6) Based on the most recent information from Ka'u Agribusiness and Mac Farms of Hawaii, an additional 100 macadamia nut picking jobs will be assumed to be created between now and 2006, although there is actually considerable uncertainty about this due to prospects for increased mechanization. (Conceptual proposals for new high-tech aquaculture or agriculture jobs, as well as employment related to space launch facilities or other proposed Ka'u Resorts, will not be considered, since these would require separate government approvals.)

(7) Of future new Ka'u jobs, 15 percent will be filled by persons voluntarily commuting in from outside the district, six-tenths of whom would probably live in the Volcano part of Puna. This is based on 1980 countywide Census data, which shows

rather than visitors to the Resort due to the relatively cold inflow of basal groundwaters. It is recognized that some visitors to the Resort would use the area for swimming. As with other areas of the Resort, interpretive displays and signs would be placed at the cove to inform people of the importance of the area as a wildlife habitat and the need to protect and preserve that habitat. Increased fishing pressure may cause adverse impacts to the marine fauna of the cove area. It is not possible to determine the relative degree of impacts that may be experienced and due to increased fishing pressure, but the present and expected continued low diversity and densities of marine organisms would tend to act as a natural inhibitor to increased fishing pressures.

As with the nearshore and offshore areas of the Resort, increased nutrient loading of the cove, should it occur as a result of Resort operations, is not expected to cause adverse impacts due to the relatively low level of nutrients that may be introduced into the cove versus the present inflow of nutrient rich basal groundwaters. In compliance with the Environmental Protection Plan, cove waters would be monitored. Appropriate action would be taken should water quality parameters indicate mitigation action is required.

2.5.5.3 Mitigation Measures

Increased human activities in and around the cove would be monitored in compliance with the Environmental Protection Plan to ensure that adverse impacts are minimized. Similarly, should water quality monitoring indicate degradation of water quality parameters, corrective actions would be taken.

2.5.6 Summary of Nearshore Marine Environment

The existing water quality of the nearshore marine environment is significantly influenced by intertidal and subtidal springs, surface water discharges from coastal ponds and fishing pressures. In general, there is a wide variation in the physical and chemical properties of the nearshore waters and relatively low biological diversity and density in most areas. The Punalu'u Harbor area is subjected to southwesterly and southerly swells and wave action, which during the majority of the time, are relatively strong and contribute to rapid mixing of nearshore waters with offshore waters; wave action also contributes to the low biological diversity of the nearshore environment, due to scouring action within the harbor.

Impacts to the nearshore and offshore waters could be caused by increased nutrient loading due to the continued use of treated sewage effluent for golf course and landscape irrigation;

TABLE IV-28

Projected Direct, Indirect and Induced Employment for Resort Operations for the State of Hawaii

Type of employment	At project completion Low	At project completion High
Direct(1)	1,302	1,699
Indirect and induced:		
Hotel and resort(2)	879	1,236
Commercial(3)	195	195
Subtotal	1,074	1,431
Total	2,376	3,130

(1) As shown in Table IV-27.

(2) Related to direct employment at the hotels, condominium units and in resort administrative positions. Estimated as 0.9 indirect and induced employees per direct employees. State of Hawaii, Department of Planning and Economic Development, The Economic Impact of Tourism in Hawaii: 1970-1980, 1983.

(3) Estimated as 0.6 indirect and induced employees per direct employees. Ibid.

4.2.2.3 Labor Supply vs. Project Demand -- A Scenario

The purpose of this section is to present one scenario for estimating future additional Ka'u labor supply from natural (plus foreseeable new demand from other economic activities not requiring separate government approvals). The difference between the projected growth in labor supply and the growth in job demand could be considered to represent the number of new workers who would inmigrate to Ka'u (assuming available housing) or who would involuntarily commute into Ka'u (assuming lack of such housing).

increased human activities in and around the Resort; increased surface water discharge; and the continued use of biocides and fertilizers on the golf course and landscape areas. The proposed project does not include any plans to physically modify the coastal ponds, except the cleaning and restabilization of Pond No. 3 and the establishment of landscape buffers on the golf course sides of Pond No. 1 and the dry mauka pond.

Adverse impacts from any of the potential impact factors are not expected due either to existing natural mitigation measures and/or those that would be implemented. The primary natural action in effect is the relatively large outflow of nutrient rich basal groundwaters into which relatively minor quantities of treated sewage irrigation waters would percolate and be diluted prior to entering the nearshore and offshore waters. Proposed mitigation measures include improving the Resort surface water collection and disposal system and the abandonment of two drainage culverts that currently discharge directly into the ocean or coastal ponds; the implementation of an Environmental Protection Plan; and the erection of signs and interpretive displays explaining the ecological importance of the nearshore and marine environment to the area and the need to protect and preserve that environment.

3. HISTORICAL AND ARCHAEOLOGICAL RESOURCES

3.1 HISTORICAL NOTES

3.1.1 Historical Uses of Punalu'u and Previous Investigations and Findings

There have been several archaeological investigations within the Punalu'u Resort project area. The earliest recorded field work was conducted in the early 1900s when Stokes described the heiau (aboriginal ceremonial sites) located adjacent to and within the project area during his inventory of heiau on the island of Hawaii (Kelly 1980:69-77). Stokes also recorded a petroglyph cluster on the coastal flats between Ninole and Punalu'u village (Cox with Stasack 1970:80-81).

Almost 50 years later, the first systematic surveying and recording of sites was started by Violet Hansen. In 1968, she recorded archaeological sites in the vicinity of Puhau (Ninole Spring) (Hansen 1968). Much of what is known about the archaeology of Ninole/Wailau and Punalu'u ahupua'a is attributed to the field surveys of Violet Hansen. She identified and recorded many sites and assisted on the later survey projects.

TABLE IV-27

Projected Direct Employment
for Punalu'u Resort Operations

Facility type	At project completion Low	High
Hotel(1)	666	932
Resort residential(2)	249	374
Commercial(3)	325	325
Resort administration(4)	62	68
Total operational employment	1,302	1,699

(1) Projected at 0.9 full-time equivalent jobs per hotel unit.

(2) Projected at 0.2 full-time equivalent jobs per condominium unit and 0.03 full-time equivalent jobs per completed sold single-family home.

(3) Projected at 1.0 job per 200 gross leasable square feet of commercial space.

(4) Estimate based on staffing observed at existing resorts in the islands. Category includes miscellaneous resort employment such as resort administration, property development and sales, accounting, grounds-keeping, infrastructural facilities and operations and maintenance of recreational facilities.

Total Employment: Total direct, indirect and induced operational employment is estimated to represent between 2,380 and 3,130 positions at project completion, as shown in Table IV-28. As for construction employment, Punalu'u and the business it supports through indirect and induced effects would compete with potential other resorts in the Kona and Kohala areas for labor to fill these positions.

The portion of Ninole/Wailau *ahupua'a* between the coast and State Highway 11 was surveyed in 1970 by Robert Hommon of B.P. Bishop Museum for the Ka'u Historical Society (funded by C. Brewer and Co., Ltd.). A total of 114 sites with 216 component features was recorded. These consisted primarily of walls, rock shelters, platforms, enclosures, depressions, mounds, terraces, and C-shaped structures. Eighteen of these sites were selected for further investigation and excavations were conducted in 1971 by William Barrera of Bishop Museum. The findings revealed historic period use of the Ninole/Wailau area, and a relative paucity of prehistoric artifacts. The violent earthquakes and tidal wave of 1868 were speculated to be the principal reason for the lack of prehistoric evidence in the coastal area. The findings of these archaeological projects, historic information on Alanui Aupuni (the old government road around the island), and the 1868 disaster are presented in "Salvage Archaeology at Ninole/Wailau, Ka'u, Island of Hawaii" (Barrera and Hommon 1972).

Late in 1971, Violet Hansen surveyed the coastal Punalu'u area and made recommendations for further work. In May 1972, Neal Crozier of Bishop Museum mapped and tested four separate areas. This archaeological work was conducted for the Ka'u Historical Society (funded by C. Brewer and Co., Ltd.), and reported in "Archaeological Survey and Excavations at Punalu'u, Island of Hawaii" (Crozier 1974). Survey Area I was located north of Punalu'u Harbor and only a small portion, containing six archaeological sites, is within the current project area boundaries. Survey Area II was located inland of Punalu'u Harbor in an area proposed for a golf course. Five sites were mapped including the Lanipao Heiau complex, B8-2, which was also tested. A third survey area, Survey Area III, was located in Ninole/Wailau and extended inland from State Highway 11. The two sites had been previously identified by Violet Hansen. Both site complexes were recorded, and one was tested. The final survey area was only identified as a "walk through survey of coastal sites," along the coast from Punalu'u Nui Heiau in Punalu'u, through Ninole/Wailau to Kai'ei'e Heiau. Numerous sites were noted in this area, although no specific site information was given. The field work conducted in Punalu'u and inland Ninole/Wailau identified prehistoric site complexes dating to the early 1600s. The range of feature types was comparable to that of adjacent Ninole/Wailau. Also, the impact of the 1868 tidal wave on the coastal archaeological resources in Punalu'u appeared to have been just as devastating as that to the coastal portion of Ninole/Wailau.

A second report entitled "Archaeological Survey and Excavations at Punalu'u Island of Hawaii" (Crozier and Barrera 1974) was published in 1974. This report included all of the information presented in the 1972 edition by Crozier, and the results of additional work. In November 1972 and January 1973, Barrera directed "plane-table surveys" of site complexes in

TABLE IV-26

Projected Range of Total Construction Employment Demand for Punalu'u Resort

	Average annual person-years(1)	Range of demand	
		Low(2)	Peak(3)
Direct employment:			
Low range	138	70	210
High range	198	100	300
Total employment:			
On-island(4):			
Low range	166	85	250
High range	238	120	360
Elsewhere in state:			
Low range	166	85	250
High range	238	120	360
Total:			
Low range	332	165	500
High range	476	240	715

(1) As shown in Tables IV-24 and IV-25.

(2) Estimated as average annual person-years less 50%.

(3) Estimated as average annual person-years plus 50%.

(4) Estimated as all direct plus on-island indirect and induced, as shown in Table IV-25.

Indirect and Induced Employment: The direct operational positions would also generate additional employment elsewhere in the state. Recent studies on the economic impacts of tourism by the DBED indicate that each full-time hotel, resort residential and resort administrative employee supports about 0.9 indirect and induced full-time equivalent positions elsewhere in the state. Resort retail and restaurant positions are estimated to support about 0.6 indirect and induced positions for each direct position. Thus, indirect and induced operational employment could be expected to amount to 1,070 to 1,430 full-time equivalent positions at project completion, as shown in Table IV-28.

Survey Area I. This additional mapping was primarily in areas outside the current project area.

At the request of Hawaiiana Investment Co., Inc. (prior name of C. Brewer Properties, Inc.), Violet Hansen conducted several limited reconnaissance surveys during the 1970s (Hansen 1974a, 1974b, 1974c). The surveys covered areas generally to the north and west of the current project area. Additional correspondence by Hansen included a letter to Dr. Pila Kikuchi concerning the fishponds at Ninole (Hansen 1978). Dr. Yoshihiko Sinoto of Bishop Museum also documented his participation on a survey of Ku'ipo, Punalu'u, an area immediately inland of the project area and included recommendations for further work (Sinoto 1970).

One site within the Wailau complex, 50-Ha-B9-21, was excavated by Bishop Museum during 1973 (Kaschko 1973). The salvage excavations were conducted for Hawaiiana Investment Co., Inc.

In Emory's 1970 "Inventory of Archaeological and Historical Sites in the District of Kona and Ka'u and in Anaehoomalu, South Kohala, Island of Hawaii" (Emory 1970), Hawaii State site numbers were given to several of the sites within the project area. Additional site numbers from the Hawaii Register of Historic Places were assigned during the Statewide Inventory of Historic Places in the 1970s. The site designations for the Ka'u district are currently being sorted out by Ms. June Cleghorn, who is under contract to the Historic Sites Division, Department of Land and Natural Resources, State of Hawaii.

In 1980, two surveys were conducted adjacent to the project area. Violet Hansen surveyed and mapped six acres east of the project boundary and inland of Punalu'u Nui Heiau (Hansen 1980). Lloyd Soehren conducted a reconnaissance survey of a 90 acre parcel, extending inland of the fifth and sixth fairways to State Highway 11 (Soehren, 1980).

A historical sketch of nine Ka'u ahupua'a in the Bishop Museum report "Majestic Ka'u: Mo'olelo of Nine Ahupua'a" (Kelly 1980) includes the ahupua'a of Ninole, Wailau, and Punalu'u, and provides much documentary material on the mythology, early descriptive accounts, settlement patterns, and land use of this area. The project was conducted by Bishop Museum for the Ka'u Historical Society.

Within the last two years, summaries of previous archaeological work and listings of existing archaeological sites within the Punalu'u Resort project area were prepared by Phillips Brandt Reddick & Associates (1984, 1985) for various permit applications. They state:

TABLE IV-25

Projected Indirect and Induced Employment for Facility Construction

(Total person-years)

Type of employment	Total project Low	Total project High	Average person-years per year for 16-year period Low	Average person-years per year for 16-year period High
Total employment(1)	5,314	7,615	332	476
Less direct employment(2)	2,214	3,173	138	198
Indirect and induced	3,100	4,442	194	278
Indirect and induced:				
On island(3)	443	635	28	40
Elsewhere in state	2,657	3,807	166	238

(1) Direct employment multiplied by 2.4. State of Hawaii, Department of Planning and Economic Development, Hawaii Construction Model: Further Developments, 1982.

(2) From Table IV-24.

(3) Direct employment multiplied by 0.2. Anderson, et al., Kauai Socioeconomic Profile, 1975.

Condominium and single-family units are estimated to generate 0.2 full-time equivalent employees per unit and .03 per sold household. Thus, the Resort could be expected to have generated about 1,300 to 1,700 full-time equivalent direct operational positions at project completion, as shown in Table IV-27.

> "Since 1972, considerable development has occurred at Punalu'u..., 47 of the 129 sites are still in existence.... Twenty-two of the sites recommended for preservation in 1972 have been protected; 4 were evidently inadvertently covered during construction or destroyed in recent tsunamis or flooding.... As noted in the Resort Master Plan, the plans are to protect the burials, restore the heiau, and to incorporate the important sites into a pedestrian network with educational and interpretive information," (Phillips Brandt Reddick & Associates 1985:Sec.4, Chapter XI-4).

3.2 ARCHAEOLOGICAL RESOURCES

3.2.1 Existing Conditions

In connection with a rezoning request (R85-27) and a Special Management Area (SMA) permit application (SMA 85-13), a preliminary archaeological assessment of archaeological resources was made by Paul H. Rosendahl, Ph.D., Inc. (PHRI) in January 1986 (Haun and Rosendahl 1986). Haun and Rosendahl found the following: (a) the site recording in the previous archaeological reports (Barrera and Hommon 1972, and Crozier and Barrera 1974) to be incomplete, based upon currently accepted standards for site recording; (b) discussions of excavated sites to be insufficient and difficult to follow; and (c) site interpretations and recommendations were limited or lacking (1986:8-9). Based on the one day field check of 21 previously recorded sites, a literature review, and consultation with Ms. Virginia Goldstein--staff planner and historic sites specialist in the Hawaii County Planning Department, an adequate and appropriate scope of work was determined for the subsequent full archaeological assessment.

A field inspection of the area south of Ninole Cove and north of Koloa Beach was carried out in February 1986 by PHRI Supervisory Archaeologist Margaret L. K. Rosendahl (Rosendahl 1986). A segment of a kerbstone trail was identified with only a short portion entering the project area.

The most recent field work at the Punalu'u Resort project area was a reconnaissance survey of the entire project area conducted in August and September 1986 by PHRI (Rosendahl and Rosendahl 1986). This work was done in connection with the preparation of a Chapter 343 HRS Environmental Impact Statement (EIS) for a General Plan Amendment (GPA) application to the Hawaii County Planning Department. Appendix A contains the final report on the reconnaissance survey (Rosendahl and Rosendahl 1986).

The reconnaissance survey of the Punalu'u Resort project area identified a total of 32 archaeological sites (Figure IV-21).

A 1975 study of Kauai's economy suggested a regional capture rate of total indirect and induced employment amounting to about 20 percent of direct employment. Although the island of Hawaii's future economy may be expected to be more developed than was Kauai's economy in 1975, this figure is assumed to be appropriate due to the number of construction workers who are expected to come from off-island. (The actual share of construction employment going to off-island workers will depend on the timing of other major projects planned throughout the state.)

Table IV-25 applies these findings to project the indirect and induced employment effects of construction for the total project. Indirect and induced construction employment effects are expected to provide employment equivalent to 3,100 to 4,400 person-years for the entire project as shown in the table. The county could be expected to capture between 440 and 640 person-years of indirect and induced construction employment effects for the entire project representing about 30 to 40 full-time equivalent positions in an average year. As for direct employment, these indirect and induced effects could be expected to range considerably in any given year.

Total Employment: In total, the direct, indirect and induced employment generated by the construction of the proposed facilities could represent about 5,310 to 7,620 person-years of work over the development of the project. This would represent a total employment effect of about 330 to 475 persons in an average year of the project's construction, as also shown in Table IV-25. Due to the short-term fluctuations in construction labor demand explained previously, total annual employment opportunities in the state at any given time during the Resort's development could be expected to range up to 715 full-time equivalent persons. This would include up to 360 persons employed on the island at any given time. The projected range of direct and total construction employment requirements at the Resort and on the island are summarized in Table IV-26.

4.2.2.2.2 Operational Employment

Direct Employment: The majority of direct operational employment at the Resort would occur in the two proposed hotels because of their relatively large size and their expected first-class levels of service. First-class resort hotels in Hawaii are found to employ between 0.8 and 1.0 full-time equivalent direct employees per hotel unit. The overall direct hotel operational employment at the Resort is projected at 0.9 full-time equivalent employees per unit.

Twenty-five sites had been previously described, and seven were newly identified. The existing sites within the project area are representative of the range of feature types found in Hawaii. There are platforms, enclosures, terraces, rock shelters, walls, and petroglyphs that appear to be prehistoric in origin. The historic period is documented by the presence of railroad beds, a wharf, a cement tomb, walls, and enclosures.

Tentative functional interpretations for the existing sites are based on the recent reconnaissance survey findings and information generated from the previous studies. One site is a named heiau (Lanipao, B8-2), while another complex has been functionally identified as a heiau (B9-174). A petroglyph cluster and a single figure are located along the coast, and a historic tomb is situated just inland on the crest of a bluff. A ku'ula (fishing shrine) is located south of Punalu'u Bay, and has two known burials immediately inland of it. A complex of terraces along the bluff appear to have been used primarily for habitation, and may also have been used for burial interments. Two other complexes of small platforms, terraces, and walls are suspected of containing burials, as is in an additional single large platform. The remaining features appear to be habitation features (prehistoric and historic), a historic school, the railroad, and features associated with ranching.

All located sites were evaluated in terms of their significance (Table IV-13). The significance of archaeological remains can be defined 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 cultural history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. Interpretive value refers to the potential of archaeological resources for public education and recreation. Cultural value, within the framework of significance evaluation used here, refers to the potential of archaeological resources for preservation and promotion of cultural and ethnic identity and values.

The findings, evaluations, and recommendations of the recent full archaeological reconnaissance by PHRI have been reviewed with Ms. Virginia Goldstein--staff planner and historic sites specialist in the Hawaii County Planning Department. Ms. Goldstein has concurred with the conclusions and recommendations made on the basis of the archaeological reconnaissance. Dr. Ross Cordy--staff archaeologist with the Historic Sites Office, State Department of Land and Natural Resources--has been consulted throughout the reconnaissance survey. Dr. Cordy is familiar with the Punalu'u Resort sites, as he initially compiled the site

TABLE IV-24

Projected Direct Employment for Facility Construction

(Person-years)

Facility type	Total project Low	Total project High	Average person years per year for 16-year period Low	Average person years per year for 16-year period High
Hotel units(1)	740	1,035	47	65
Condominiums(2)	1,302	1,961	81	122
Single-family lots:				
Lot development(3)	13	15	1	1
Home construction(4)	40	43	2	3
Commercial(5)	39	39	2	2
Infrastructure(6)	80	80	5	5
Total person-years	2,214	3,173	138	198

(1) Employment demand calculated at 0.5 full-time equivalent jobs per year per unit and an average two-year construction period per hotel.

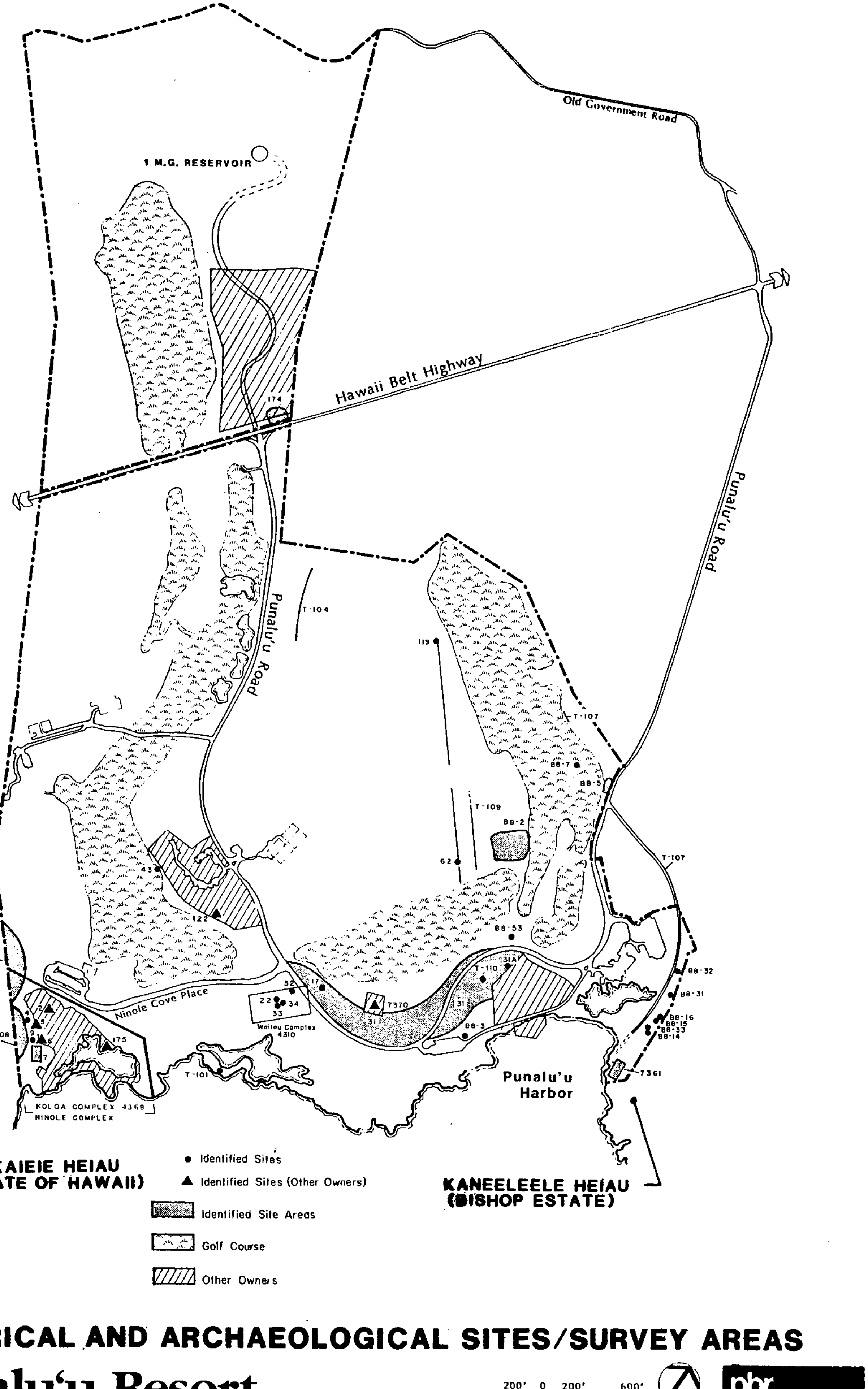
(2) Demand calculated at 0.7 full-time equivalent jobs per year per unit and an average 18-month construction period per project.

(3) Demand calculated at 0.2 full-time equivalent jobs per year per lot and an average one-year construction period per lot.

(4) Demand calculated at 2.0 full-time equivalent jobs per year per home and an average one-year construction period per home.

(5) Demand calculated at 0.6 person-years per 1,000-square foot gross leasable space.

(6) Based on construction cost estimates provided by PBR Hawaii. Includes roads, site work, water lines, and electrical facilities.



HISTORICAL AND ARCHAEOLOGICAL SITES/SURVEY AREAS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE IV-21

Indirect effects occur when directly affected establishments purchase goods or services from other businesses in order to fill new visitor demand. Induced effects are those supported throughout the state's economy when employees or proprietors directly or indirectly dependent on visitor expenditures spend their earnings.

4.2.2.2.1 Construction Employment

Direct Employment: Direct construction employment is that which would be supported directly by the construction of the various facilities. Such employment would include the on site laborers, operators and craftsmen, as well as the professional, managerial, sales and clerical workers whose usual places of employment may be elsewhere on the island or in the state.

Direct demand for construction employees is estimated based on the employment experiences of comparable resort-related facility construction projects in the state. Direct construction employment demand may be expected to require about 2,200 to 3,100 person-years over the entire construction period to project completion, as shown in Table IV-24. This would represent an average annual employment of about 140 to 200 full-time equivalent persons per year. However, actual construction labor demands vary considerably with the stage of construction of individual projects. Monitoring of on site construction workforce counts during the development of Mauna Lani Resort's first hotel, condominium and golf course projects showed that the actual workforce varied from the average workforce by ±29 percent and -35 percent. Assuming variation could actually be as high as ±50 percent during the concurrent development of several facilities, the construction labor needs of Punalu'u at any given time could be expected to range from about 70 to 210 persons under the low development scenario and about 100 to 300 persons under the high development scenario. Assuming concurrent other resort developments in the Kona and Kohala areas, Punalu'u would have to compete for local labor to fill these positions, and proportionately more employees could be expected to come from off-island during periods of peak employment compared to periods of low employment.

Indirect and Induced Construction Employment: The direct employment of construction workers at Resort projects will stimulate additional purchases of goods and services on the island and elsewhere in the state. In its most recent (1982) revisions to a model of the construction industry in Hawaii, the DBED calculated that 2.4 full-time jobs are created in the state for every full-time job in the building construction industry. This multiplier is used to project the indirect and induced employment to be supported by the direct construction employment.

TABLE IV-23

Projected Annual Visitor Expenditures

(In 1986 dollars; millions)(1)

Expenditure type and place of stay	At project completion Low	At project completion High
Direct:		
Hotel(2)	$ 35.8	50.1
Condominium(3)	22.5	33.9
Subtotal	58.3	84.0
Indirect and induced	54.2	78.1
Total(4)	$ 112.5	162.1

(1) 1983 Hawaii Visitors Bureau expenditure data updated to 1986 dollars based on consumer price index data reported by the U. S. Bureau of Labor Statistics.

(2) Average daily expenditures estimated at $93 in 1986 dollars.

(3) Average daily expenditures estimated at $86 in 1986 dollars.

(4) Projected at $1.93 per $1.00 direct expenditure. Based on unpublished 1984 data from the Department of Planning and Economic Development, personal communication.

Sources: Hawaii Visitors Bureau, 1984 and 1983 Visitor Expenditure Survey; First Hawaiian Bank - Research Department, January/February 1986, Economic Indicators; and U. S. Bureau of Labor Statistics, 1984.

Table IV-13

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS
AND RECOMMENDED GENERAL TREATMENTS
PUNALU'U RESORT PROJECT AREA

Site Designation Numbers		Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
B8-2*	3512#	+	-	+	+	+	-	+	-
B8-3	3513	+	-	+	+	+	-	+	-
B9-17		+	-	+	+	+	-	+	-
B9-174	-	+	-	+	+	+	-	+	-
T-101	-	+	-	+	+	+	-	+	-
T-110	-	+	-	+	+	+	-	+	-
T-111	-	+	-	+	+	+	-	+	-
Subtotal: 7		7	0	7	7	7	0	7	0

General Significance Categories:

A=Important for information content, further data collection necessary (PHRI=research value);
X=Important for information content, no further data collection necessary (PHRI=research value, SHPO=not significant);
B=Excellent example of site type at local, region, island, State or National level (PHRI=interpretive value);
C=Culturally significant (PHRI=cultural value).

Recommended General Treatments:

FDC=Further data collection necessary (intensive survey and testing, and possibly subsequent data recovery/mitigation excavations);
NFW=No further work of any kind necessary, sufficient data collected, archaeological clearance recommended, no preservation potential (possible inclusion into landscaping suggested for consideration);
PID=Preservation, with some level of interpretive development recommended (including appropriate related data recovery work);
PAI=Preservation "as is," with no further work (and possible inclusion into landscaping), or only minimal further data collection necessary.

*B.P. Bishop Museum site designation system: all site numbers prefixed by 50-Ha-B8- or B9- (50=State of Hawaii, Ha=Island of Hawaii, B=District of Ka'u, 8=Land of Punalu'u, 9=Lands of Ninole and Wailau).

#Hawaii Register of Historic Places (HRHP) site designation system: all four-digit site numbers prefixed by 50-10-68- (50=State of Hawaii, 10=Island of Hawaii, 68=USGS 7.5' series quad map, "Punalu'u, Hawaii").

T- =Sites recorded by PHRI.

TABLE IV-22

Projected Visitor Population
at Punalu'u Resort

(Average daily population)

Facility type	At project completion Low	At project completion High
Hotel units	1,055	1,475
Condominium units(1)	716	1,079
Total	1,771	2,554

(1) Visitors staying in those units kept in transient rental pools.

Indirect and Induced Visitor Expenditures: Based on multipliers derived from the most recent information available from the Department of Business and Economic Development's (DBED, formerly Department of Planning and Economic Development - DPED) state Input/Output Model, the direct visitor expenditures could be expected to generate indirect and induced expenditures amounting to $54 million to $78 million per year at project completion, as also shown in Table IV-23.

Total Expenditures: Including direct, indirect and induced effects, expenditures in the state attributable to the Resort visitors are projected to total about $113 million to $162 million per year at project completion, in 1986 dollars.

4.2.2.2 Employment Impact

Planned developments at the Resort will generate short-term employment during the construction of new facilities and long-term employment in the operation and support of those facilities. Employment effects may also be classified as being direct, indirect or induced. Direct effects are those directly supported by visitor expenditures, such as the employment at hotels and other establishments that serve visitors. Direct employment would generally be located in the County of Hawaii both at and outside of the Resort.

Table IV-13 (Cont.)

Site Designation Numbers		Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
B9-31	4309	+	-	-	*	+	-	-	*
T-108	-	+	-	-	*	+	-	-	*
Subtotal: 2		2	0	0	2	2	0	0	2
B8-5	B8-37/3515	+	-	+	-	+	-	+	-
B8-14	-	+	-	+	-	+	-	+	-
B8-15	-	+	-	+	-	+	-	+	-
B8-16	-	+	-	+	-	+	-	+	-
B8-31	-	+	-	+	-	+	-	+	-
B8-32	-	+	-	+	-	+	-	+	-
B8-33	-	+	-	+	-	+	-	+	-
B8-53	-	+	-	+	-	+	-	+	-
B9-4	4368/3519	+	-	+	-	+	-	+	-
B9-7	4368/3522	+	-	+	-	+	-	+	-
B9-9	4368/3524	+	-	+	-	+	-	+	-
B9-22	4310	+	-	+	*	+	-	+	-
B9-43	4330	+	-	+	-	+	-	+	-
Subtotal: 13		13	0	13	2	13	0	13	0
B8-7	-	+	-	-	-	+	-	-	+
B9-32	4310	+	-	-	-	+	-	-	+
B9-33	4310	+	-	-	-	+	-	-	+
B9-34	4310	+	-	-	-	+	-	-	+
7361	-	+	-	-	-	+	-	-	+
Subtotal: 5		5	0	0	0	5	0	0	5
B9-62	-	-	+	-	-	-	+	-	+
B9-119	4360	-	+	-	-	-	+	-	+
T-104	-	-	+	-	-	-	+	-	+
T-107	-	-	+	-	-	-	+	-	+
T-109	-	-	+	-	-	-	+	-	+
Subtotal: 5		0	5	0	0	0	5	0	5
Total: 32		27	5	20	9*	27	5	20	12*

*Includes possible burial sites; therefore, a provisional assessment, definite assessment pending further data collection (i.e., testing features for presence/absence of skeletal remains).

TABLE IV-21

Assumptions for On-Resort Population Projections

Facility and occupational types	Percentage of distribution(1)	Occupancy	Average party size(2)
Hotel units	100%	75%	1.9
Condominium units:			
Full-time residents	15	95	2.5
Part-time residents	30	25	2.5
Visitors	55	50	2.1
Single-family units:			
Full-time units	25	95	2.8
Part-time units	75	25	2.8

(1) Distribution of uses within facility type.
(2) Occupied units only.

Sources: Based on interviews with resort operators and brokers at similar first-class resort developments and Hawaii Visitors Bureau, Profile: The Resort Condominium Market and Profile: The Resort Hotel Market, 1985.

Projected Visitor Population: Based on the above assumptions and the facilities proposed for development, additional visitor population at Punalu'u could be expected to range from about 1,771 to 2,554 persons on any given day, by project completion, as presented in Table IV-22.

4.2.2.1.2 Visitor Expenditures

Direct Expenditures: Direct visitor expenditures are projected based on average daily 1986 expenditures of $93 and $86 for hotel and condominium guests, respectively. These expenditures were estimated based on 1983 Hawaii Visitors Bureau (HVB) expenditure data and consumer price index trends as reported by the U. S. Bureau of Labor Statistics. The direct visitor expenditures, in 1986 dollars, could amount to $58 million to $84 million per year by project completion, as shown in Table IV-23.

information from published reports and the State Historic Preservation Office files for the landowner. This was done for the 1984 "Request for a Change of Zone and Special Management Area Permit" (Phillips Brandt Reddick & Associates 1984).

3.2.2 Impacts on Historical/Archaeological Resources

The reconnaissance field work revealed that most of the project area (at least 90 percent) has already been either mechanically cleared, or altered by floods and tsunamis. It should be noted that all of the initial Resort clearing and grading activities that were performed at the time the Resort was originally started were performed in accordance with applicable federal, state and county rules, regulations and construction permit conditions. As noted previously, archaeological surveys were performed prior to the initiation of the construction work and, in accordance with applicable rules and regulations. In general, the more substantial archaeological sites have survived both natural disasters and man's impact on the area.

Resort development has the potential to disturb or destroy significant archaeological sites identified in the archaeological reconnaissance survey. The potential to sites recommended for preservation would also be increased due to increased opportunities for public access. Site B9-17, a historic concrete crypt, appears to be within a planned shopping mall, and could be impacted by initial construction as well as eventual pedestrian traffic.

Similarly, Resort development will increase the numbers of residents and visitors to the Resort and, it is likely that increased numbers of people would visit the heiau on either side of, but outside of the Resort boundaries. The increase in visitors could result in damage and/or vandalism to the heiau. CBP has contacted both the State of Hawaii and Kamehameha Schools/B.P. Bishop Estate, land owners on which the heiau area are located, regarding their plans for the heiau. Neither owner has any plans at present, but in an effort to reduce or curtail damage and vandalism, the history, importance and other information regarding the heiau, will be included in the cultural resources interpretive program to be developed for the Resort.

Sites with moderate or low research, interpretive, or cultural values that have been recommended for preservation "as is could also be directly impacted by development. Preservation is not essential for these sites, though they may be included into the landscaping.

TABLE IV-20

Cumulative Residential and Visitor Unit Facility Development for Punalu'u Resort

Facility type	At project completion(1) Low	At project completion(1) High	Percent distribution of units Low	Percent distribution of units High
Existing development:				
Condominium units	76	76	3%	2%
Single-family:				
Homes	3	19	-	1
Vacant lots	16	-	1	-
Subtotal, existing units	95	95	4	3
Proposed development:				
Hotel units	740	1,035	35	33
Condominium units	1,240	1,868	58	61
Single-family:				
Homes(2)	20	22	1	1
Vacant lots	51	56	2	2
Subtotal, proposed units	2,051	2,981	96	97
Total visitor and residential units	2,146	3,076	100%	100%
Commercial square feet:				
Existing	10,000	10,000		
Proposed	65,000	65,000		
Total commercial square feet	75,000	75,000		

(1) Assumed to occur in about year 2005; most hotel and condominium units completed, and about 44% of single-family lots assumed to have been improved with home construction.

(2) Homes built on sold houselots. Construction on sold houselots projected at 5% within 4 years following lot sale, 30% between 5 and 9 years of lot sale, and 60% between 10 and 14 years.

3.2.3 Mitigation Measures

Based on the findings of the 1986 reconnaissance survey (Appendix A), it is believed that all sites present within the project area have been identified and evaluated. Table IV-13 summarizes the general significance assessments and recommended general treatments for all existing sites within the Punalu'u Resort Project Area. Of the 32 sites, five sites have been recorded and no further work is recommended and 27 will require further data collection.

At present, 20 of the 27 sites requiring further data collection are recommended for preservation with some level of interpretive development. Additional archaeological work will occur at these sites to aid interpretation. The plans for the archaeological work and interpretive work will be specified in a scope of work to be reviewed and approved by the Historic Sites Section and the County of Hawaii, Planning Department. The archaeological consultant has been contracted to prepare a general scope of work and content outline for preparation of a projected Historical Sites Management Plan (Appendix K) as one task of the current reconnaissance survey project work (Appendix A). It must be emphasized that archaeological work here is not to be archaeological data recovery, but limited gathering of information for interpretation.

The remaining seven of 27 sites requiring further data collection will either be preserved "as is," with no further archaeological work or interpretive work, or undergo archaeological data recovery. Data recovery would be in two stages and will include osteological analyses and subsequent reinterments if burials are removed. Again, data recovery plans would be reviewed and approved by the State of Hawaii, Historic Preservation Office, and the County of Hawaii, Planning Department, and execution of these plans would be verified by these offices.

The final concern is with the clearing of Ninole Pond (Cove). Plans for any work in the general vicinity of the ponds need to reviewed and approved by the State of Hawaii, Historic Preservation Office, and the U.S. Army Corps of Engineers. This work will have to undergo separate compliance with the U.S. National Historic Preservation Act of 1966 (as amended). The proposed project does not include plans to clear or restore Ninole Cove.

During project area construction grading, all archaeological sites within the area will be adequately flagged, and a sufficient buffer established to protect the resources. Monitoring will be conducted for all archaeologically sensitive areas. Should subsurface features be encountered, all site grading in that area will cease, and the applicant will notify the County of Hawaii Planning Department. Professional archaeosider the economic impacts attributable to the 76 condominium units, 19 single-family homes and lots, golf course, restaurants and other existing developments at Punalu'u.

4.2.2.1 Visitor Expenditures

The Resort will generate direct, indirect and induced visitor expenditures in the State and County of Hawaii. Visitors to the Resort will make direct expenditures for food, accommodations, gift items and other goods and services. These expenditures will, in turn, require those establishments serving direct visitor demands to purchase goods and services from other establishments in the state. The latter expenditures are considered an indirect effect of the original visitor expenditures. Induced expenditures are those made by employees and proprietors with income derived from the establishments serving the direct and indirect visitor demands.

In order to estimate these expenditure effects, the analysis begins with a projection of the growth in visitor population expected to be driven by the proposed developments.

4.2.2 1.1 Visitor Population

Estimation of the average daily visitor population at the Resort is the basis for projecting the additional visitor expenditures resulting from the Resort's development. The projected visitor population is based on the proposed facilities for visitor accommodations and on average occupancy and party size assumptions derived from a survey of comparable properties in the state.

<u>Facility Development</u>: The proposed additional residential and visitor unit facility development at the Resort amounts to 2,051 to 2,981 units by project completion. The completed development would be distributed by facility type as follows: 33 percent to 35 percent hotel units, 61 percent to 63 percent condominium units and three to four percent single-family lots, including the existing and proposed developments, as presented in Table IV-20.

<u>Population Assumptions</u>: All of the hotel units and 55 percent of the condominiums units could be assumed to be used for visitor rentals. For purposes of this analysis it was assumed that visitors would not utilize single-family homes. Annual occupancy rates were assumed to average 75 percent for the hotel units and 50 percent for the condominium units at project completion. Party size was estimated at 1.9 and 2.1 for the hotel and condominium units, respectively. Table IV-21 presents the assumptions regarding resident/visitor distribution, occupancy rates and average party size for the planned facilities.

logists will be summoned to examine the finds, and recommend appropriate mitigative actions.

3.3 SUMMARY OF HISTORICAL AND ARCHAEOLOGICAL RESOURCES

The Punalu'u area is thought by some to be the first landing area in Hawaii by the Polynesians who became the forefathers of Hawaii's people. There have been several archaeological investigations within the Punalu'u Resort project area and numerous prehistoric and historic features have been found, surveyed and described. The archaeological investigation performed for this EIS identified a total of 32 archaeological sites, 25 of which had been previously described. The existing sites within the project area are representative of the range of feature types found in Hawaii. There are platforms, enclosures, terraces, rock shelters, walls and petroglyphs that appear prehistoric in origin.

Impacts on the archaeological and historical sites within the proposed project boundaries could be caused by construction activities and increased numbers of people visiting the area. In accordance with applicable federal, state and county regulations, appropriate measures would be taken to preserve and record the archaeological and historical sites within the project boundaries. In addition, a Cultural Resources Management Plan would be developed to ensure (1) that the sites are properly protected and preserved and (2) that an educational program regarding the history of Punalu'u is established.

Mitigation measures to be employed include the development of the Historical Sites Management Plan (Appendix K) and, during construction all archaeological sites within the area would be adequately flagged and a sufficient barrier established to protect the resources.

4. SOCIOECONOMIC ENVIRONMENT

4.1 BACKGROUND INFORMATION

Ka'u is reputed to have been the first landfall of the Polynesian voyagers who became the forefathers of Hawaii's people. According to a missionary census of the population of Ka'u in 1835, there were 4,766 persons then living in the area (Kelly, 1980). Ka'u's sparse population has been often attributed to its geography and limited resources. The rugged windswept terrain of Ka'u is dominated by the slopes of Mauna Loa. With no permanent streams in the area, the Hawaiians of Ka'u were dependent upon freshwater springs along the shoreline for their only source of potable water. Drought, sometimes followed by

As of 1980, median family income in Ka'u was $17,555, well below that for South Kona, Volcano, or the island as a whole (Table IV-17). However, despite high unemployment, the proportion of families below the federal poverty level was lower in Ka'u than the other areas. (This was not true for Ka'u's small number of non-family households, nearly half of which fell below the poverty line.)

4.2.1.3 Labor Force Characteristics

As shown in Table IV-14, Ka'u labor force participation rates in recent years have been low, while unemployment rates (especially in the 1980's) have been very high. According to estimates provided by the Hawaii State Department of Labor and Industrial Relations, average 1986 unemployment rates were even higher: 10.8 percent for Ka'u, 12.5 percent for Census Tract 210 (upper Puna, including Volcano), and 6.0 percent for South Kona.

Unemployment within Ka'u has been more concentrated in Na'alehu than in Pahala. It has also been more concentrated among females than males. The State Department of Labor and Industrial Relations estimates the average 1986 labor force as about 1,780 and the average number of unemployed as about 215. Assuming "full employment" would still include a three percent unemployment rate to reflect persons temporarily between jobs, this means that the average available labor supply through unemployment was about 162 in 1986 -- and possibly considerably more through "hidden" unemployment reflected in the low labor force participation rates.

The occupation and industry profile of Ka'u's employed workers reflects the strong agricultural orientation of the current workforce. The two "industries" involving sugar or macadamia operations (agriculture and manufacturing) employed more than 50 percent of Ka'u workers in 1980, compared with a combined 20 percent islandwide.

Table IV-14 also indicates that relatively few Ka'u residents commute long distances (45 minutes or more) to work, reflecting the area's isolation and dependence on economic activities within or bordering Ka'u.

4.2.2 Impacts on Economic Environment

This section describes the economic impacts of Punalu'u Resort's development in terms of additional visitor expenditures, employment, and resident income. These impacts are assessed for the proposed additional hotel, condominium, single-family and commercial developments at the Resort. The analyses do not confamine, was not uncommon (Kelly, 1980). The vastness of the area and the severity of its landscape combined to give its people a reputation for independence and ruggedness.

The traditional agrarian economy of Ka'u -- dry-land taro and sweet potato cultivation, augmented by fishing -- was systematically replaced by a variety of agricultural pursuits with the arrival of Westerners beginning in the late 1700's. By the 1850's, cattle, horses and goats were becoming numerous (Kelly, 1980). Foreigners and Hawaiians alike were experimenting with the cultivation of produce to trade with the occasional ships that would risk the dangerous mooring along the rocky coastline. Wheat growing was undertaken in the mid-1850's (Kuykendall, 1966). For a period of time, an active trade developed around the gathering of pulu, a brown silky fiber from the Hawaiian tree fern used for stuffing mattresses and pillows. However, it was the early experimentation with sugar cane cultivation that eventually led to the development of a stable cash crop for the Ka'u area. By the early 1880's, there were a dozen plantations of varying sizes, at least three with sugar mills (Kelly, 1980). Two of these were in Pahala and Na'alehu, which grew to become the district's major communities.

Success in the sugar industry led to improvements to the roads and harbors serving the district. Honu'apo Bay was deepened in the 1870's and a wharf completed in 1883. Punalu'u harbor was known as the "port town of the district", serving both the sugar mills and visitors to the volcano area (Kelly, 1980).

In 1883, C. Brewer and Company, Limited, later to become the owner of both the Pahala and Na'alehu mills, was incorporated. Continued growth in the sugar industry and improvements to plantation technology during the 1900's resulted in expansion and eventual consolidation of the Ka'u sugar industry, with only Pahala retaining a mill today. As sugar began to decline in the 1970's, the area's major employer, C. Brewer, began converting some of its sugarlands to the cultivation of Macadamia nut trees and initiated the development of the present Punalu'u Resort.

4.2 ECONOMIC ENVIRONMENT

4.2.1 Existing Conditions

Tables IV-14 through IV-17 provide 1970 and 1980 Census data for the County of Hawaii and the district of Ka'u (census tract 212), which is considered the primary Study Area for socio-economic impact analyses. These tables also provide Census data for the adjacent areas of South Kona (Census Tracts 213 and 214) and Volcano Village (most of which is contained in Enumeration District 351 of the upper Puna Census Tract 210, although a small portion of Volcano is in Ka'u).

Na'alehu have larger proportions of Filipinos than the district as a whole, indicating that few Filipinos live in the surrounding subdivisions, while the reverse is true for Caucasians. Na'alehu is a more Hawaiian community than Pahala.

Together, the plantation communities of Pahala and Na'alehu contained nearly three-quarters of the Ka'u district's population as of 1980. However, there has been steady recent population growth in Ka'u's various subdivisions, where there are increasing numbers of retirement homes (primarily occupied by Mainland-originating Caucasians) and where inexpensive land is also beginning to attract a younger and more ethnically diverse population.

The largest and best established of these subdivisions is Hawaiian Ocean View Estates, located by the South Kona border about 15 miles west of Na'alehu. It consists of more than 10,000 one-acre lots (now on the resale market for prices ranging from $3,000 to $15,000 for vacant lots). It boasts an active community association with a community center, as well as a few small stores and restaurants. Population estimates vary. In 1986, the community association's part-time office manager said that the subdivision was home to some 400 to 500 permanent residents, and nearly as many part-time seasonal residents (personal communication, Sharon Fisher, August 13, 1986). More recently, a Realtor specializing in the area (personal communication, Anne Pettingill, McKee Realty, October 27, 1987) estimated the total population at 2,000 or more. Some 100 children from the Estates now attend Ka'u schools, and about 500 homes have post office boxes.

The population of the Estates -- as of most Ka'u subdivisions -- is predominantly Caucasion. Many of the permanent residents are retirees originally from the Mainland. In recent years, younger families and/or longtime Hawaii residents have begun to move there, attracted by low purchase prices, the climate, and the wooded landscape. There are no waterlines, though, and electric service is limited to homes at lower elevations.

Subdivisions closer to Na'alehu include Discovery Harbor (which includes an 18-hole golf course), Mark Twain Estates, and the Green Sands subdivision. According to a Realtor specializing in the area (personal communication, Walt Taylor, Walt Taylor Realty, October 28, 1987), these subdivisions now contain perhaps 100 homes among them. Lot prices begin at around $4,000 and can reach $18,000 in Discovery Harbor, where electricity, water, and County-dedicated roads are available. There has also been some recent home construction in the subdivision in the Ka'u portion of Volcano.

TABLE IV-14

Labor Force Size and Characteristics: County of Hawaii and Various Parts of Study Area, 1970 and 1980

	COUNTY OF HAWAII		KA'U (C.T. 212)		SOUTH KONA (C.T. 213-214)		VOLCANO (ENUM. DIST. 351)		PAHALA CDP		NA'ALEHU CDP	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
POTENTIAL LABOR												
FORCE (aged 16+)	43,075	67,205	2,210	2,646	2,629	4,265	N/A	859	N/A	1,181	N/A	722
not in labor force	39.5%	38.7%	45.6%	45.9%	41.6%	33.8%	N/A	43.1%	N/A	44.6%	N/A	44.5%
armed forces	0.4%	0.3%	2.8%	1.5%	0.0%	0.0%	N/A	1.9%	N/A	0.0%	N/A	0.0%
civil. labor force	60.1%	61.0%	51.6%	52.6%	58.4%	66.2%	N/A	55.1%	N/A	55.4%	N/A	55.4%
CIVILIAN LABOR												
FORCE	25,889	41,006	1,140	1,391	1,535	2,823	N/A	473	N/A	654	N/A	401
unemployed	2.7%	7.0%	2.1%	10.8%	2.3%	5.7%	N/A	19.0%	N/A	9.9%	N/A	14.5%
TOTAL EMPLOYED												
CIVIL. LABOR FORCE	25,180	38,150	1,116	1,240	1,500	2,662	N/A	383	N/A	589	N/A	343
OCCUPATION												
service	16.3%	16.5%	12.5%	14.7%	16.0%	17.3%	N/A	13.6%	N/A	12.1%	N/A	11.7%
manager./profes.	NC	20.0%	NC	17.4%	NC	13.6%	N/A	18.0%	N/A	13.2%	N/A	16.6%
technical, sales & adminis.	NC	26.1%	NC	11.3%	NC	24.8%	N/A	19.8%	N/A	12.7%	N/A	6.7%
farm/fish/forest	NC	10.3%	NC	30.2%	NC	19.5%	N/A	19.6%	N/A	31.2%	N/A	38.2%
precision, craft, repair	NC	12.7%	NC	10.0%	NC	14.8%	N/A	20.4%	N/A	13.1%	N/A	7.3%
operators, fabri-cators, laborers	NC	14.4%	NC	16.4%	NC	10.0%	N/A	8.6%	N/A	17.7%	N/A	19.5%
INDUSTRY (selected)												
agric., forest, fish, mining	12.5%	11.2%	NC	32.6%	N/A	19.4%	N/A	18.3%	N/A	32.1%	N/A	46.1%
construction	10.6%	9.1%	36.3%	6.4%	20.4%	14.3%	N/A	14.9%	N/A	1.0%	N/A	1.5%
manufacturing	15.0%	8.3%	2.8%	18.8%	3.2%	1.2%	N/A	2.1%	N/A	30.4%	N/A	13.1%
retail trade	14.8%	17.5%	6.8%	9.8%	8.9%	18.4%	N/A	11.5%	N/A	5.1%	N/A	11.7%
financial, insur., real estate	2.8%	5.7%	1.0%	2.0%	3.5%	4.5%	N/A	5.7%	N/A	0.5%	N/A	0.0%
personal, entertain. & recreat. services	11.2%	10.9%	N/A	7.5%	N/A	15.2%	N/A	8.6%	N/A	6.0%	N/A	7.0%
health, educ, & professional	14.1%	16.7%	12.1%	15.1%	18.3%	13.1%	N/A	8.4%	N/A	18.0%	N/A	12.5%
public adminis.	6.5%	7.3%	4.6%	5.0%	3.7%	4.8%	N/A	14.9%	N/A	4.4%	N/A	0.0%
COMMUTE TO WORK												
45 minutes or more	N/A	6.0%	N/A	6.1%	N/A	6.1%	N/A	18.8%	N/A	2.7%	N/A	7.9%
mean travel (min.)	N/A	16.5 m	N/A	12.4 m	N/A	20.6 m	N/A	34.8 m	N/A	9.1 m	N/A	16.1 m

Notes: All figures based on 15% sample; hence, numbers represent estimates.
"N/A" = "Not Available" in published form. "NC" = 1970 categories or bases "Not Comparable" to 1980 Census.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape File 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

The major economic activities in areas adjacent to Ka'u include macadamia nut operations in South Kona and visitor-oriented activities at the Hawaii Volcanoes National Park. According to interviews with employers there, many Ka'u residents now commute to these jobs. Mac Farms of Hawaii, located in South Kona just above the Ka'u border, employs an estimated 10 regular and 110 seasonal Ka'u residents; these 130 Ka'u residents represent about 62 percent of the total Mac Farms work force (personal communication, Charles Young, Vice President for processing, October 26, 1987). Reports from various employers associated with the National Park indicate about 70 Ka'u residents work for the National Park Service, the Volcano House hotel and dining complex, and various other National Park operations.

4.2.1.2 Population, Housing and Income Characteristics

Table IV-15 indicates a 1980 population of 3,699 in Ka'u -- a ten-year increase of 8.9 percent, in contrast to the island-wide increase of 45 percent and 48 percent increase in South Kona.

Despite the lack of new economic opportunities in Ka'u, it is possible that this slow population growth pattern of the 1970's has changed in more recent years. According to most recent available estimates from the Hawaii State Data Center, the July 1, 1986 population was 4,612 for Ka'u, 7,113 for South Kona, and 18,397 for the entire Puna district, the island's fastest growing area.

The estimated 1986 Ka'u population implies an average annual growth rate of 3.6 percent since 1980, as compared with an average annual growth rate of just 0.9 percent for the preceding ten years.

However, community and social agency informants interviewed for this report believe there has been some definite Ka'u population growth since 1980. School enrollment data indicate growth has occurred less in Pahala than in Na'alehu and neighboring subdivisions, particularly Hawaiian Ocean View Estates. The new population reportedly consists mostly of recent Filipino immigrants, younger persons from other islands, and older Mainland residents retiring to subdivision homes. However, there are no data to indicate which group, if any, dominates recent population growth through inmigration.

Table IV-15 indicates the dominant ethnic groups in Ka'u are Filipino, Caucasian, and Hawaiian (or part-Hawaiian), with Japanese rapidly declining as a proportion of the overall population. The same is also generally true of neighboring South Kona, although the Filipino population is declining there, but the Volcano area is largely Caucasian. Within Ka'u, individual communities have different ethnic profiles. Both Pahala and

TABLE IV-15

Total Population and Demographic Breakdowns: County of Hawaii and Various Parts of Study Area, 1970 and 1980

	COUNTY OF HAWAII		KA'U (C.T. 212)		SOUTH KONA (C.T. 213-214)		VOLCANO (E.D. 351)		PAHALA CDP		NA'ALEHU CDP	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
TOTAL POPULATION	63,468	92,053	3,398	3,699	4,004	5,914	N/A	1,181	1,507	1,619	1,014	1,168
	%	%	%	%	%	%	%	%	%	-%	%	%
ETHNICITY												
Caucasian	28.8	35.0	24.7	27.0	17.7	30.0	N/A	59.8	18.6	20.2	17.7	12.3
Japanese	37.5	26.6	25.9	18.3	39.6	27.5	N/A	16.8	30.4	22.6	28.4	19.9
Chinese	2.9	1.7	2.5	1.4	0.8	0.8	N/A	2.4	1.5	1.5	2.4	1.4
Filipino	16.5	13.9	32.3	28.3	26.2	13.0	N/A	2.7	38.8	36.6	36.4	35.4
Hawaiian/part-Haw'n	12.3	18.8	13.3	20.5	14.7	23.5	N/A	12.6	9.4	15.5	13.8	26.8
Other	2.0	4.1	1.2	4.5	1.0	5.2	N/A	5.6	1.3	3.6	1.2	4.1
AGE												
Less than 5 yr.	8.6	9.1	9.2	9.9	9.0	9.8	N/A	10.5	8.5	9.4	10.0	10.8
5 - 17 yr.	27.8	21.5	30.7	23.7	29.8	20.7	N/A	18.2	30.0	25.0	32.2	26.9
18 - 64 yr.	54.4	59.2	51.7	54.7	48.9	58.8	N/A	59.8	53.3	52.3	49.9	52.9
65 or more yr.	9.2	10.2	8.4	11.7	12.4	10.6	N/A	11.5	8.2	13.3	7.9	9.4
Median age	28.9 yr	29.4 yr	27.5 yr	29.8 yr	29.7 yr	29.7 yr	N/A	29.8 yr	29.0 yr	29.9 yr	26.0 yr	27.3 yr
PLACE OF BIRTH*												
Hawaii	NC	70.5	NC	61.8	NC	71.2	N/A	59.4	N/A	67.5	N/A	65.5
Other U.S.**	NC	20.0	NC	16.1	NC	20.8	N/A	36.1	N/A	7.7	N/A	4.3
Foreign country	NC	9.4	NC	22.1	NC	7.8	N/A	4.5	N/A	24.8	N/A	30.2
RESIDENCE 5 YRS. PREVIOUS (people aged 5+)												
Same house	62.5	52.9	63.9	63.0	56.1	57.4	N/A	46.4	N/A	65.0	N/A	74.3
Same island	NC	24.9	NC	14.6	NC	22.9	N/A	15.9	N/A	15.5	N/A	19.3
Different island	NC	8.1	NC	4.6	NC	6.5	N/A	26.0	N/A	4.9	N/A	0.0
Different state	NC	11.1	NC	10.4	NC	10.7	N/A	11.7	N/A	6.0	N/A	0.0
Different country	NC	3.1	NC	7.4	NC	1.2	N/A	0.0	N/A	8.5	N/A	6.3
EDUCATION* (people aged 25+)												
Less than H.S.	53.2	43.8	54.1	32.7	48.0	23.6	N/A	9.2	N/A	37.3	N/A	45.2
H.S. graduate	31.6	27.6	20.8	38.7	24.1	46.2	N/A	39.9	N/A	38.8	N/A	36.1
Some post H.S.	7.6	14.3	17.8	14.3	21.5	17.8	N/A	30.0	N/A	13.2	N/A	10.4
College, 4+ yr.	7.5	14.3	7.3	14.3	6.3	12.4	N/A	20.9	N/A	10.7	N/A	8.3

Notes: *Figures based on 15% sample; hence, numbers represent estimate.
**Including persons born in U.S. territories, and persons born abroad or at sea to American parent/s.

"NC" = 1970 categories or bases "Not Comparable" to 1980 (1970 Census kept a "non-response" category, while 1980 Census allocated non-responses to other categories shown).
"N/A" = "Not Available" in published form.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape Files 1-A and 3-A; State of Hawaii,1973,Community Profiles for Hawaii.

TABLE IV-19

Demographic Characteristics of C. Brewer Resort Jobs at Punalu'u

	Golf Course Operations	Salaried Personnel	Black Sand Restaurant	TOTAL
Age				
under 30	20	1	14	30
30-39	14	3	5	20
40-49	9	1	6	15
50-59	6	2	1	8
60 plus	2	0	1	2
no data	0	1	1	2
Sex				
male	19	3	4	24
female	32	5	25	53
Ethnicity				
Caucasian/Portuguese	4	0	6	9
Japanese	6	1	3	10
Filipino	2	1	1	3
Hawaiian/Part-Haw'n	33	5	17	48
Other or Mixed	6	1	2	7
TOTAL:	51	8	29	77

Notes:

(1) "TOTAL" column shows only the 77 individuals who held the 88 different jobs.

(2) Ethnic categories reflect standard demographic categories, although it should be noted that most "Mixed" employees were part-Filipino.

Source: C. Brewer & Co.

TABLE IV-16

Housing Stock and Characteristics: County of Hawaii and Various Parts of Study Area, 1970 and 1980

	COUNTY OF HAWAII		KA'U		SOUTH KONA		VOLCANO		PAHALA CDP		NA'ALEHU CDP	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
TOTAL YEAR-ROUND HOUSING UNITS	18,972	33,854	984	1,362	1,139	2,052	N/A	563	437	511	272	339
vacant (total)	9.0%	13.9%	9.4%	18.6%	7.2%	9.7%	N/A	22.0%	4.8%	6.6%	5.9%	5.9%
vacant forsale	N/A	1.3%	N/A	1.2%	N/A	0.3%	N/A	1.2%	N/A	0.4%	N/A	0.0%
vacant for rent	N/A	5.6%	N/A	5.0%	N/A	2.1%	N/A	1.4%	N/A	1.8%	N/A	0.9%
held for occas'l use	N/A	2.5%	N/A	1.4%	N/A	3.6%	N/A	9.4%	N/A	0.8%	N/A	0.9%
other	N/A	4.5%	N/A	11.0%	N/A	3.6%	N/A	9.9%	N/A	3.7%	N/A	4.1%
TOTAL YEAR-ROUND OCCUPIED UNITS	17,260	29,237	900	1,108	1,059	1,853	N/A	439	416	477	256	319
TENURE												
owner-occupied	56.9%	60.6%	41.4%	66.8%	36.9%	52.7%	N/A	68.3%	44.2%	69.8%	34.4%	70.5%
renter-occupied	43.1%	39.4%	58.6%	33.2%	63.1%	47.3%	N/A	31.7%	55.8%	30.2%	65.6%	29.5%
SELECTED CONDITIONS												
lacking some or all plumbing	17.2%	8.1%	20.3%	12.3%	36.9%	34.5%	N/A	11.4%	21.9%	6.5%	7.7%	1.5%
1.51 or more persons/room	6.5%	5.0%	8.7%	8.0%	13.1%	10.1%	N/A	4.3%	6.2%	7.3%	11.7%	9.7%
PERSONS PER HOUSEHOLD	3.61	3.09	3.70	3.30	3.71	3.14	N/A	2.69	3.60	3.37	3.91	3.66
MEDIAN CASH RENT (renter-occupied)	$54	$223	$33	$95	$60 to $79	$151	N/A	$257	$31	$64	$36	$122
as % of median family income	6.6%	14.0%	0.4%	6.5%	7.8% to 7.9%	9.5%	N/A	14.9%	N/A	4.3%	N/A	8.2%
MEDIAN VALUE* (owner-occupied)	$24,800	$70,300	$15,200	$42,500	$35,000 to $49,999	$102,600	N/A	$59,200	$13,000	$43,000	$11,600	$34,500
MEDIAN MONTHLY MORTGAGE* (owner-occupied)**	N/A	$371	N/A	$204	N/A	$389	N/A	$376	N/A	$194	N/A	$222
as % of median family income	N/A	23.3%	N/A	13.9%	N/A	24.4%	N/A	21.7%	N/A	13.0%	N/A	15.0%

Notes: * For 1980, median values are for non-condominium housing units.
** Figures based on 15% sample; hence, numbers represent estimates.
"N/A" = "Not Available."

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

TABLE IV-18

C. Brewer Resort Jobs at Punalu'u by Hourly Wage and Full-Time Status

Hourly Wage	Temporary Casual	Temporary Full-Time	Regular Full-Time	TOTAL
$3.99 or less	17	3	11	31
$4.00 to $4.99	13	5	7	25
$5.00 to $5.99	0	1	9	10
$6.00 to $6.99	0	1	14	15
$7.00 to $7.99	0	0	5	5
$8.00 or more	0	0	2	2
TOTAL:	30	10	48	88

Notes:

(1) Figures based on eight salaried positions (salaries converted to hourly wages based on 40-hour week); 29 Punalu'u Black Sand Restaurant positions; and 51 positions at golf course operations, including clubhouse and convenience store. A few top management and concession positions are not included.

(2) The 88 positions were held by 77 different individuals. Of 11 people with two jobs, three had two full-time jobs.

(3) Of the "Regular Full-Time" positions, 17 were at Black Sand Restaurant, which returned to a part-time schedule after these figures were compiled.

(4) Condominium management, housekeeping, and groundskeeping jobs not included because these are not C. Brewer employees.

Source: C. Brewer & Co.

TABLE IV-17

Family Characteristics and Income Levels: County of Hawaii and Various Parts of Study Area, 1970 and 1980

	COUNTY OF HAWAII		KA'U		SOUTH KONA		VOLCANO		PAHALA CDP		NA'ALEHU CDP	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
POPULATION IN FAMILIES	N/A	81,728	N/A	3,373	N/A	5,158	N/A	1,017	N/A	1,510	N/A	1,100
as percentage of total population	N/A	88.8%	N/A	91.2%	N/A	87.2%	N/A	86.1%	N/A	93.3%	N/A	94.2%
NUMBER OF FAMILIES	14,533	22,825	720	865	848	1,378	N/A	320	330	393	211	270
	%	%	%	%	%	%	%	%	%	%	%	%
HEAD												
Husband/wife	87.1	82.1	89.4	87.4	88.3	83.4	N/A	86.9	89.4	88.8	87.7	82.2
Male only	5.2	5.2	6.1	4.8	4.4	6.1	N/A	2.2	7.3	3.0	5.7	4.8
Female only	7.7	12.7	4.4	7.7	7.3	10.5	N/A	10.9	3.3	8.1	6.6	13.0
WITH OWN CHILDREN UNDER 18	6.3	52.7	8.3	51.3	12.4	51.5	N/A	47.5	N/A	57.2	N/A	49.2
Female head	2.1	7.4	2.2	3.9	4.4	5.4	N/A	10.9	N/A	4.3	N/A	6.3
BELOW POVERTY LEVEL	9.7	10.3	10.7	7.7	18.5	9.8	N/A	9.1	N/A	6.6	N/A	10.0
MEDIAN FAMILY INCOME	$9,750	$19,132	$8,500	$17,555	$10,000 to 11,999	$19,128	N/A	$20,750	N/A	$17,838	$11,600	$17,778
NON-FAMILY HOUSEHOLDS	N/A	6,432	N/A	222	N/A	478	N/A	121	N/A	85	N/A	50
percentage below poverty level	N/A	27.8%	N/A	45.0%	N/A	27.2%	N/A	25.6%	N/A	46.0%	N/A	46.0%

Notes: All figures (except "Population in Families" and "Non-Family Households") based on 15% sample; hence, numbers represent estimates.
"N/A" = "Not Available."

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape File 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

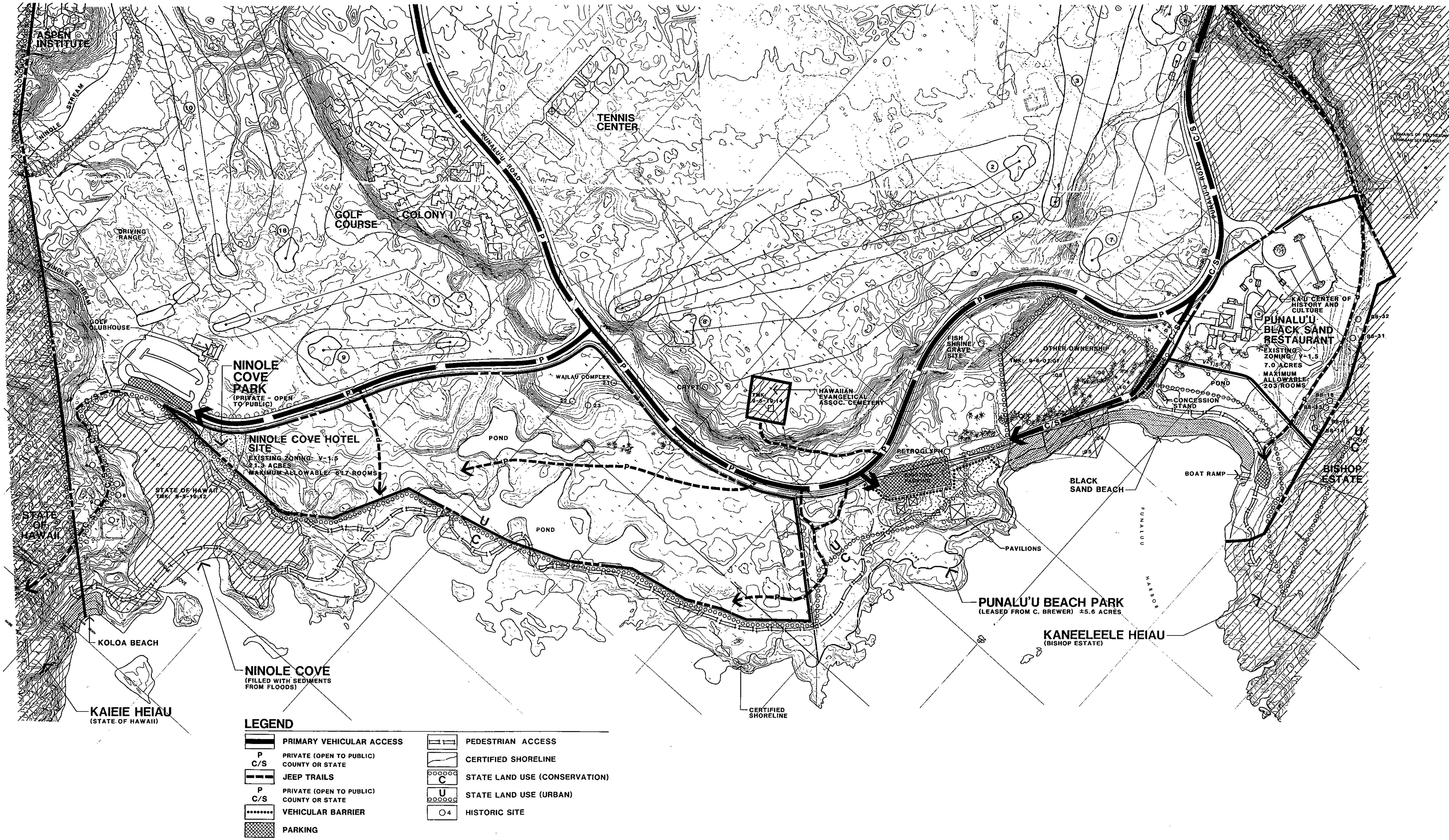
Ka'u is the largest district on the Big Island, with a land area of 636,742 acres (24.7 percent of the island's total area). The proposed project site is located between the primary residential communities of Pahala and Na'alehu, both demarcated as Census Designated Places (CDP's) and included in Tables IV-14 through IV-17. Other residential areas include Waiohinu (a small village just west of Na'alehu) and numerous subdivisions, the largest of which is Hawaiian Ocean View Estates.

4.2.1.1 Primary Economic Activities

Agricultural development continues to dominate economic activity in Ka'u. Major endeavors include sugar cultivation, macadamia nut farming, and some limited cattle ranching. C. Brewer's Ka'u Agribusiness is the district's major employer with about 700 employees at peak season, or about 55 percent of the employed civilian work force. About 75 are salaried employees; 350 are in the sugar plantation bargaining unit; and 250 work in the macadamia nut industry. More than 80 percent of the macadamia workers are seasonal employees, although the typical season extends nine or ten months. Employment at non-Brewer agricultural operations is extremely limited. For example, Kahuku Ranch employs only eight persons to run cattle on some 11,000 of its total 130,000 acres.

Other Ka'u economic activities include the Punalu'u Resort, small retail and commercial operations in Pahala and Na'alehu, and local governmental functions. The Resort currently employs approximately 90 people at peak season. Tables IV-18 and IV-19 contain a profile of the 88 jobs filled by 77 individuals under direct C. Brewer operation. (Additional employment associated with condominium maintenance and rental activities is provided by the homeowners' association and the Punalu'u Rental Management Co.) Table IV-19 indicates more than half the golf course and restaurant employees are Hawaiian or part-Hawaiian. This is in marked contrast to the plantation sector, where more than half of Ka'u Agribusiness employees are Filipino (personal communication, Claire Barton, personnel director, August 8, 1986).

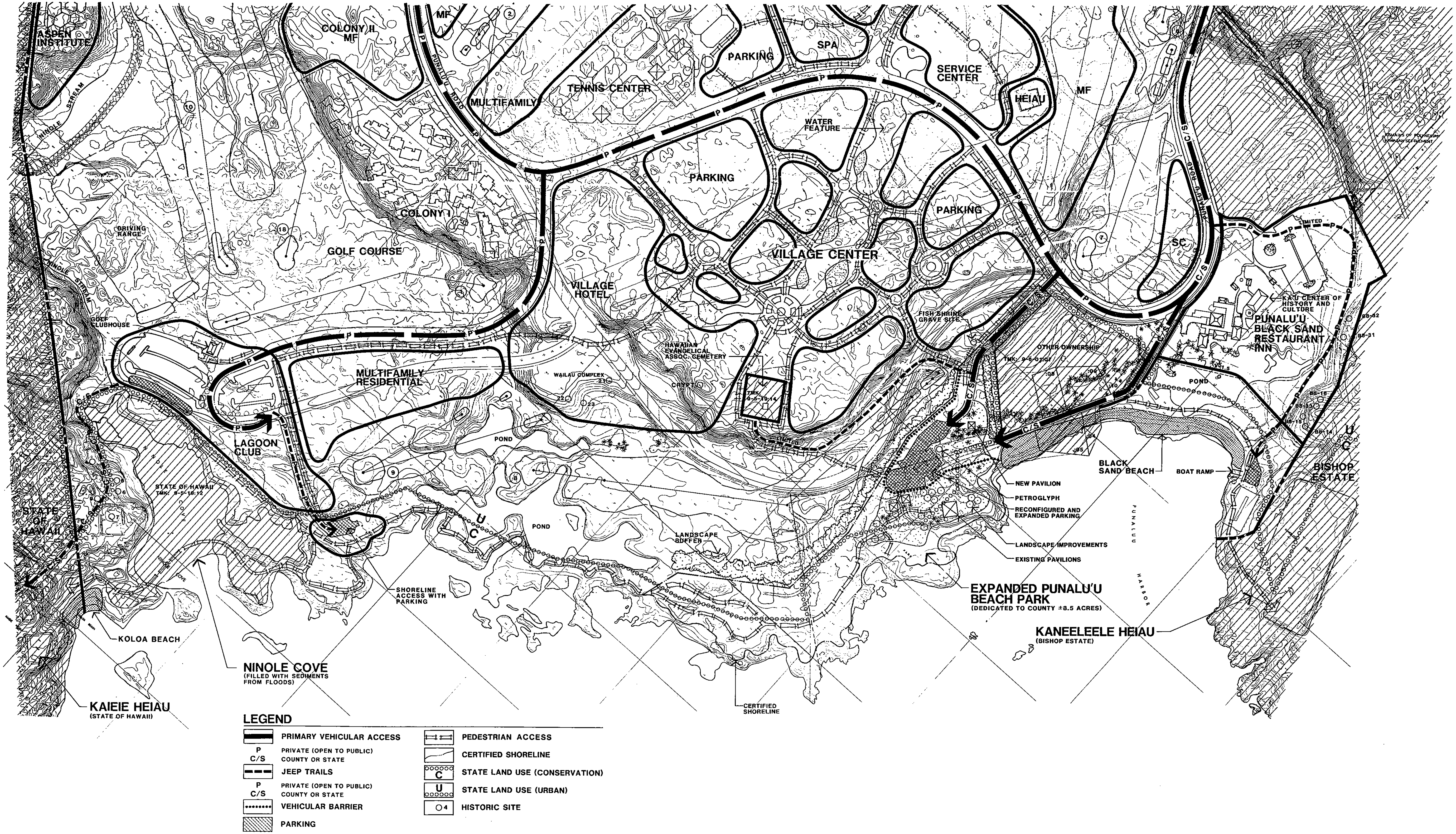
While it is difficult or impossible to quantify, a significant subsistence economy also exists in Ka'u. Traditional farming and fishing activities allow some people in the region to exist outside of the economic mainstream and others to supplement wage earnings. This is also characteristic of the Volcano and South Kona areas. In addition, the illegal cultivation of marijuana in many areas of the Big Island may result in a significant contribution to the area's cash economy, although it is virtually impossible to determine the specific size or impact.



EXISTING SHORELINE ACCESS

Punalu'u Resort

FIGURE IV-23



PROPOSED SHORELINE ACCESS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE IV-24

the capacity to accommodate the expected number of users of the beach/shoreline area. CBP would continue to work with appropriate state and county agencies to improve and maintain the quality of these recreational facilities and shoreline habitat areas.

To mitigate the closure of vehicular access to the shoreline areas, a series of nature trails and paths would be established along the shoreline. The specific location of the trails and paths would be developed in consultation with appropriate state and federal agencies. The trails and paths would be designed and located to provide adequate recreational opportunities while preserving and protecting environmentally sensitive nature areas and wildlife habitats.

Further, CBP would continue to encourage state and county agencies to improve and possibly enlarge existing recreational facilities in the region, such as Whittington Beach Park at Honuapo.

At present, the Punalu'u beach/shoreline areas including the County Punalu'u Beach Park and Ninole Cove areas, are used by Ka'u District and Big Island residents for fishing, swimming, sunbathing, picnicking, camping and organization meetings and gatherings. In addition, visitors to the island on circle island tours stop at the Black Sand Restaurant for lunch and visit the black sand beach area. Based on the coastal use survey performed for this EIS (see Appendix D), it is estimated that a maximum of 200 persons visit or use the beach/shoreline area on any given day. The majority of these people are on the circle island tours and are at the Resort for no more than approximately one hour on any given day.

The present and future beach/shoreline area covers about 25 acres, including Ninole Cove, the coastal pond areas and the black sand beach. The existing beach park is approximately 5.6 acres. Utilizing beach/shoreline capacity factors determined for other Big Island beach parks (Environs Pacific, Inc., 1985), it is estimated that the carrying capacity of the increased beach park and shoreline recreation areas would adequately meet the projected needs of the community and Resort.

The proposed beach park improvements include expanding the beach park at Punalu'u to approximately 8.5 acres and constructing a new pavilion and picnic areas that would increase the carrying capacity of the park. In addition, a new access road and parking area east of Ninole Cove would be developed so shoreline users can drive directly to the shoreline. According to the County Department of Parks and Recreation, proposed changes to the County liquor ordinance would not affect the hours of alcohol consumption at Punalu'u Beach Park.

To maintain and protect environmentally sensitive areas and for public safety reasons, vehicular access to the coastal ponds would be closed and two of the coastal ponds (Pond No. 1 and the dry mauka pond) would be closed to fishing and swimming activities. Similarly, overnight camping would be restricted to areas within the county beach park as specified by the County. Increased use of the swimming areas adjacent to the launching ramp could increase congestion and safety problems in that area.

7.3 MITIGATION MEASURES

Expanded development of the Resort would increase the level of activity at both Punalu'u Beach Park and Ninole Cove recreational facilities. To mitigate increased activity levels, Punalu'u County Beach Park would be expanded and a new shoreline access road and parking area would be constructed on the east side of Ninole Cove. The expanded Punalu'u Beach Park would be dedicated in fee to the county. Based on the projected use, it appears that the Punalu'u beach, shoreline and park areas have improved and parking enlarged from the present 35 stalls to 55 stalls. Parking for loading/unloading, short-term parking and handicap persons would also be provided. Realignment of Punalu'u Road mauka would provide an all-weather access and evacuation route. The realignment is required to accommodate the relocated 8th and 9th golf holes and the relocation of the former Ninole Cove Hotel to the Village Hotel site. As noted, vehicular access to the church and cemetery would be provided and has been agreed to by agreement between the owners of the church and cemetery (Hawaii Conference Foundation) and CBP. Access to parking within the golf clubhouse parking lot would continue to be provided and access to the shoreline in the Ninole Cove area would be provided. Access to the boat launching ramp area is to remain. The closure of vehicular access to the shoreline area fronting the Resort is expected to result in positive impacts through the protection of wildlife and environmentally sensitive areas. It is recognized that this restriction may be perceived as a hardship on some local residents. Pedestrian access to the shoreline and coastal pond areas would be maintained in compliance with applicable state and county rules and regulations.

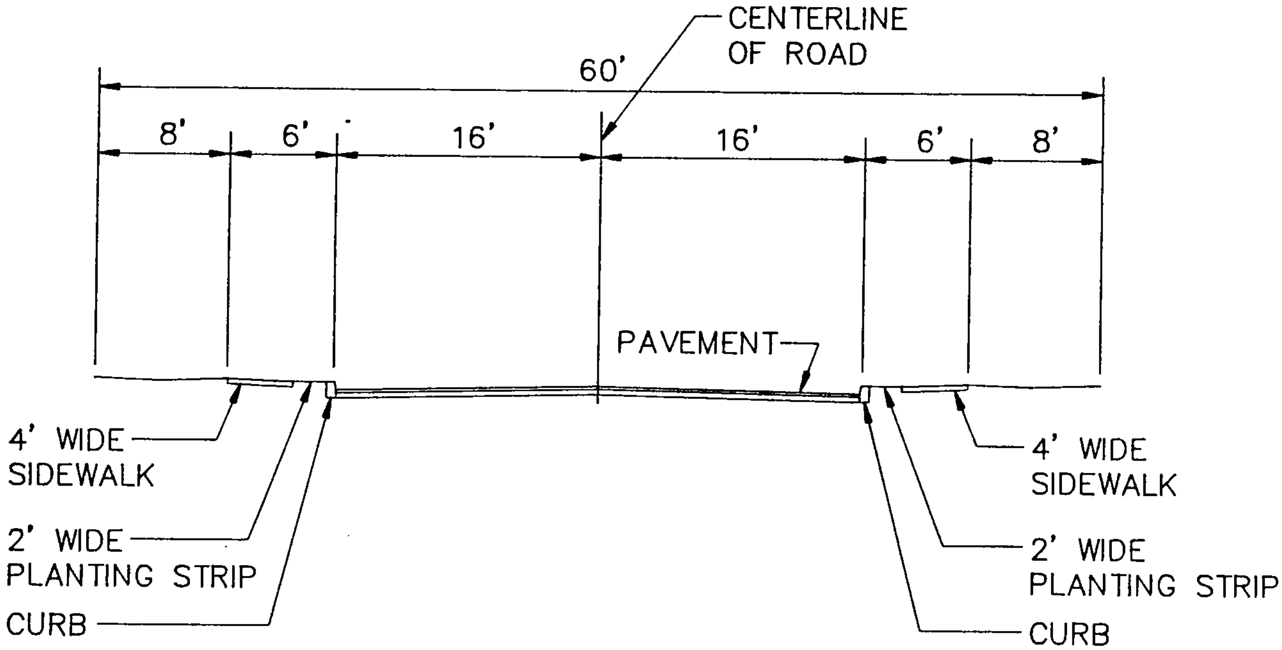
5.1.2.3 Mitigation Measures

As noted, the planned modifications to the Resort internal access roadways are expected to result in positive impacts to the movement of pedestrians and traffic. As such, measures to mitigate potential adverse impacts do not appear warranted at this time. Should future conditions indicate that adverse impacts are being experienced, appropriate mitigations measures would be taken.

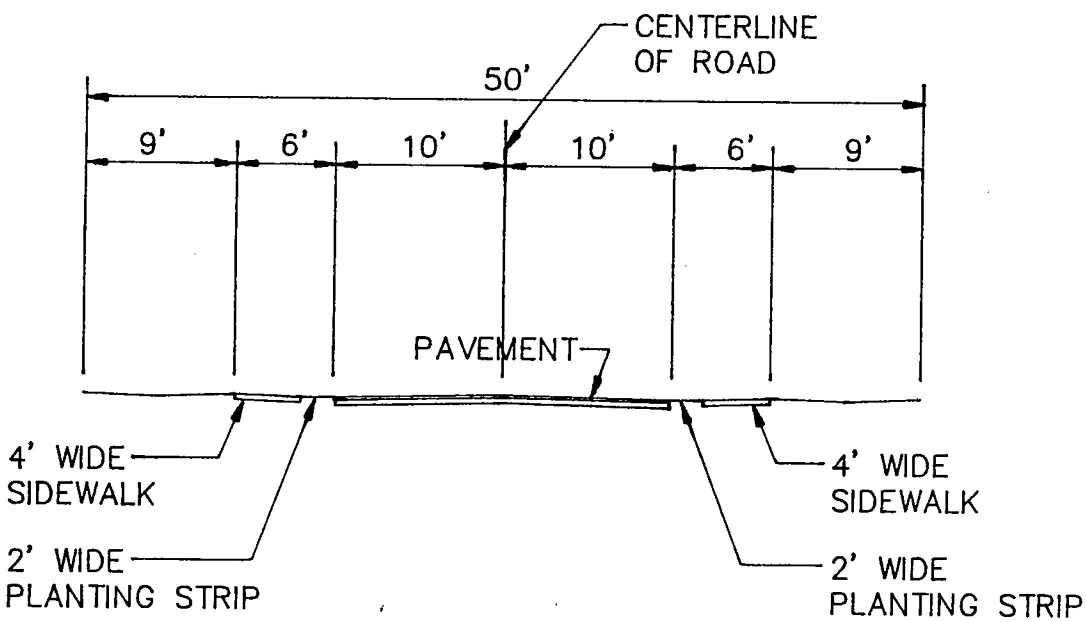
5.1.3 <u>Shoreline Access</u>

5.1.3.1 Existing Conditions

As noted previously, public access to the shoreline, beach park, coastal ponds and heiau flanking the Resort boundaries is provided via two routes: (1) Alanui Road (Punalu'u Road), the primary Resort access road that is the privately owned portion of Punalu'u Road running through the center of the Resort from the Hawaii Belt Highway; and (2) the county portion of Punalu'u Road which intersects with the Hawaii Belt Highway approximately 3,500 feet northeast of the Alanui Road/Belt Highway intersection. The county portion of Punalu'u Road enters the Resort boundaries mauka of the Punalu'u Black Sand Restaurant and proceeds to the beach park parking lot. Access to the Ninole Cove, Kaieie heiau and golf course clubhouse areas is provided via Ninole Cove Place which runs southwestward off Alanui Road makai of the Colony I condominiums. Direct shoreline and coastal



PUNALU'U ROAD



MINOR STREETS AND CUL-DE-SACS

TYPICAL ROADWAY CROSS-SECTIONS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

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FIGURE IV-25

pond access is now via several jeep trails leading from Alanui Road. The majority of the jeep trails are on CBP property (see Figure IV-23).

5.1.3.2 Proposed Shoreline Access

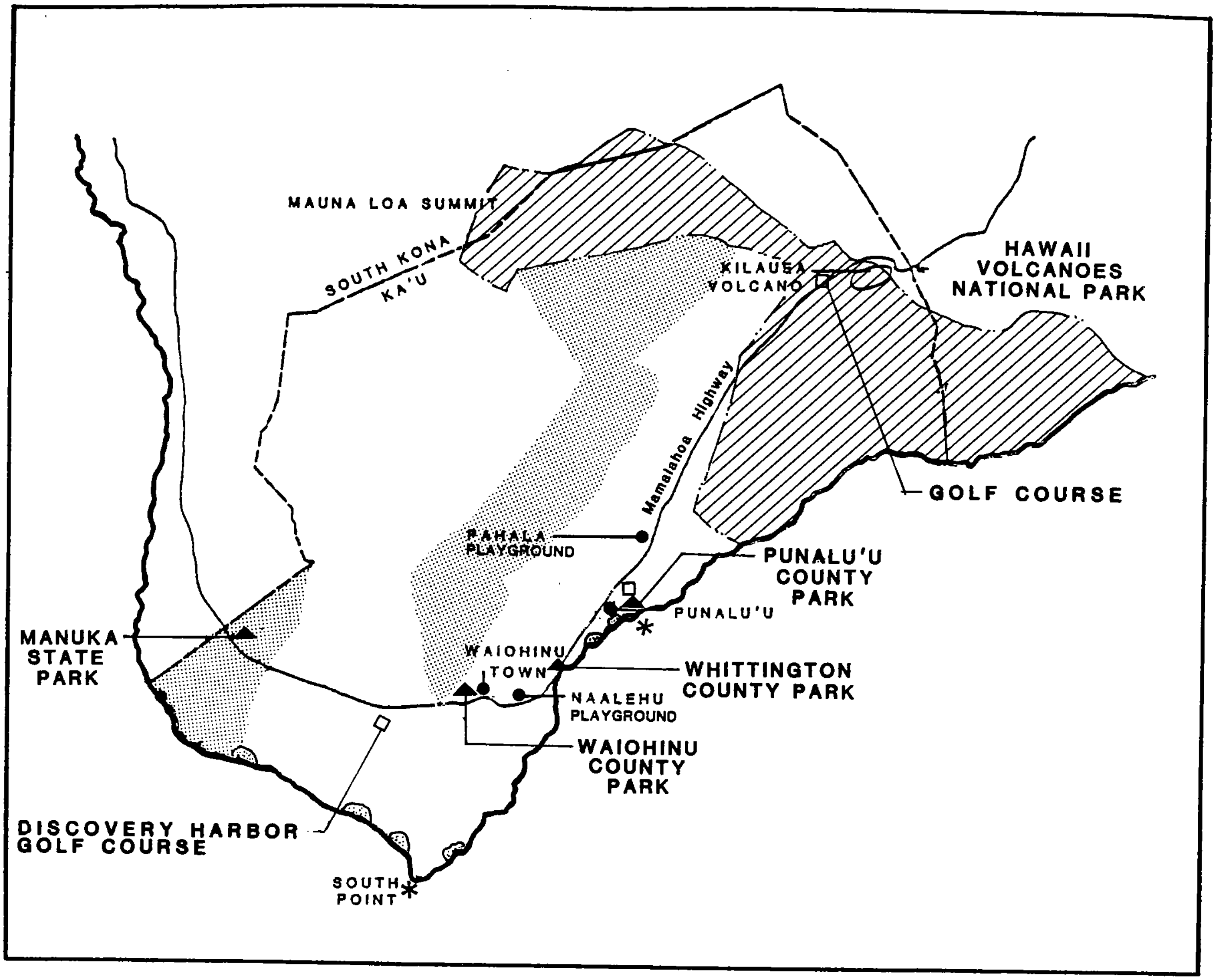
From the inception of the Punalu'u Resort project in the early 1970's, CBP has negotiated with the State of Hawaii regarding ways to ensure continued public access to the coastline between Ninole Cove and Punalu'u Bay in a way that was compatible with the development of the Punalu'u Resort. At a meeting on July 28, 1972, the Board of Land and Natural Resources ("BLNR") approved the conveyance to C. Brewer of an abandoned 15-foot wide "Old Government Trail" and an abandoned 50-foot wide "Old Government Road" located on land owned by C. Brewer. See Figure IV-26. The BLNR's approval of these conveyances was conditioned, in part, upon "Prior completion of the planned subdivision roads and acceptance by the County of Hawaii by dedication as public roads." Subsequently, in letters to C. Brewer dated April 9, 1981 and July 21, 1985, the Chairman of the BLNR informed C. Brewer that the County would not accept dedication of the resort roadways because they were considered "private interior roads" and, in lieu of such dedication, that C. Brewer grant "a perpetual easement to the State of Hawaii to provide public access over selected resort roadways to Ninole Cove and beach areas."

The negotiations between C. Brewer and DLNR regarding public shoreline access culminated in October 1986 with the recordation of the following conveyance documents: (1) Quitclaim Deed conveying the "Old Government Road" from the State to C. Brewer; (2) Quitclaim Deed conveying the "Old Government Trail" from the State to C. Brewer; and (3) Easement Agreement granting various public access easements to the Punalu'u shoreline from C. Brewer to the State.

Figure IV-26 graphically depicts the areas covered by the two Quitclaim Deeds as well as the location of the various public shoreline access easements granted to the State. The background, nature and legal status of the two Quitclaim Deeds and the Easement Agreement are discussed below.

Quitclaim Deed - Old Government Trail

The Quitclaim Deed for the "Old Government Trail" covers an existing trail approximately 15 feet wide that runs in an east-west direction along the coast as shown in Figure IV-26. The Quitclaim Deed conveys to C. Brewer a portion of the Old Government Trail containing an area of 33,480 square feet (0.769 acres).



LEGEND

- ✱ BOAT LAUNCHING
- SANDY BEACHES
- □ GOLF COURSE
- HUNTING AREAS
- ▲ PARKS

SOURCE: COUNTY OF HAWAII DATA BOOK 1980, DEPT. OF RESEARCH AND DEVELOPMENT, HILO, HI, 1980 ATLAS OF HAWAII, DEPT. OF GEOGRAPHY, UNIVERSITY OF HAWAII, HONOLULU, HI, 1983

KA'U REGIONAL RECREATIONAL FACILITIES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

MILES 0 1 2

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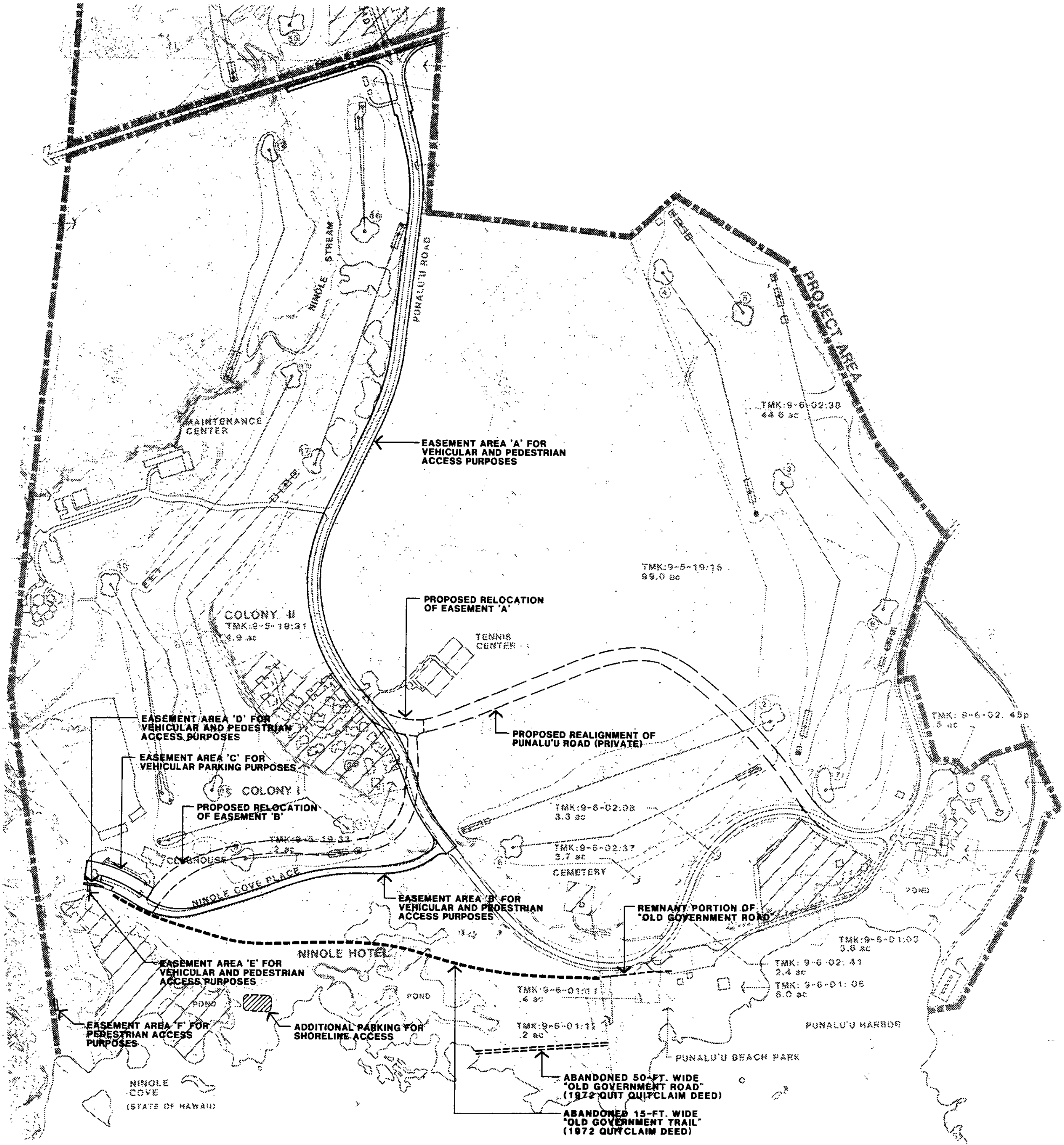
FIGURE IV-28



PUBLIC SHORELINE EASEMENTS

Punalu'u Resort

KA'U, ISLAND OF HAWAII

NORTH SCALE 200 0 200 600 FEET

OCTOBER 1987

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FIGURE IV-26

provision of reliable and continuous electrical power and communications to the Resort.

7. RECREATIONAL FACILITIES

7.1 EXISTING CONDITIONS

Neighborhood parks and school yards in Pahala and Na'alehu provide limited recreational opportunities for the residents of Ka'u District (Figure IV-28). These facilities include gyms, tennis courts and community centers. Safe beach swimming areas in Ka'u are limited to Whittington Beach Park (0.8 acre) in Honuapo Bay and Punalu'u Beach Park (5.6 acres)) within the Resort. The County beach pavilion at Punalu'u Beach Park is used by Ka'u District community groups for picnics, meetings and general gatherings. South Point offers unique scenic landscape, historic sites and good fishing. The County Kamaoa park site (28.8 acres) is presently undeveloped. Manuka State Botanical Park, the Kilauea State Recreation Area and Hawaii Volcanoes National Park offer other unique recreational opportunities. The District's forest reserve has limited access. Both the 18-hole Volcano Golf Course and Punalu'u Resort Golf Course, although privately owned, are open to the public. Shoreline and ocean fishing are enjoyed by the residents of Ka'u and is practiced wherever access to the shoreline is provided. Boat launching ramps are located at the Resort and at Kaulana Bay at South Point. It is noted that the County Department of Parks and Recreation does not consider either Punalu'u or Whittington County beaches at "safe". CBP will be installing signs around the Beach Park and black sand beach areas advising people of the unsafe conditions.

7.2 IMPACTS ON RECREATIONAL FACILITIES

The proposed project is, in part, designed to increase and improve the recreational opportunities of the residents of Ka'u District as well as visitors to the Resort. Access to Punalu'u Beach Park would be relocated and improved and the beach park expanded from its present 5.6 acres to approximately 8.5 acres with the addition of a new pavilion and landscaped play and picnic areas. The Punalu'u Beach Park parking lot would be expanded from 35 stalls to 50 stalls and the golf clubhouse/Ninole Cove Park parking lot would be expanded as necessary, based on demonstrated use and need. The increased recreational facilities and opportunities are considered to be positive impacts benefiting both the residents of Ka'u District and island of Hawaii as well as visitors to the Resort.

Streetlights would be installed along the makai side of the Resort internal roads. The location of the emergency warning system for tsunamis and hurricanes would also be reviewed and relocated if necessary. Utilities would be installed according to their respective standards.

The Hawaii Electric Light Company (HELCO) estimates that the electrical demand of the proposed development would be 6200KVA. The Honuapo Substation cannot support this electrical requirement alone. In addition, HELCO's normal practice in serving resort complexes is to provide two independent circuits to assure continuity of service in the event of a service disruption.

The proposed development would require, at minimum, a new 7500KVA 69-12KV substation to provide a primary source of electricity. The substation would be located on or near the Resort on C. Brewer property and on a minimum lot size of 120 ft. x 120 ft. (0.33 acres).

6.8.2 Impacts on Electrical Power and Communications

Positive impacts due to the installation of power/ telephone utilities are anticipated. Installation of the new substation would result in the clearing of 0.33 acres of land adjacent to the Hawaii Belt Highway. There would be short-term impacts in the vicinity due to construction work. After construction, the substation would be visible from the highway. However, it would be appropriately landscaped to minimize its visual impact. Additionally, depending on the final location of the substation, overhead power transmission lines from the substation to the underground distribution lines may be required. Should overhead lines be required, minor visual impacts may be experienced.

As an added conservation measure, the developer would analyze the possibility of utilizing roof mounted solar panels for hot water and, possibly, air conditioning purposes. Should this alternative prove feasible, reductions in electrical power requirements may be possible.

6.8.3 Mitigation Measures

Based on the planned Resort improvements to the electrical power and communications systems, the lack of impacts to the remainder of the district electrical power and communications systems and the potential use of solar panels for water heating and air conditioning, additional mitigation measures do not appear warranted at this time. Should future conditions indicate, appropriate measures would be taken to ensure the continued

At a public hearing conducted on July 28, 1972, Board of Land and Natural Resources ("BLNR") found that it was in the public interest to abandon the Old Government Trail and to sell a portion of the Government Trail to C. Brewer on the condition that the "public shall, at all times, have full and uninterrupted passage along the coast and access to Ninole Cove and other beach areas" satisfactory to State of Hawaii, Department of Land and Natural Resources ("DLNR").

Pursuant to BLNR approval, the State conveyed a portion of the Old Government Trail to C. Brewer for $11,048 via a Quitclaim Deed which was recorded on October 16, 1986 in Liber 19952, p. 59. In conjunction with this conveyance, C. Brewer conveyed to the State various easements for public shoreline access via an Easement Agreement as discussed below. This deed is currently going through the required approval process. C. Brewer anticipates that the process will be completed by mid-1988.

In February 1988, C. Brewer formally initiated negotiations with the DLNR to acquire a remnant portion of the Old Government Trail which was not conveyed under the Quitclaim Deed. This remnant portion, which is shown on Figure IV-26, was not included in C. Brewer's earlier negotiations with BLNR due to the fact that the land surrounding the remnant was then owned by Bishop Estate. C. Brewer subsequently acquired the land surrounding the remnant from Bishop Estate in 1984. In order to accommodate the current Master Plan for the Punalu'u Resort, C. Brewer has initiated formal negotiations with BLNR to acquire the remnant portion of the Old Government Trail.

Quitclaim Deed - Old Government Road

The Quitclaim Deed for the "Old Government Road" covers an abandoned road approximately 50 feet wide containing an area of 50,416 square feet (1.158 acres) in two parcels: (1) 47,648 square feet (1.094 acres); (2) 2,768 square feet (0.64 acres). As shown in Figure IV-26, the Old Government Road runs in an east-west direction along the coast and has been partially washed away by the wash of the waves.

At a public hearing conducted on July 28, 1972, the BLNR declared this portion of the Old Government Road to be a "remnant" and found that it was in the public interest to sell a portion of the Old Government Road to C. Brewer on the condition that the "public shall, at all times, have full and uninterrupted passage along the coast and access to Ninole Cove and other beach areas" satisfactory to State of Hawaii, Department of Land and Natural Resources ("DLNR").

Pursuant to BLNR approval, the State conveyed a portion of the Old Government Trail to C. Brewer for $16,941 via a

6.7.2 Impacts of Solid Waste Disposal

With the addition of the planned resort and residential units, solid waste generation is projected to increase by up to 54,360 pounds/day. Using an approximate density of 24 pounds/cubic foot of loose refuse, the ultimate solid waste generation of 60,800 pounds per day is equivalent to 2,530 cubic feet/day.

Collection of solid waste from the Resort facilities (hotels, restaurants, golf clubhouse, single- and multifamily residential units and commercial operations) would be performed on at least a twice weekly basis to maintain proper vector and odor control. Collection and disposal operations would be performed in compliance with appropriate state and county rules and regulations. Disposal would be accomplished by either public or private services in compliance with county Department of Public Works requirements, capabilities and performance standards within the community. Disposal could occur at the county operated solid waste transfer station in Ka'u, at the state approved county sanitary landfill in Hilo or at a presently unidentified site mutually agreed upon by CBP and the county.

6.7.3 Mitigation Measures

As noted above, solid waste collection and disposal would be performed in compliance with state and county rules and regulations and capabilities. Solid wastes would be disposed of at an approved disposal site(s). Additional mitigation measures do not appear warranted at this time. Should future conditions indicate, appropriate measures would be taken to ensure that solid wastes are continued to be collected and disposed of properly.

6.8 ELECTRICAL POWER AND COMMUNICATIONS

6.8.1 Existing Conditions

Power and telephone utilities are currently being provided to all existing residences and facilities in the planning area, including Punalu'u Black Sand Restaurant, the Golf Clubhouse, the Tennis Center, Aspen Institute of Humanistic Studies, the wastewater reclamation plant, and Colony I. Electrical service is currently being supplied via a single 12KV circuit from the 1500KVA 69-12KV Honuapo Substation located about four miles away.

Electricity, telephone and cable television services would be extended to all future residences and facilities. Electrical and telephone distribution lines would be buried in underground conduits within the sidewalk or shoulder area.

Quitclaim Deed which was recorded on October 16, 1986 in Liber 19952, p. 67. In conjunction with this conveyance, C. Brewer conveyed to the State various public access easements to the shoreline and to a segment of an ancient kerbstone trail via an Easement Agreement as discussed below. Furthermore, the Cultural Resource Management Plan for the Punalu'u Resort calls for the preservation of visible segments of the trail and provides for signs and interpretive displays explaining the historical significance of the kerbstone trail.

Since the BLNR approved the sale of this road and since the quitclaim deed has been recorded, this conveyance has been consummated and C. Brewer now owns this portion of the Old Government Road.

Easement Agreement - Public Shoreline Access

As a condition to BLNR approval of the two quitclaim deeds discussed above, and in lieu of the dedication of the internal resort roadways to the County, C. Brewer was required to provide the public with "full and uninterrupted passage along the coast and access to Ninole Cove and other beach areas satisfactory to DLNR." In satisfaction of this condition, C. Brewer conveyed to the State six shoreline access easements (designated A - F) via an Easement Agreement which was recorded on October 16, 1986 in Liber 19952, p. 76. See Figure IV-26. The easements conveyed to the State are described as follows:

(1) Easement A: Easement for pedestrian/vehicular access running the length of Alanui Road in its present configuration, consisting of 5.75 acres;

(2) Easement B: Easement for pedestrian/vehicular access running the length of Ninole Cove Place, consisting of 1.838 acres;

(3) Easement C: Easement for vehicular travel and parking in roughly the same area where parking lot for golf clubhouse is located, consisting of 19,390 square feet;

(4) Easement D: Easement for pedestrian and vehicular travel in the general area of Easement C, consisting of 496 square feet;

(5) Easement E: Easement for pedestrian travel only, and excludes vehicular travel including bicycles, motorcycles and other wheeled vehicles, in an area adjacent to Easement D, consisting of 296 square feet; and,

TABLE IV-56

Solid Waste Generation Projections

Area	Zoning	Planned Maximum # Units	Estimated Population	Refuse Generation Equivalents[1] (lb/capita)	Solid Waste (lb/day)
PSBR Complex & Inn	V-1.5	210	588	6	3,530
Restaurant (200 seats, 1800 patrons/day)	--	--	--	2	3,600
Bar (100 seats, 500 patrons/day)	--	--	--	1	500
Village Hotel & MF Res./Condo	V-1.0 & RM-2.0	280	784	6	4,700
Golf Clubhouse (300 patrons/day)	--	--	--	2	600
Village Center	V-1.5	770	2,156	6	12,900
Central	RM-2.5	1,008	2,822	6	16,900
Colony I (Existing)	RM-2.0	76	213	6	1,280
Colony II	RM-2.0	96	269	6	1,610
Aspen Institute	RM-5.0	0	0	0	0
Ninole Bluffs	RM-2.5	315	882	6	5,290
Kalana I (Existing)	RS-20	19	76	6	460
Kalana II	RS-15	78	312	6	1,870
Kalana III	RM-3.0	450	1,260	6	7,560
TOTAL		3,302	9,362		60,800

[1]From "Engineering Report Covering the Civil Improvements for the SeaMountain Club of Hawaii," March 1974.

Note: Number of Planned Maximum Number Units overstated in analysis to provide a conservative engineering estimate of solid waste generation.

(6) Easement F: Easement for pedestrian travel only, and excludes vehicular travel including bicycles, motorcycles and other wheeled vehicles, in an area on the tip of the Old Government Trail located between the southwestern border of the C. Brewer property and the southwestern border of Ninole Cove for the sole purpose of providing access to a "kerbstone" trail, consisting of 543 square feet.

The above referenced easements have been effectively transferred from C. Brewer to the State and are in full force and effect as of the date of the Easement Agreement (9/26/86).

Since the road alignments for Alanui Road and Ninole Place will change pursuant to the latest Punalu'u Resort Master Plan, the locations and areas of various easements will need to be changed to conform to the new road alignments. The Easement Agreement allows C. Brewer to change the easement areas as long as such changes do not adversely affect the public's use of the easements.

5.1.3.3 Impacts on Shoreline Access

Impacts on shoreline access as a result of the proposed Resort project are expected to be minor. The relocation of Alanui Road (Punalu'u Road) mauka above the bluff to accommodate the Village Hotel and Center and relocated golf holes would not affect access to the beach park or coastal area other than by changing the present access route. Uninterrupted access via Alanui Road would continue to be provided to the beach park parking area, which would be expanded. Similarly, relocating Ninole Cove Place would not affect access other than changing the route slightly. Uninterrupted public access via the realigned Ninole Cove Place would continue to be provided to the public. Access to the coastal ponds and shoreline will be affected by closure of jeep and foot trails that currently pass over CBP property. However, access via jeep or foot trails on State property could be available if allowed by the State and/or county. To accommodate the proposed realignment of Alanui Road, Easement A as described above, would be redescribed and modified. As noted, uninterrupted public access for pedestrian and vehicular traffic would continue to be provided. Additionally, the description of Easement B would be modified to accommodate the proposed relocation of Ninole Cove Place.

To eliminate potential health hazards associated with sewage spills and inadequate treatment, the following action will be taken. In accordance with State Department of Health Regulations and County of Hawaii Standards, all critical functions of the treatment plant and sewage pump stations will be equipped with 100 percent backup, or redundant, capacity. An alarm system indicating abnormal liquid levels in the treatment tanks will sound to provide warning to the plant operator of an imminent problem. This warning will sound early in advance to allow the operator sufficient time to correct the problem or switch to standby units. In addition, all critical equipment will be connected to an emergency generator. This generator will turn on whenever the main power from HELCO is interrupted.

6.6.3 Mitigation Measures

Measures that have been taken to ensure adequate wastewater treatment and disposal are described above. Based on these measures, it appears that additional mitigation measures to minimize potential adverse impacts are not required. CBP would continue to monitor wastewater treatment and disposal in accordance with applicable federal, state and county rules and regulations. Should future conditions indicate, additional measures would be taken to ensure that adequate wastewater treatment and disposal are provided.

6.7 SOLID WASTE DISPOSAL

6.7.1 Existing Conditions

Data for current solid waste generation is minimal. Estimates for current generation as well as future projections are based on the "Engineering Report Covering the Civil Improvements for the SeaMountain Club of Hawaii" (March 1974) and are shown in Table IV-56. The estimated maximum population is based on the same capita-per-unit assumptions used in the wastewater flow projections. A unit generation rate of six pounds/capita/day was used for all residential units. For the restaurant and bar at Punalu'u Black Sand Restaurant and the Golf Clubhouse, generation rates of two pounds/patron, one pound/patron and two pounds per patron respectively, were used. Table IV-56 shows that the existing facilities, which consist of Punalu'u Black Sand Restaurant, the Golf Clubhouse, Colony I and Kalana I, are generating up to 6,440 pounds/day of solid waste.

5.1.3.4 Mitigation Measures

Due to the lack of expected impacts on shoreline access as a result of the proposed project, mitigation measures to minimize potential adverse impacts do not appear warranted at this time.

5.2 AIRPORTS

5.2.1 Existing Conditions

The Resort is serviced by two major airports; Hilo (General Lyman Field) and Keahole Airport. Both are operated by the State Department of Transportation. Hilo Airport is capable of handling large, wide-bodied aircraft (B-747 and DC-10) and Ke'ahole Airport is being upgraded to handle larger aircraft.

Punalu'u Resort is located approximately 60 miles southwest of Hilo and 70 miles southeast of Kailua-Kona (Keahole Airport) on west Hawaii and is not expected to significantly impact the operations of either of the two state airports. The loss of direct mainland air service to/from Hilo in 1986 is not expected to affect the proposed project due to the number of interisland air carrier flights and the initiation of direct mainland air service to Keahole Airport.

5.2.2 Impacts on Airports

As noted previously, both major airports serving the island and the Resort are presently capable of handling the forecast increased number of visitors to the island and Resort. As such, no impacts to the air transportation facilities of the island are expected to result from the proposed project. It is noted that the State Department of Transportation reviews actual and forecast air passenger movements at each airport and takes whatever action is required to ensure that the airports adequately serve the needs of the State. Improvements to Ke'ahole Airport are planned and are only indirectly tied to the proposed project.

5.2.3 Mitigation Measures

The proposed project is not expected to impact the island airports. As such, mitigation measures do not appear warranted at this time. Should future conditions change, appropriate mitigation measures would be taken.

From the Babbit equation referenced in the design standards, the maximum flow factor for the planning area's population of 9,740 persons is 3.17. The total average wastewater flow is multiplied by this factor to yield the maximum wastewater flow as shown below:

Maximum Wastewater Flow = 779,160 x 3.17 = 2,469,940 gpd

The peak wastewater flow is the sum of the maximum wastewater flow and total infiltration. Hence,

Peak Wastewater Flow = 2,469,940 + 6,430 = 2,476,370 gpd

In summary, wastewater flow projections for the planning area, including flows from existing subdivisions, are as follows:

Average Wastewater Flow at 100% occupancy = 0.82 mgd
Maximum Wastewater Flow at 100% occupancy = 2.47 mgd
Peak Wastewater Flow at 100% occupancy = 2.48 mgd

This ultimate average wastewater flow would not completely satisfy the irrigation requirements for an 18-hole golf course. Potable water is required to supplement the irrigation demand of the golf course.

6.6.2 Impacts on Wastewater Treatment and Disposal

Impacts due to the expansion of the existing wastewater collection and treatment system are not expected. All elements of the system would be designed and constructed in accordance with applicable federal, state and county standards. The existing secondary treatment level is considered to be more than adequate for the Resort. Disposal of the treated wastewater effluent for irrigation of the golf course and landscape areas is considered to be an effective and environmentally benign and acceptable method of disposal as described previously in Section 2.4.1.2 of this Chapter.

During periods of intense, prolonged rainfall, it is potentially possible that treated wastewater disposal into the storage ponds would exceed the ponds' capacity if it is assumed that golf course irrigation were to stop. However, to prevent the ponds from overflowing, it is likely that irrigation would continue. As such, the treated effluent would be significantly diluted by the rainfall prior to percolation into or runoff from the golf course. An alternative measure would be to place berms around the 17th golf fairway, thereby creating a retention basin that would be capable of storing approximately 15 to 30 days effluent discharge. Both possible methods of handling the treated wastewater effluent during intense, prolonged rainfall periods are still under investigation.

5.3 HARBORS

5.3.1 Existing Conditions

The major harbors serving the Resort, at present and for the foreseeable future, are Hilo Harbor in east Hawaii and Kawaihae Harbor in west Hawaii. Both harbors are operated by the State Department of Transportation and are adequate to serve the commercial needs of the proposed project. Punalu'u Harbor boat launch ramp at the project site, is a small, privately owned boat launching facility for local fishing and pleasure craft. The boat launch ramp is owned and maintained by CBP. The proposed project does not include plans to alter the launch ramp. Access to the ramp will be slightly changed by providing an access roadway along the eastern portion of the Resort (Figure IV-24). The access road and ramp will continue to be open to all users of the facility.

5.3.2 Impacts to Harbor Facilities

As with air transportation facilities, the major commercial harbors on the island are capable of handling forecast increases in service that may be required for the Resort improvements. Punalu'u Harbor would be affected by the project to the extent that the proposed new access road along the eastern side of the Resort would provide access to the harbor without the need to transit through the lower portion of the Resort. This new access is expected to be a positive impact to the users of the boat launching facilities. No other changes to the boat launch ramp area are planned.

5.3.3 Mitigation Measures

The proposed project is not expected to impact the commercial harbors of the island. Impacts to the recreational harbor facilities (boat launch ramp) are expected to be positive. As such, mitigation measures do not appear to be warranted at this time. Should conditions change in the future, appropriate measures would be taken.

TABLE IV-55

Wastewater Generation Projections

Area	Zoning	Gross Acreage	Planned Maximum # Units	Estimated Population	Average Wastewater Flow (GPD)	Infiltration[1] (GPD)
PSBR Complex & Inn	V-1.5	7.0	210	588	47,000	175
Village Hotel & MF Res./Condo	V-1.0 & RM-2.0	11.4	280	784	62,720	285
Village Center	V-1.5	37.0	770	2,156	172,500	925
Central	RM-2.5	63.8	1,008	2,822	225,800	1,595
Colony I (Existing)	RM-2.0	5.4	76	213	17,000	135
Colony II	RM-2.0	4.9	96	269	21,500	123
Ninole Bluffs	RM-2.5	23.8	315	882	70,600	595
Kalana I (Existing)	RS-20	10.9	19	76	6,100	272
Kalana II	RS-10	40.3	78	312	25,000	1,008
Kalana III	RM-3.0	35.0	450	1,260	100,800	875
Subtotal		239.5	3,302	9,362	749,020	5,988
Commercial:						
Punalu'u Restaurant	--	5.6	--	1,000 patrons/day	10,000	140
Tennis Center	--	7.9	--	180 visitors/day	1,800	198
Golf Clubhouse	--	1.9	--	180 visitors/day	4,500	47
Aspen Institute	RM-5.0	2.7	--	200 visitors/day	1,000	67
New Commercial (Lagoon Club)	--	5.0	--	4,280 visitors/day	12,840	125
TOTAL					779,160	6,430

[1]Based on 25 GPD/Acre from "Engineering Report on Conceptual Plan of Modular Wastewater Reclamation Facilities for Administration, Inc." March 1971.

Source: R.M. Towill Corp. 1986. Engineering Report for Punalu'u Resort Report Prepared for Phillips, Brandt, Reddick & Assoc. (Hawaii), Inc.

Note: Number of Planned Maximum Number Units overstated in analysis to provide a conservative engineering estimate of Average Wastewater Flow.

6. PUBLIC SERVICES AND FACILITIES

6.1 SCHOOLS

6.1.1 Existing Conditions

The Ka'u School Complex (K-12), located in Pahala, and Na'alehu School (K-8) presently serve the Resort area (Figure IV-27). Ka'u School currently (1986) has an enrollment of 551 students versus 681 in 1971. Na'alehu School has a current (1986) enrollment of 357 students versus 340 in 1971. It is expected that the proposed project would cause an increase in the population levels of both communities due to increased employment opportunities at the Resort.

6.1.2 Impacts on Schools

The State Department of Education has estimated that the proposed project would generate the following student enrollment:

School	Grade	Approximate Enrollment
	K- 6	50-100
Ka'u High and Pahala Elementary	7- 8	20- 30
	9-12	25- 40

Ka'u High and Pahala Elementary, a Kindergarten through grade 12 school, are presently operating at capacity. Additional classrooms may be required at the affected schools to accommodate projected growth in the service area.

The expected increase in population and employee levels would result in an increased number of students attending both Ka'u High and Pahala Elementary Schools. The Department of Education has not indicated any effect on Na'alehu School. While the impact on staffing levels and facility requirements may be significant, it is difficult to quantify at this time due to the reasons cited above. However, it is expected that the impact would be positive due to increased educational staff employment opportunities and potentially new school facility construction. [Note: See market analysis for estimates of tax revenues versus public expenditures.]

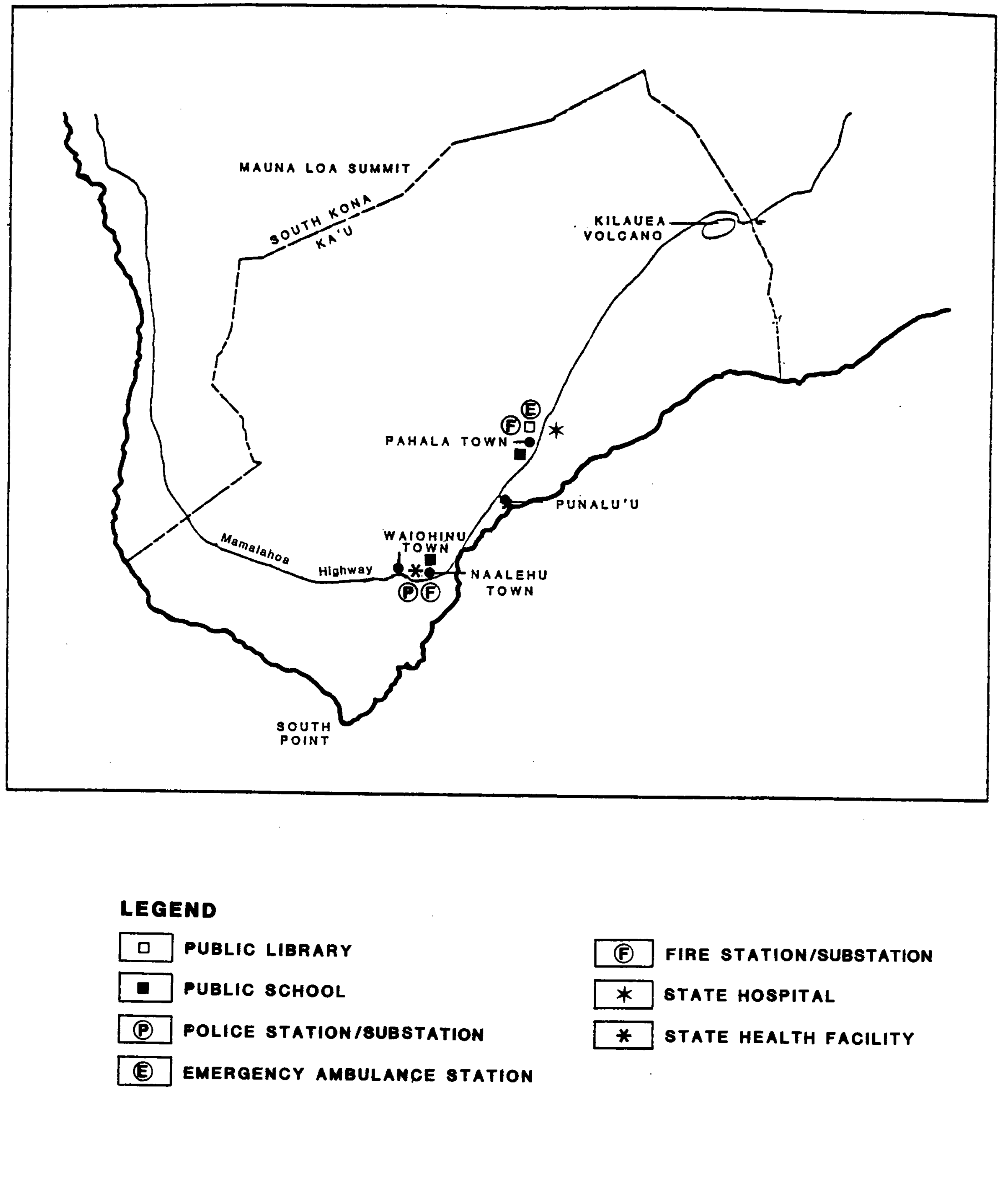
bined flows from Kalana and Ninole Bluffs would then gravity flow to the wastewater reclamation plant.

The majority of the new flow would connect to the existing 10-inch and 12-inch gravity sewer lines in Punalu'u Road. The realigned portion of Punalu'u Road would have new 6-inch and 8-inch gravity sewer lines which would connect to the existing sewer line. Sewage would flow to the Ninole Lift Station and would be pumped to the wastewater reclamation plant through the two existing 6-inch force mains. This lift station would be expanded from 325 gpm to 1,500 gpm in order to handle a peak flow of 2,164,000 gpd.

A small portion of the new flow from the Central area would be diverted to the Punalu'u Lift Station. This lift station would be expanded to 370 gpm in order to handle a peak flow of 529,800 gpd. Flows collected at this point would be pumped to Ninole Lift Station through a 6-inch force main under the realigned Punalu'u Road. From there, it would be pumped through the existing force mains to the wastewater reclamation plant.

The wastewater reclamation plant would be augmented by modular expansion to process future wastewater flows. Project Projections for wastewater generation were based on the "Design Standards of the Division of Wastewater Management" of the City and County of Honolulu (February 1984), Chapter 57 of the State Department of Health Regulations and "Wastewater Engineering," Metcalf and Eddy (1979). For this residential/resort complex, the flows generated would be essentially domestic wastewater. Based on the above mentioned design standards, the population densities used were 4.0 persons per unit for single family residences (RS), and 2.8 persons per unit for multiple family residences (RM) and resort units (V). The planned maximum number of units for each resort and residential area were used with these densities to determine the estimated maximum population at 100 percent occupancy. Also from the design standards, a wastewater generation rate of 80 gallons per capita per day was used to obtain the basic wastewater flow. For the commercial areas, 5 gpd per visitor was used for Aspen Institute, 10 gpd per patron for Punalu'u Restaurant and the Tennis Center, 25 gpd per visitor for the Golf Clubhouse and 3 gpd per visitor for the new commercial area. Wastewater generation projections are shown in Table IV-55.

Wastewater flows as generated by the existing residents have been included in the projections shown in Table IV-55. Infiltration flows were also included to determine total wastewater flows. A unit infiltration rate of 25 gpd/acre was used as given in the "Engineering Report on Conceptual Plan of Modular Wastewater Reclamation Facilities for Administration, Inc." (March 1971).



KA'U DISTRICT PUBLIC FACILITIES

Punalu'u Resort

KA'U, ISLAND OF HAWAII

FIGURE IV-27

Chapter 20, Title 11, Administrative Rules and would be subject to the approval of the State Director of Health. Modifications to the wells would also comply with State Department of Land and Natural Resources Administrative Rule, Title 13, Chapter 166.

6.5.3 Mitigation Measures

Based on the proposed water supply system expansion described above and compliance with appropriate state and county rules and regulation affecting potable water supplies and distribution systems, it appears that additional mitigation measures are not required. Should future conditions change, appropriate measures would be taken to ensure a reliable and continued supply of potable water for the proposed Resort.

6.6 WASTEWATER TREATMENT AND DISPOSAL

6.6.1 Existing Conditions

The existing wastewater collection system consists of gravity flow sewer lines, force mains and two lift stations which transport the existing wastewater flows to a wastewater reclamation plant. The Punalu'u Lift Station, located near the Punalu'u Black Sand Restaurant, pumps wastewater from the restaurant to the Ninole Lift Station through a force main along the existing Punalu'u Road. The Ninole Lift Station also receives wastewater which originates from the Kalana subdivision area and gravity flows along Alahaki Road under the State Highway and down Punalu'u Road through a 10-inch and 12-inch sewer lines. The Ninole Lift Station has an existing capacity of 325 gpm. It pumps the merged flows to the wastewater reclamation plant through a 6-inch force main which crosses under the fairways of golf hole Nos. 1, 18 and 11. The existing wastewater reclamation plant has a capacity of 0.18 mgd. The wastewater effluent is pumped to storage ponds along the 17th fairway and is used to irrigate the golf course.

The existing system would be expanded by the addition of sewer lines and a force main and lift station in order to accommodate the future residential areas. In the upper Kalana area, a 6-inch gravity line would be installed along the new road and connected to the existing 8-inch sewer line. In the area between Ninole Stream and the Na'alehu side property line, a new gravity line would be constructed to transport flows toward the State Highway. A new lift station would be required to convey the wastewater across the highway to the Ninole Bluffs area. This Kalana Lift Station would have a pumping capacity of 175 gpm to handle a peak flow of 252,400 gpd. A 4-inch force main would be installed between the lift station and Ninole Bluffs. The com-

TABLE IV-54

Projected Domestic Water Demand

Area	Zoning	Planned Maximum Number Units	Water Demand[1] (gpd)
PSBR Complex & Hotel	V-1.5	210	126,000
Village Hotel & MF Res./Condo	V-1.0 & RM-2.0	280	168,000
Village Center	V-1.5	770	462,000
Central	RM-2.5	1,008	604,880
Colony I (Existing)	RM-2.0	76	45,600
Colony II	RM-2.0	96	57,600
Ninole Bluffs	RM-2.5	315	189,000
Kalana I (Existing)	RS-20	19	11,400
Kalana II	RS-15	78	46,800
Kalana III	RM-3.0	450	270,000
Subtotal		3,302	1,981,200
Commercial:			
Punalu'u Restaurant	--	5.6 Acres	16,800[2]
Tennis Center	--	7.9 Acres	23,700[2]
Golf Clubhouse	--	1.9 Acres	5,700[2]
Aspen Institute	RM-5.0	2.7 Acres	8,100[2]
New Commercial	--	5.0 Acres	15,000[2]
TOTAL			2,050,500

[1]Based on 600 gallons/day/unit from "Rules and Regulations," Department of Water Supply, County of Hawaii, January 1982.

[2]Commercial demand based on 3,000 gpd/acre from "Water System Standards," Board of Water Supply, County of Hawaii, 1985, Volume 1.

Note: Number of Planned Maximum Number Units overstated in analysis to provide a conservative engineering estimate of water demand.

6.1.3 Mitigation Measures

Positive and/or the lack of impacts on the schools in the project area (Ka'u District) indicate that mitigation measures are not warranted at this time. CBP, in cooperation with the State Department of Education, would continue to monitor possible adverse impacts on the schools and, should future conditions indicate, appropriate action would be taken.

6.2 HEALTH CARE FACILITIES

6.2.1 Existing Conditions

Ka'u District and the Resort area are currently served by the Ka'u Hospital, a 15-bed public facility in Pahala. In 1984 the hospital had an average occupancy rate of under 10 percent. Persons in need of critical medical attention are transported to Hilo hospitals, which are also adequate to serve expected increases in east Hawaii population levels.

6.2.2 Impacts on Health Care Facilities

The proposed project is not expected to impact the health care facilities in Ka'u District or Hilo.

6.2.3 Mitigation Measures

Mitigation measures to minimize potential adverse impacts are not warranted at this time. Should future conditions indicate, CBP in cooperation with the State Department of Health, would take appropriate action.

6.3 POLICE PROTECTION

6.3.1 Existing Conditions

The present primary county police station for Ka'u District is located in Na'alehu at the Civic Center. In addition to the main station, police utilize a portion of a building in Pahala as a substation. A new county owned facility is planned for the Ka'u District and would be located in Na'alehu. Site selection and sizing of the facility have not been finalized, nor has the time period for construction and operation. There are 16 authorized persons assigned to Ka'u District at present. This includes one Captain, one Lieutenant, two Sergeants, 11 Patrol Officers and one Operations Clerk. Projected increases in per-

6.5 WATER SUPPLY

6.5.1 Existing Conditions

Currently, two deep wells and a pump station at Ninole are supplying water to the Colony I condominiums, Kalana I residences, Punalu'u Black Sand Restaurant and the golf course facilities. The wells have combined pumping capacity of 3.0 million gallons per day (mgd). Water is delivered to these areas through a distribution system which includes 16-inch and 12-inch ductile iron transmission pipes. A 1.0 mg storage reservoir located at elevation 305 feet satisfies the current water demand. The Ninole wells pump station delivers water to the reservoir through a 16-inch transmission main. This line serves the dual purpose of transporting water to the reservoir and delivering the stored water by gravity flow to the service area as required.

6.5.2 Impacts on Water Supply

The proposed project is not expected to affect the island and/or regional water supply due to the large resource available in the project area and due to the relatively low level requirement of the Resort. As previously noted, existing water resources in the area are large and the existing Resort wells are underused (Mink, 1981).

The existing water system will be expanded according to future incremental water requirements which are 0.3 MG for the higher elevations above the existing reservoir and 0.8 MG for the remaining lower elevations. Water demands of the various zoning areas are shown in Table IV-54. The construction of a single 1.1 MG reservoir at elevation 500 feet will increase the total storage capacity to 2.1 MG, thereby meeting the total water demand of the Resort. This reservoir will also be supplied by the existing Ninole wells. A new booster pump station will be constructed at the existing reservoir to pump water from that elevation to the new reservoir. A 12-inch dual purpose transmission line will also be installed between the new booster pump station and new reservoir.

All new water lines will be installed within the road right-of-ways. The distribution main in the realigned Punalu'u Road will be 12-inch ductile iron pipe. Water lines to the cul-de-sacs off Punalu'u Road,will be 8-inch ductile iron pipe.

Expansion of the water system is not expected to have any adverse impacts on the environment. All aspects of the water system will be designed in accordance with the most recently published water standards of the County of Hawaii. Modifications to the Resort water system would comply with the provisions of sonnel levels are unknown and would depend on the level of service required within the district. The average number of calls received per year during the past five years has been 1,760, with 507 being criminal and 1,253 being non-criminal calls. Average response time from the Na'alehu station to the Ka'u boundary (east or west) is approximately 15 to 20 minutes. During the past five years there have been a total of 280 traffic accidents, two of which involved fatalities. Also, over the past five years there have been approximately 750 major offenses reported (including murder, rape robbery, assault, burglary, theft and auto theft) and 425 arrests of residents and 15 arrests of non-residents. According to the County Police Department, the present and planned new station would be adequate to provide police services for the projected development of Punalu'u Resort and surrounding communities. Additional developments in the District would require an increase in the number of personnel assigned to Ka'u.

6.3.2 Impacts on Police Protection

Based on information provided by the County Police Department, the proposed project is not expected to affect the current level of county provided police protection. However, increased population in Ka'u District could increase the need for additional police services for traffic control purposes. It is likely that the present police facilities in Na'alehu are adequate for any increased services that may be required. However, a new police/fire station is planned for an area east of Na'alehu to accommodate forecast natural population grown in Ka'u. Additionally, private security forces would be increased as required to meet the needs of the Resort. The County Police Department foresees no adverse effects on their operations or facilities as a result of the proposed project. (See County Police Department Letter of December 2, 1986 to A. L. Lyman).

6.3.3 Mitigation Measures

Based on the information provided by the County Police Department and the planned increase in Resort security personnel that would accompany the Resort development, it appears that additional mitigation measures are not warranted at this time. Should conditions change in the future, CBP would work with the County Police Department to ensure that adequate police protection is provided to the residents of Ka'u District.

6.4 FIRE PROTECTION

6.4.1 Existing Conditions

The present Ka'u county fire station is located in Pahala and is staffed with a two-man crew and 750-gallon per minute pumper and a two-man EMS/fire crew proposed for Naalehu. Volunteers provide additional support. A second 750-gallon per minute pumper unit is assigned to the Pahala volunteers as back-up for the paid fire fighters. The six-man crew will be supervised by a Fire Captain assigned to the district by January 1, 1988. Also, emergency medical services will be initiated from Naalehu January 1, 1988. Future personnel increases planned for fiscal year 1988-89 are seven additional fire fighter/EMS personnel. Although there are no future Fire Department facilities planned at present, future facilities would be contingent upon area development and corresponding population increases. The average number of calls for the past five years has been 83 per year. Thirty-three major fires (brush or structure) have been reported. Also, 49 fire rescue calls (auto accidents, drownings, swimmers in distress, overdue hikers, etc.) have been reported over the past five years. Of these calls, three persons have been injured and none killed. The dollar value of lost property over the last five years has been about $423,000. In addition to the county fire department forces, the military camp in the volcano area provides support as required.

6.4.2 Impacts on Fire Protection

Development of the proposed project is not expected to affect the fire protection services currently provided by the county and volunteer forces. All Resort buildings would be designed and constructed to meet applicable county fire codes and fire hydrants would be installed as part of the water distribution system improvements. It is possible that as the Resort expands additional county and/or volunteer forces would be required.

6.4.3 Mitigation Measures

Based on information from the County Fire Department and the design and construction measures described above, it appears that additional mitigation measures are not required. Should future conditions change, CBP would work with the County Fire Department to ensure that adequate fire protection services are provided to the residents of Ka'u District.

Chapter V: Relationship of the Proposed Action to Land Use Plans, Policies and Controls For the Affected Area

Response: As described in Chapter V, Section 4, the proposed development is consistent with the goals, policies, and standards of the General Plan.

7. FLOOD HAZARD CONTROL

Proposed plan for the resort would be in compliance with the Hawaii County Code - Chapter 22, Flood Hazard Control as follows:

Statement of Purpose: To promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by provisions designed:

(1) To protect human life and health;

(2) To minimize expenditure of public money for costly flood control projects;

(3) To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;

(4) To minimize prolonged business interruptions;

(5) To minimize damage to public facilities and utilities located in areas of special flood hazard;

(6) To help maintain a stable tax base by minimizing future flood loss;

(7) To assist in notifying potential buyers that property is in an area of special flood hazard; and,

(8) To insure that those who occupy areas of special flood hazard assume responsibility for their actions.

Position: Based on the project development plans, and the project engineer, appropriate measures will be taken in areas that present some risk. Although construction is not expected to increase potential flood hazard, the proper mitigating measures, as required by regulatory agencies and as recommended by consulting engineers, would be implemented in order to minimize any adverse environmental effects.

The proposed project is in conformance with the Hawaii State Plan - Revised (1986) since the plan supports making the visitor industry a major component of Hawaii's economy (sec. 226-8(a), -103(b)(1) through (8), HRS), especially on the neighbor islands (sec. 226-5(b)(2) and (3), HRS). Additionally, the project would improve opportunities for public use of coastal resources and would be planned and designed in such a way as to be compatible with the environmental and cultural resources of the site.

In general, the proposed Punalu'u Resort expansion is consistent with the overall intent of the Hawaii State Plan - Revised (1986). Specific objectives, policies and priority actions contained in the State Plan most relevant to the proposed project are discussed below.

Objective and policies for population, Section 226-5 includes:

(a) "guide population growth to be consistent with the achievement of physical, economic, and social objectives."

(b)(2) "Encourage an increase in economic activities and employment opportunities on the Neighbor Islands consistent with community needs and desires."

(b)(3) "Promote increased opportunities for Hawaii's people to pursue their socio-economic aspirations throughout the islands."

Discussion: At a time when employment opportunities are decreasing in the agricultural sector of Hawaii's economy, opportunities are increasing in the visitor industry. Permanent operational employment opportunities at Punalu'u Resort would be significant and indirectly, employment throughout the region and State would also be stimulated by this development. The proposed development is of a scale and character that is consistent with that of the district and will encourage increased economic activities in the region.

Adequate services and facilities would be ensured by the resort developers. State and County tax revenues generated by the resort (property taxes, income taxes, etc.) are projected to more than offset the cost of providing public services to visitors and new residents.

- Adequate and properly located public recreation areas and wildlife preserves are reserved;

<u>Response</u>: Public recreation areas are provided for within the proposed development including the expansion of Punalu'u Beach Park, providing additional parking and recreation facilities, and establishing foot trails along the entire shoreline area if deemed necessary. If it is determined that wildlife preserves are necessary to ensure the protection of important wildlife habitats, such preserves would be established and managed using normal conservation measures.

- Provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon Special Management Area resources;

<u>Response</u>: Provisions have been made within the development plans for solid and liquid waste treatment, disposition, and management which is expected to minimize any potential adverse effects upon Special Management Area resources. Refer to this Final EIS, Chapter IV, Sections 2.4, 2.5, 6.6, and 6.7.

- Alterations to existing land forms and vegetation, except crops, and construction of structures shall cause minimum adverse effect to water resources and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation, or failure in the event of earthquake;

<u>Response</u>: The measures that have been taken to date and measures that would be taken as part of the proposed project have been designed to minimize future dangers of flooding due to blockage of Ninole Stream at Ninole Cove. Additionally, the Black Sand Inn will be constructed in conformance with State and County standards to minimize potential for failure in the event of earthquake. It is believed that the scenic and recreational amenities of the project area will be enhanced.

- Adverse environmental or ecological impacts are minimized to the extent practicable; and

<u>Response</u>: Throughout the planning and design of the development plans for the Punalu'u Resort, anticipated adverse environmental impacts have been considered and are minimized to the extent practicable. The anticipated impacts are summarized in Chapter I, Section 5.

- The proposed development is consistent with the goals, policies, and standards of the General Plan.

Objectives and policies for the economy in general, Section 226-6 states:

(a)(1) "Increased and diversified employment opportunities to achieve full employment, increased income and job choice, and improved living standards for Hawaii's people."

(b)(6) "Strive to achieve a sustained level of construction activity responsive to, and consistent with, State growth objectives."

(b)(8) "Encourage labor-intensive activities that are economically satisfying and which offer opportunities for upward mobility."

(b)(10) "Stimulate the development and expansion of economic activities which will benefit areas with substantial or expected employment problems."

(b)(13) "Encourage businesses that have favorable financial multiplier effects within Hawaii's economy."

Discussion: When fully developed, the labor-intensive resort development would provide a full spectrum of employment and new business opportunities (to service the resort development) for the Ka'u District. Refer to Chapter IV, Section 4.2.

Relevant Hawaii State Plan policies for the economy - visitor industry, Section 226-8 are as follows:

(a) "a visitor industry that constitutes a major component of steady growth for Hawaii's economy."

(b)(3) "Improve the quality of existing visitor destination areas."

(b)(4) "Encourage cooperation between the public and private sectors in developing and maintaining well-designed, adequately serviced visitor industry and related developments which are sensitive to neighboring communities and activities."

(b)(5) "Develop the industry in a manner that will continue to provide new job opportunities and steady employment for Hawaii's people."

(b)(6) "Provide opportunities for Hawaii's people to obtain job training and education that will allow for upward mobility within the visitor industry."

Response: To satisfy the requirements of a General Plan Amendment for a portion of the resort, Draft and Final Environmental Impact Statements have been completed that assess the potential environmental and ecological effects, and the potential cumulative impact of the entire Punalu'u Resort development. For a summary of the anticipated impacts, refer to Chapter I, Section 5. In addition, preparation of the Draft and Final EIS's have analyzed separately and collectively on a comparative basis, the potential impacts, such as socioeconomic, market, air quality and traffic impacts of other planned resorts in Ka'u and on the island with the proposed project.

- o The development is consistent with the objectives and policies as provided by Chapter 205A, HRS, and the Special Management Area guidelines as contained herein; and

Response: As described herein and in the Draft EIS, Chapter V, the development of Punalu'u Resort is consistent with the objectives and policies as provided by Chapter 205A, HRS, and the Special Management Area Guidelines.

- o The development is consistent with the County General Plan and zoning. Such a fining of consistency does not preclude concurrent processing when a general plan or zoning amendment may also be required.

Response: The proposed development within the SMA is consistent with the County General Plan and zoning. This SMA petition is being processed concurrently with change of zone requests that include a significant portion of the SMA project area. Refer to Chapter II, Section 3.3.2.15.

(3) All development permitted in the Special Management Area shall be subject to reasonable terms and conditions as necessary in order to ensure that:

- o Adequate access, by dedication or other means, to publicly owned or used beaches, recreation areas, and natural reserves is provided to the extent consistent with sound conservation principles;

Response: Public access to the entire shoreline area of Punalu'u Resort will be maintained and certain lands will be dedicated to the County for expansion of existing beach park lands and facilities. The nature, layout and type of access have been designed to be sensitive to coastal habitats, such as the breeding areas for sea turtles and areas of historical or cultural significance. Natural reserve areas may also be established and managed utilizing established conservation measures.

(b)(9) "Foster an understanding by visitors of the aloha spirit and of the unique and sensitive character of Hawaii's cultures and values."

<u>Discussion</u>: State and County tax revenues generated by the development would contribute toward the cost of providing public services to new residents and visitors. Punalu'u Resort is being carefully planned and located in a coastal area which has been designated by the County of Hawaii General Plan for resort development. Punalu'u Resort intends to maintain the high standards set by other resorts on the island.

The proposed project would further the policy of providing opportunities for Hawaii's people to obtain job training and would allow for upward mobility within the visitor industry. The proposed development would offer short-term and long-term employment to residents of the State and County of Hawaii and would contribute to sustaining the level of construction activity in the State.

As noted in Chapter II, Section 3.4, Need for the Project, the projected market support for development at Punalu'u would support 1,000 to 1,400 hotel rooms, 900 to 1,800 condominium units and 71 to 78 residential lots at build-out. To be carefully planned and developed to meet market demands, the resort would provide a diverse range of employment opportunities within the region.

Relevant Hawaii State Plan objectives and policies for the physical environment - land-based, shoreline, and marine resources, Section 226-11 include:

(a)(1) "Prudent use of Hawaii's land-based, shoreline, and marine resources."

(a)(2) "Effective protection of Hawaii's unique and fragile environmental resources."

(b)(2) "Ensure compatibility between land-based and water based activities and natural resources and ecological systems."

(3) "Take into account the physical attributes of areas when planning and designing activities and facilities."

(6) "Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii."

(8) "Pursue compatible relationships among activities, facilities, and natural resources."

not anticipated to be impacted by the increased use and development of the project area. Temporary short-term impacts to the coastal waters are anticipated due to increased siltation and nearshore turbidity due to connecting Pond No. 1 and the dry mauka pond. All reasonable steps will be taken to minimize these impacts during reclamation.

b) Existing Areas of Open Water Free of Visible Structures: There are currently no such physical features within the project area and none are proposed.

c) Existing and Potential Fisheries and Fishing Grounds: No significant adverse impacts are anticipated to the fishing grounds adjacent to the project area.

d) Wildlife Habitats: The significant wildlife habitats have been identified within the Draft EIS and will be protected and managed in accordance with the conservation measures to be implemented pursuant to the Environmental Protection Plan. One of the primary aims of the Plan is to ensure the maintenance and/or improvement of the wildlife habitat value. These areas include the coastal ponds and the nesting areas for the sea turtles.

e) Estuarine Sanctuaries: None are located within the project area.

f) Agricultural Use of Land: There are no existing agricultural uses of the subject project area and the potential for such use is minimal due to shallow soils, high land value, and lack of a crop that would be economically viable to produce. Certain areas of the resort can be utilized as grazing/pasture areas which are capable of supporting a small herd of cattle.

(2) No development shall be approved by the Authority or the Director unless it is first found that:

- The development will not have any significant adverse environmental or ecological effect, except as such adverse effect is minimized to the extent practicable and clearly outweighed by public health, safety, or compelling public interest. Such adverse effect shall include, but not be limited to, the potential cumulative impact of individual developments, each one of which taken in itself might not have a substantial adverse effect and the elimination of planning options;

(9) "Promote greater accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes."

<u>Discussion</u>: The major physical features within the project have been identified as the coastal ponds, Punalu'u Black Sand Beach, Punalu'u Bay, Ninole Cove, significant historic sites and the scenic back drop of Mauna Loa. These important physical attributes of the site are planned to be preserved and/or integrated into the resort project.

The applicant is proposing to at least maintain, if not improve, the accessibility for public recreational, educational and scientific use of the shoreline fronting the project site. An Environmental Protection Plan for the project has been prepared to provide the management guidelines to protect critical habitat areas that do or can support plant and animal species native to Hawaii.

Relevant Hawaii State Plan policies for the physical environment-scenic, natural beauty, and historic resources, Section 226-12, include:

(a) "enhancement of Hawaii's scenic assets, natural beauty, and multicultural/historical resources."

(b)(1) "Promote the preservation and restoration of significant natural and historic resources."

(b)(3) "Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features."

(b)(4) "Protect those special areas, structures, and elements that are an integral and functional part of Hawaii's ethnic and cultural heritage."

(b)(5) "Encourage the design of developments and activities that complement the natural beauty of the islands."

<u>Discussion</u>: The Punalu'u and Ka'u District region, including the present Resort area, is rich in natural and cultural resources. The resort was conceived for Punalu'u based on the unique site attributes and has thus been planned and designed to maintain and/or enhance the natural features of the site. Building groups will be sited to maintain the primary vistas to the mountains and ocean. Punalu'u Resort proposes to preserve significant individual archaeological sites. As mentioned previously, the shoreline area, including the ponds, is not planned to be altered. The low density, landscaped character of the resort would provide a means for the development to accommodate and be complemented by the surrounding environment.

- o Any development which would reduce the size of any beach or other area usable for public recreation.

Response: The proposed enlargement of Punalu'u Beach Park will provide additional public recreation areas along the shoreline.

- o Any development which would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the Special Management Area and the mean high tide line where there is no beach.

Response: The proposed development will not reduce public access to tidal and submerged lands, beaches, portions of rivers and streams within the Special Management Area and the mean high tide line where there is no beach. Although public access will be improved and additional park lands dedicated to the County, some restrictions, including limited vehicular access along the shoreline, will be imposed to protect and preserve unique habitat areas such as breeding areas for sea turtles and historic sites of religious or cultural significance.

- o Any development which would substantially interfere with or detract from the line of sight toward the sea from the State highway nearest the coast or from other scenic areas identified in the General Plan.

Response: State Highway 11 (Hawaii Belt Highway) is almost one mile from the shoreline at an elevation of 190-300 feet above sea level, and thus the proposed low-rise development will not substantially interfere with or detract from the line of sight toward the sea. Punalu'u, identified as an area of natural beauty within the General Plan, is anticipated to be maintained as such with the proposed development being set back from the shoreline, low-rise in nature, and including appropriate landscape plantings to blend the structures into the site. The open space character of the shoreline will be maintained.

- o Any development which would adversely affect water quality, existing areas of open water free of visible structures, existing and potential fisheries and fishing grounds, wildlife habitats, estuarine sanctuaries, potential or existing agricultural uses of land.

Response: The Draft and Final EIS's have assessed the potential cumulative impacts of the resort development on the environment as follows:

a) Water Quality: Potable water for the resort has been developed and it shall meet all State public health standards. The coastal and pond waters are

Relevant Hawaii State Plan objective and policy for the physical environment - land, air and water quality, Section 226-13 include:

(a)(2) "Greater public awareness and appreciation of Hawaii's environmental resources."

(b)(1) "Foster educational activities that promote a better understanding of Hawaii's limited environmental resources."

Discussion: Improved access to the Punalu'u Resort lands and the shoreline would be made available to the general public via the relocated Punalu'u Road. Access to archaeological sites would support activities that promote a better understanding of Hawaii's heritage. Preserving the coastal ponds contained in the shoreline area would serve to further both visitors' and residents' understanding of Hawaii's unique natural heritage. A Draft Environmental Protection Plan and Cultural Resource Management Plan will provide the details of the required resource management measures that will be implemented in conjunction with the resort development.

Relevant Hawaii State Plan objective and policies for facility systems - solid and liquid wastes, Section 226-15 include:

(a)(1) "Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.

(b)(1) "Encourage the adequate development of sewerage facilities that complement planned growth."

(b)(2) "Promote re-use and recycling to reduce solid and liquid wastes and employ a conservation ethic."

Discussion: Punalu'u Resort intends to expand the present self-contained sewage treatment facility which treats sewage to the secondary level as development of the resort progresses and as demand on the system warrants. The effluent would be safe to use for golf course irrigation while serving to conserve and recycle water.

Relevant Hawaii State Plan objective and policies for facility systems - water, Section 226-16 include:

(a) "the provision of water to accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities."

Expanded resort facilities would probably improve the local economy by providing additional employment opportunities. Based on the economic consultant, the Big Island as a whole and the State's economy overall would also benefit from the resort development as summarized in Chapter IV, Section 4.2.

(6) Coastal Hazards

Objectives:

- o Reduce hazards to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

Policies:

- o Control development in areas subject to coastal hazards;
- o Ensure that developments comply with the requirements of the Federal Flood Insurance Program.
- o Prevent coastal flooding from inland projects.

Position: One of the objectives of the development plan was to address the coastal hazards so as to minimize any potential threat to life or property. Adequate setbacks and building designs will be utilized to reduce any potential hazards to the coastal area of the resort.

Special Management Area Guidelines

The following summary responses are provided to the SMA guidelines used in the review of developments proposed in the Special Management Area. Two SMA Use Permit petitions will be submitted to the County of Hawaii Planning Department requesting approval to proceed with coastal development at Punalu'u.

(1) The Authority and/or the Director, in reviewing any proposed development, shall seek to minimize where reasonable:

- o Dredging, filling or otherwise altering any bay, estuary, salt marsh, river mouth, slough, or lagoon.

Response: The proposed project does not include the dredging or filling of any of the coastal ponds with the exception that the presently dry mauka pond would be connected to Pond No. 1 through removal of the earthen barrier separating the two ponds. This action would improve the water and habitat quality of the area. All work would be performed in accordance with applicable federal, state, and county environmental protection regulations.

CHAPTER V

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

The General Plan Amendment Application and Petition were submitted to the Hawaii County Planning Department on May 22, 1986. Upon acceptance of the Environmental Impact Statement, the General Plan Amendment will be processed by Hawaii County. The remaining approvals will be applied for sequentially or concurrently as allowed by law.

The proposed project would be consistent with: the Hawaii State Plan; the State Functional Plans; the Hawaii County General Plan; and the Special Management Area (SMA) Rules and Regulations of the County of Hawaii.

The proposed project's relationship to these and other relevant land use plans and controls is described in sections which follow.

1. HAWAII STATE PLAN

The Hawaii State Plan, Revised (Hawaii, State of, Department of Planning and Economic Development, 1986) shall "serve as a guide for the future long-range development of the State; identify the goals, objectives, policies, and priorities for the State of Hawaii; provide a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improve coordination of state and county plans, policies, programs, projects, and regulatory activities; and to establish a system for plan formulation and program coordination to provide for an integration of all major state and county activities." Among its stated goals, objectives and policies is a clear statement of intent to support the visitor industry as a major element of steady growth in Hawaii's economy.

Policies related to the development of the visitor industry emphasize the need for cooperation between the public and private sectors to assure a viable industry that is responsive to the economic, social, environmental and aesthetic values of the community as a whole. The proposed development at Punalu'u would be consistent with the economic and social policies of the State Plan.

(b)(1) "Coordinate development of land use activities with existing and potential water supply."

(b)(3) "Reclaim and encourage the productive use of runoff water and waste water discharges."

Discussion: Water for Punalu'u Resort would continue to be supplied from existing wells near the intersection of the Belt Highway and Punalu'u Road. The waste water treatment plant has been designed so that waste water can be recycled; treated effluent is being used to irrigate the resort golf course.

Relevant Hawaii State Plan policies for socio-cultural advancement - housing, Section 226-19, include:

(b)(7) "Foster a variety of lifestyles traditional to Hawaii through the design and maintenance of neighborhoods that reflect the cultures and values of the community."

Discussion: According to project designers, the resort's village concept will lend itself towards the fostering a variety of lifestyles traditional to Hawaii. It is the intent of the proposed Punalu'u Village of the resort to create a character that reflects the culture and values of the Ka'u region.

Relevant Hawaii State Plan policies for socio-cultural advancement - education, Section 226-21 include:

(b)(3) "Provide appropriate educational opportunities for groups with special needs."

(b)(6) "Assist individuals, especially those experiencing critical employment problems or barriers, or undergoing employment transitions by providing appropriate employment training programs and other related educational opportunities."

Discussion: Refer to the previous discussion of the Hawaii State Plan policies for the economy - visitor industry: Section 226-8.

Relevant Hawaii State Plan objective and policy for socio-cultural advancement - leisure, Section 226-23 include:

(a) "the achievement of the objective of adequate provision of resources to accommodate diverse cultural, artistic, and recreational needs for present and future generations."

(b)(1) "Foster and preserve Hawaii's multicultural heritage through supportive cultural, artistic, recreational, and humanities - oriented programs and activities."

(4) Coastal Ecosystems

Objective:

- Protect valuable coastal ecosystems and to minimize adverse impact on all coastal ecosystems.

Policies:

- Preserve valuable coastal ecosystems of importance;
- Minimize disruption of coastal ecosystems;
- Protect water quantity and quality management practices.

Position: Based on the biological consultant, the proposed development is not expected to have significant adverse effects on the coastal ecosystem or pond complex. Refer to Chapter IV, Sections 1.6 and 1.7 for detailed discussion.

For more information regarding the project drainage system, storm water runoff and the potential impacts of the project on water quality and nearshore waters, please refer to Chapter IV, Sections 2.4 and 2.5 for detailed discussions.

(5) Economic Uses

Objective:

- Provide public and private facilities and improvements important to the State's economy in suitable locations.

Policies:

- Concentrate coastal dependent development in appropriate areas;
- Ensure coastal dependent developments minimize adverse social, visual, and environmental impact;
- Direct location and expansion of development to existing designated areas.

Position: According to market consultants, Punalu'u has the desired scenic and climatic environment to support a destination resort development., Moreover, using resort marketing criteria, the proposed project qualifies as a coastal dependent development. As presently designed, the proposed resort will be developed in such a way that would seek to minimize any adverse social, visual and environmental impacts that may occur. See Chapter IV.

(b)(4) "Promote the recreational and educational potential of natural resources having scenic, open space, cultural, historical, geological, or biological values while ensuring that their inherent values are preserved."

(b)(5) "Ensure opportunities for everyone to use and enjoy Hawaii's recreational resources."

Discussion: The planned resort would provide lateral and mauka-makai access to the recreational resources of the shoreline and promote the recreational and educational potential of the natural resources. The sites of cultural interest at Punalu'u Resort are predominately of Hawaiian origin. The historic and archaeological resources of significance would be preserved and/or restored and integrated into the design of the resort.

Priority Guidelines (Sec. 226-101 to 106)

The economic priority guidelines of the Hawaii State Plan include the following relevant priority guidelines to:

(a) "stimulate economic growth and encourage business expansion and development to provide needed jobs for Hawaii's people and achieve a stable and diversified economy."

(b) "to promote the economic health and quality of the visitor industry."

(b)(2) "Encourage the development and maintenance of well-designed, adequately serviced hotels and resort destination areas which are sensitive to neighboring communities and activities and which provides for adequate shoreline setbacks and beach access."

(b)(4) "Encourage visitor industry practices and activities which respect, preserve, and enhance Hawaii's significant natural, scenic, historic, and cultural resources."

(b)(5) "Develop and maintain career opportunities in the visitor industry for Hawaii's people, with emphasis on managerial positions."

Discussion: The resort development would provide a steady level of construction employment over a period of several years, lead to the establishment of permanent full-time and part-time operational jobs, and stimulate employment growth in other sectors of Hawaii's economy. It is estimated that many employees would be Hawaii Island residents, and that most of the remaining employees would be from other islands.

Position: A Full Archaeological Reconnaissance Survey (Appendix A) has been completed for the project area and several significant archaeological sites have been identified within the resort area. The resort project proposes to protect, preserve, and foster the restoration of significant historic and cultural resources where feasible.

The general mitigation plan calls for preservation/ exhibition of 20 sites as described in Appendix A and in Chapter IV, Section 3. The remaining sites will undergo archaeological data recovery or preservation. Archaeological data recovery would be in two stages--(1) detailed mapping, sample surface collection, test excavation, and selected dating and then (2) further excavation and data recovery work as needed to recover adequate and reasonable amounts of information in sites to be destroyed. Analysis of relevant research problems, lab analyses and report write-up would also be integral parts of the data recovery work. Specific preservation and data recovery plans (and execution of these plans) would be reviewed and approved by the State Historic Preservation Office and County of Hawaii Planning Department. In addition, CBP is continuing to work with the State and B.P. Bishop Estate regarding protection of the heiau on their property and development of the Cultural Resources Management Plan.

(3) Scenic and Open Space Resources

Objective:

o Protect, preserve and where desirable, restore or improve the quality of coastal scenic and open space resources.

Policies:

o Ensure that new developments are compatible with the visual environment;

o Preserve and maintain shoreline open space and scenic resources;

o Encourage developments which are not coastal dependent to locate inland.

Position: The development, as planned, would implement certain conservation measures which are designed to protect, preserve, restore or improve the quality of coastal, scenic, and open space resources. Building improvements would be set back from the shoreline (Figure II-11) so that the shoreline retains its scenic and open space character. The coastal developments would include attractive water play facilities to be built inland. This is anticipated to reduce pressure on the shoreline resources.

The resort, although somewhat isolated from the neighboring communities of Pahala and Na'alehu, is planned at a scale and density that is sensitive to these communities and the rural character of the Ka'u district. With adequate shoreline setbacks and beach access, the resort, through its Environmental Protection Plan and Cultural Management Plan, will respect, preserve and enhance the sites significant natural, scenic, historic and cultural resources.

Development at Punalu'u Resort would conform with relevant State and County land use regulations, as well as other regulations pertinent to the proposed development. As noted earlier, the planned resort will provide lateral and mauka-makai access to the shoreline resources, including the beaches. Placement of resort facilities will comply with the required shoreline setbacks.

Local agricultural products, including fish, meat, vegetables, and fruits, would be purchased for consumption at the resort, contributing to the maintenance and expansion of the agricultural base.

The historic and archaeological resources determined to be significant pursuant to the final archaeological report would be preserved and/or restored and integrated into the design of the resort.

The population growth and land resources priority guidelines of the Hawaii State Plan include the following relevant priority guidelines:

(b)(1) "Encourage urban growth primarily to existing urban areas where adequate public facilities are already available or can be provided with reasonable public expenditures and away from areas where other important benefits are present, such as protection of important agricultural land or preservation of lifestyles.

(b)(10) "Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats (on land and in the ocean); areas with endangered species of plants and wildlife; natural streams and water bodies; scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources."

(b)(11) "Identify all areas where priority should be given to preserving rural character and lifestyle."

(1) Recreational Resources

Objective:

- Provide coastal recreational opportunities accessible to the public.

Policies:

- Protect unique coastal recreational resources;
- Replace areas of recreational value as damaged or destroyed by development;
- Provide adequate public access;
- Develop new coastal recreational opportunities;
- Encourage the dedication of coastal areas with recreational value for public use.

Position: At present, the primary access to the shoreline at Punalu'u from the Hawaii Belt Highway is via the Belt Highway / Punalu'u Road intersection. The public would continue to be provided access to the coastal recreational opportunities via Punalu'u (Alanui) Road. Public access to the shoreline area will be maintained. Vehicular traffic, however, will be restricted in some areas to protect environmentally sensitive species and areas. Provisions within the development plan would protect the ecologically sensitive areas along the shoreline as well as the adjacent coastal ponds. Improvements such as increased parking facilities for the public and other ancillary recreational facilities are to be part of the overall resort master plan and further detail will be provided in the site development plans and Special Management Area Permit applications.

(2) Historic/Archaeological Resources

Objective:

- Protect, preserve and where desirable, restore significant historic and cultural resources.

Policies:

- Identify and analyze significant historic resources;
- Maximize information retention through preservation and salvage.

(b)(12) "Utilize Hawaii's limited land resources wisely, providing adequate land to accommodate projected population and economic growth needs while ensuring the protection of the environment and the availability of the shoreline, conservation lands, and other limited resources for future generations."

(b)(13) "Protect and enhance Hawaii's shoreline, open spaces, and scenic resources."

<u>Discussion</u>: The proposed project would be constructed according to a phased schedule as demand warrants and resources allow and employ locally available labor for long-term employment at the resort. The master plan includes the provision of public access to the shoreline from the Hawaii Belt Highway and lateral access along the shoreline. An open space area (golf hole No. 8) between the shoreline and resort facilities would provide a buffer. As previously noted, an Environmental Protection Plan will provide the necessary measures for the protection of coastal ponds and other critical habitats.

The <u>affordable housing</u> priority guidelines of the Hawaii State Plan include the following relevant priority guidelines:

(1) "Seek to use marginal or non-essential agricultural land and public land to meet housing needs of low and moderate-income and gap-group households.

(2) "Encourage the use of alternative construction and development methods as a means of reducing production costs."

(3) "Improve information and analysis relative to land availability and suitability for housing."

(6) "Encourage public and private sector cooperation in the development of rental housing alternatives."

(7) "Encourage improved coordination between various agencies and levels of government to deal with housing policies and regulations."

<u>Discussion</u>: To meet the anticipated demand for housing which is directly attributable to the resort development, the developer will strive to accomplish the above stated goals. Refer to Chapter IV, Section 4.3.3.2 related to employee housing requirements.

The orderly development of a master planned resort community would provide the visitor industry with the necessary facilities to adequately serve the projected increase in visitor travel. The resort is designed as a destination resort area and is planned to provide the residents and visitors of the resort with a total and unique visitor/residential experience. As part of that experience, educational opportunities relating to the historic and cultural resources of the project area will be provided.

5. COUNTY ZONING

The current County zoning maps designate the project area as partially Open (O), partially Village Commercial (CV-10), partially multi- or single-family residential (RS-7.5, RS-20, RM-2.0), partially Hotel/Resort (V-1.5) and partially Agriculture (A-20a). As indicated in Chapter II, Section 3.2, implementation of the Resort Master Plan requires changes in the allowed density of some parcels within the project boundaries, while others would revert to Open Space.

6. COASTAL ZONE MANAGEMENT/SPECIAL MANAGEMENT AREA (SMA)

Regulations regarding the use of coastal lands and resources were established through the State Coastal Zone Management Act (Chapter 205A, HRS) and are administered by the County Planning Department. The intent of Coastal Zone Management and SMA regulations is to assure that adequate attention is paid to coastal resources and that development impacts are mitigated before damage occurs. Special controls on developments within an area along the shoreline are necessary to avoid permanent losses of valuable resources and the foreclosure of management options, and to ensure that adequate access is provided, by dedication or other means, to public owned or used beaches, recreation areas, and natural resources. It is the State policy to preserve, protect, and where possible, to restore the natural resources of the coastal zone.

The designated SMA boundary includes all land makai of the Hawaii Belt Highway (approximately 325 acres) of the proposed project area. Accordingly, SMA permits would be required prior to the development of the Punalu'u Resort.

The resort, as planned, would be consistent with the objectives and policies of the coastal zone management program and SMA policies, regulations and guidelines as summarized below.

2. STATE FUNCTIONAL PLANS

The Hawaii State Plan mandated the creation of twelve functional plans to provide detailed guidelines to implement its broad range of planning objectives. Ten of these plans were adopted by the 1984 legislature, with the remaining two adopted in 1985. Development at Punalu'u considers the guidelines of the functional plans and the relevant goals and objectives of each.

The relevant State functional plans were examined to determine their relationship to the proposed Punalu'u Resort. All of the plans had been adopted by 1985; they function as guidelines only and are not to be interpreted as law or statutory mandate.

State Historic Preservation Functional Plan - Historic Properties

"B. Objective: Compilation of an inventory that adequately locates and describes a significant portion of Hawaii's historic properties."

Discussion: A "Full Archaeological Reconnaissance Survey" (Paul H. Rosendahl, 1986) was completed for the project area to locate, describe and determine the significance of historic sites and features within the project area. The findings and recommendations of this survey are summarized in Chapter IV, Section 3 and Appendix A. Also, a draft Outline Cultural Resources Management Plan has been prepared and will provide the guidelines under which historic/cultural sites will be protected. Further, CBP has been working with and will continue to work with the State and B.P. Bishop Estate regarding the heiau located on their property. A copy of the draft Outline Cultural Resources Management Plan has been forwarded to both organizations for their review and input.

State Housing Functional Plan

"B. Objective: Assist the orderly development of residential areas sensitive to community needs and other land uses."

Discussion: If the necessary governmental approvals for the proposed project are received as requested, and a need is determined, the applicant would assist in providing low to moderate-income housing.

Position: Based on the studies conducted, the presence of the resort is anticipated to have a minimal impact on transportation. The internal road system is efficient in its service of the resort and planned improvements are expected to increase that efficiency. The resort itself is of a scale and plan as to be primarily pedestrian in nature.

(12) Land Use

The following goals relate specifically to resort development.

Goals:

- o Guide the orderly development of the visitor industry.
- o Provide for resort development that maximizes conveniences to its users.
- o Ensure that resort developments maintain the social, economic, and physical environments of Hawaii and its people.

Policies:

- o Impose incremental and conditional zoning based on performance requirements to ensure the orderly use of resort zoned areas and to curb speculation and resale of undeveloped lots in order to assure a certain percentage of buildings will be constructed.
- o Promote and encourage utilization of resort areas which are presently served by basic facilities and utilities.
- o Grant zoning in resort areas when the proposed development is consistent with and incorporates the stated goals, policies, and standards of the County of Hawaii General Plan.
- o Encourage the visitor industry to provide resort facilities which provide an educational experience of Hawaii, as well as recreational activities.
- o Reevaluate existing undeveloped resort zoned areas and reallocate zoned land in appropriate locations.

Position: There is a need for an expanded tourism based employment facility in the Ka'u District in order to continue to provide a variety of employment opportunities.

State Recreation Functional Plan - Access

"D. Objective: Assure the provision of adequate public access to lands and waters with public recreation value."

Discussion: The project would conform to the objective of assuring adequate public access to waters with recreational value by providing unobstructed pedestrian access along the shoreline, and providing mauka-makai access to the shoreline and providing increased parking facilities for public use.

State Tourism Functional Plan - Physical Development

"B. Objective: Development and maintenance of a well-designed and adequately serviced visitor industry and related developments in keeping with the needs and aspirations of Hawaii's people."

Discussion: The applicant has initiated physical planning for the resort in order to develop a visitor facility of high quality. Implementation of a master planned resort would eliminate the need for government funds for capital improvements. Planning for the proposed resort has taken into consideration land and water resources. The master plan for the resort reflects consideration for environmental, scenic and cultural resources.

State Tourism Functional Plan - Employment and Career Development

"C. Objective: Enhancement of career and employment opportunities in the visitor industry."

Discussion: The Punalu'u Resort would provide significant employment, construction related and operational, that would enhance career opportunities in the visitor industry. The direct and indirect employment generated from the resort is expected to be significant. Refer to Chapter IV, Section 4.2.2.

State Tourism Functional Plan - Community Relations

"D. Objective: Development of better relations and mutual awareness and sensitivity between the visitor industry and the community."

Discussion: The development at Punalu'u Resort would be sensitive to the community concerns of the Ka'u District (See Chapter IV, Section 4.3). In order to foster better relations with the community, the developer has engaged and will continue to enter into further discussions, with members of the community

- Identify, designate, and acquire areas of recreational importance, such as sandy beaches and other prime shoreline areas.

- Provide public access in accordance with adopted programs.

- Establish a system of trails to places of scenic, historic, natural, or recreational interest.

- Identify and evaluate marine and terrestrial natural areas for preservation of unique Hawaiian wildlife, especially rare and endangered species.

- Conduct an ongoing educational program to obtain the cooperation of all people in maintaining the quality of recreation areas.

- Disseminate recreational information for the public use.

- Require subdivisions to provide land area for park and recreational use.

Courses of Action: Encourage the establishment of the Punalu'u-Ninole Springs region as a recreation area.

Position: One of the primary objectives of the resort development is to enhance the natural beauty of the area and toward that end, the design of the Resort facilities has attempted to incorporate the natural, historic and cultural character of the area. Additional public access to the shoreline is planned and the Punalu'u Beach Park expanded. Golf and tennis would be two intensive recreational amenities available at the resort. In total the proposed resort improvements would increase the recreational resources available to the community and achieve the above stated Courses of Action. Refer to Chapter II, Section 3 and Chapter IV, Section 7 for specific recreation improvements proposed within the Resort area.

(11) Transportation

Goals:

- Provide an efficient, safe, comfortable, and economical transportation system.

Policies:

- Promote and encourage improvement of existing transportation systems and allowing for future demands.

in order to address their concerns or objections to the proposed project. Relatively far removed from any existing communities, the resort will become a destination resort community.

3. STATE LAND USE

The entire Punalu'u Resort area, less the coastal strip along the shoreline, lies within lands designated Urban (U) by the State Land Use Commission. As such, State land use boundary changes are not required to proceed with the proposed project.

4. HAWAII COUNTY GENERAL PLAN

The 1971 Hawaii County General Plan expresses the broad goals and policies for long-range development of the island of Hawaii. It also provides a legal basis for more detailed levels of County Land Use controls and the expenditure of public improvement funds. An administrative effort to update the General Plan is currently underway. This update will evaluate areas of strength and weakness in the initial plan and reevaluate the thirty year horizon of the plan in relationship to current and anticipated economic and social conditions.

In the 1971 Plan, resort development areas in Ka'u were designated at four locations: Ninole-Punalu'u (Minor); Honuapo (Minor); Volcano (Retreat) and Waiakukini (Retreat).

The Land Use Pattern Allocation Guide (LUPAG) map of the General Plan designates the Punalu'u Resort area for resort (Minor) development that includes a mix of two resort sites (at Ninole Cove and Punalu'u Black Sand Beach), medium density urban, low density urban, and open area. The Ninole Stream that runs through the area is also designated as a flood plain.

The master plan for the makai portion of the resort conforms to the existing General Plan as it includes resort, medium density urban and open area. Mauka of the Hawaii Belt Highway, the resort master plan includes low density urban, medium density urban and open area. Although the planned overall density of the mauka area would not exceed the current low density urban designation, the inclusion of medium density urban and open area has been determined to require a General Plan Amendment by the Hawaii County Planning Department. Refer to Figures II-7 and II-8.

The proposed General Plan Amendment for the mauka portion of Punalu'u Resort would revise the LUPAG map of the General Plan so that it would conform to the Resort Master Plan (Figure II-11).

Policies:

- o Provide utilities and service facilities which minimize total cost to public and effectively service the needs of the community.

- o Design utility facilities to minimize conflict with natural environment and natural resources.

<u>Position</u>: The existing infrastructure systems would be expanded to implement the proposed development plans, including roadways, sewer and water systems, drainage and electric systems. The expansion of these infrastructure systems will largely be at the developer's expense and consequently, is not expected to require substantial governmental expenditures. Continued use of underground utilities would improve the physical appearance while increasing safety and reliability. The existing sewage treatment plant has been located in such a way as to be screened from view and any future expansion will strive for the same effect. The facilities would conform to governmental standards of efficiency and quality.

(10) <u>Recreation</u>

Goals:

- o Provide a wide variety of recreational opportunities for the residents of the County.

- o Maintain the natural beauty of recreational areas.

- o Provide a diversity of environments for active and passive pursuits.

Policies:

- o Improve existing facilities for optimum use. Features shall be incorporated for use by all age groups, including the handicapped and the elderly.

- o Construct facilities which reflect the natural, historic, and cultural character of the area, and encourage recreational land uses which are compatible with the adjoining areas.

- o Provide compatible, multiple use recreational facilities.

- o Coordinate recreational programs and facilities with both governmental and private agencies which will offer a wider range of recreational opportunities.

The applicable goals, policies, standards, and courses of action are provided below along with the applicants position related to the proposed action.

(1) Economic Element

Goals:

- The economic system of the County should provide its residents with opportunities to improve their quality of life.
- Economic development and improvement should be accomplished in an orderly manner which is in balance with the physical and social environments of the Island of Hawaii.
- The County of Hawaii should strive for stability in its economic system.

Policies:

- Strive for an economic climate which provides its residents an opportunity for choice of occupation.
- Encourage the development of visitor industry which is consistent with the social, physical, and economic goals of the residents of the county.
- Require a study of the total social and physical impact of large developments prior to approval.
- Encourage the expansion of higher and continuing educational services and institutions.
- Study the feasibility of establishing a business development loan program.
- Consider the land, water, air, sea, and people as an essential economic resource for present and future generations and to protect and enhance the use of economics incentives.
- Strive for full employment.
- Reevaluate all economic goals and policies, particularly in the area of tourism.

utilization would not be impaired except that vehicular access will be restricted where necessary to protect environmentally sensitive areas and species. Presence of the resort has the potential of stimulating interest and funding to keep public shoreline areas clean. By providing certain services in the resort area, the adjacent public uses of the shoreline are enhanced. The coastal ponds within the project boundaries would be preserved and maintained as an integral part of the resort complex.

(8) Public Facilities

Goals:

o Provide public facilities that effectively service community needs and continue to seek ways of improving public service through better and more functional facilities which are in keeping with the environmental and aesthetic concerns of the community.

Policies:

o Continue to seek ways of improving public service through the coordination of service and by maximizing the use of personnel and facilities.

Position: The proposed resort development, which is expected to generate increased revenues to the State and County, would support the goal of expanded protection services and health and sanitation installations throughout the district. The resort would provide public dining, entertaining and recreational facilities that service the community needs.

(9) Public Utilities

Goals:

o Ensure that adequate, efficient, and dependable public utility services will be available to users.

o Maximize efficiency and economy in the provision of public utility services.

o Improve the physical appearance of public utility facilities and/or to conceal them from public view.

Courses of Action:

- Resort development in the area shall be in balance with the social and physical goals as well as economic desires of the residents of the district. Necessary pollution controls should be available prior to development. Other necessary support facilities such as transportation and nursery facilities shall also be provided.

<u>Position</u>: The utilization of this land resource would result in an increased quantity and variety of job opportunities for local residents resulting in higher employment which in turn increases the opportunities to improve their quality of life. By utilizing sensible planning principles, and developing facilities in an orderly manner, the proposed project is seeking to minimize the adverse effects on the physical and social environment of the area and at the same time, is striving to expand the variety and quality of services available to the community. The proposed improvements would create a successful resort development which in turn would be a stable economic force within the island's economy. The resort development has been designed to minimize adverse social and physical impact, and also create more employment which in turn, would likely provide more economic stability in the region.

(2) <u>Environmental Quality</u>

Goals:

- Reduce air pollution.
- Improve water quality.
- Eliminate soil pollution.
- Establish acceptable solid waste disposal systems.
- Minimize noise pollution.

Policies:

- Take positive action to further maintain the quality of the environment for residents both in the present and in the future.
- Reinforce and strengthen minimum controls established by the federal and state governments pertaining to the control of pollutants that effect the environment.
- Encourage the concept of recycling wastes.

- Review criteria for safeguards of natural beauty in the design of developments so that manmade elements will blend with the natural setting.

<u>Position</u>: The integrity and natural beauty of the shoreline areas would be maintained. The plan contemplates a number of view planes and view corridors using golf or other recreational amenities for this purpose. Since beautiful views are integral to economic as well as aesthetic values, the development has identified significant views worthy of preservation.

(7) <u>Natural Resources and Shorelines</u>

Goals:

- Protect and conserve the natural resources of the County of Hawaii from undue exploitation, encroachment, and damage.

- Provide opportunities for the public to fulfill recreational and educational needs without despoiling or endangering natural resources.

Policies:

- Require users of natural resources to conduct their activities in a manner that avoids or minimizes the adverse effects on the environment.

- Encourage a program of collection and dissemination of basic data concerning natural resources.

- Maintain the shoreline for recreational, educational, and/or scientific manner that is protective of resources and is of the maximum value to the general public.

- Protect from the encroachment of manmade improvements and structures.

- Coordinate programs to protect natural resources with other government agencies.

- Investigate methods of beach replenishment and sand erosion control.

<u>Position</u>: Scientific surveys and studies of the environment have been made and one of the objectives of the proposed project is to minimize any significant adverse effects on the environment. The integrity of the shoreline would be kept intact and in some areas, the related recreational resources would be improved by the proposed project. Public access and

Position: The resort developers would endeavor to maintain and/or improve environmental quality and would act in a manner to mitigate, as much as possible, the adverse impacts caused to the environment for present and future residents of the area. The resort developer would also comply with all Federal, State and County environmental rules and regulations. Based on the consulting biologist, the proposed project is not expected to have any significant adverse impacts on environmental quality that are not capable of being minimized. The project plans call for the use of treated wastewater effluent to be used to irrigate the golf course.

(3) Flood Control and Drainage

Goals:

- Conserve scenic and natural resources.
- Protect human life.
- Prevent damage to man-made improvements.
- Control pollution.
- Prevent damage from inundation.
- Reduce surface water and sediment runoff through the employment of soil conservation measures.

Policies:

- Maintain standards which minimize the danger to life and property in areas of recurrent flooding.
- Minimize the threat of tsunami inundation.
- Restrict land use and building structures in areas of severe wave action impact.
- Maintain drainage systems as well as to assist in developing comprehensive flood damage prevention programs, and in the construction of flood control features.

Position: The resort development would respect, preserve, and improve the scenic beauty and natural resources found within the project area. The plan avoids areas with flood potential or incorporates appropriate protective measures. Infrastructure improvements and mitigating measures during construction would minimize potentially adverse environmental impacts associated with development of the resort. Since the inception of the resort, certain flood control measures have been

- Protect residential property values from depreciating influences.

Standards:

Housing Standards shall consist of and comply with:

- Housing code.
- Building code.
- Electric code.
- Plumbing code.
- Zoning ordinance.
- Subdivision ordinance.
- Uniformity of housing information system.
- Standards listed for single family and multiple residential land use elements.

<u>Position</u>: Housing within the resort would be available as primary housing. Assuming a sufficient need for such housing is identified in more specific housing studies, the developer will work closely with the appropriate governmental agencies to see that such employee housing needs are met. See Chapter IV, Section 4.3.3.2.

(6) <u>Natural Beauty</u>

Goals:

- Protect and enhance the integrity of areas endowed with natural beauty.
- Protect scenic vistas from becoming obstructed.
- Maximize opportunities for present and future generations to experience natural beauty.

Policies:

- Establish viewplane regulations to preserve views of scenic or prominent landscapes from specific locations.
- Identify and develop view-sites.

implemented to reduce the likelihood of flooding from Ninole Stream. Also, to protect the hotel structures from possible flooding and tsunami wave action, such structures are planned to be constructed on fill material so as to be elevated above the high-water mark.

(4) Historic Sites

Goals:

- Protect and enhance the sites, buildings, and objects of historical and cultural importance to Hawaii.
- Agencies, either public or private, pursuing knowledge about the historic sites should keep the public apprised of projects.
- Access to significant historic sites, buildings and objects of public interest should be made available.

Policies:

- Evaluate and protect important historic sites, buildings, and objects in appropriate ordinances.
- Require developers of land to provide a historical survey prior to clearing or development of land where there is an indication of historical significance.
- Acquire public access to significant historic sites and objects.
- Give preference to complexes with a preponderance of original materials rather than single isolated sites unless they are of great significance.
- Encourage the restoration of significant sites on private lands.
- Collect and distribute historic site information for public interest and to keep a current inventory of sites. Aid in the development of a program of public education concerning historic sites.
- Encourage the installation of sites explaining historic sites, buildings, and objects that are in character with the surrounding area and cultural aspects of the feature.
- Evaluate the significance of historic sites.

Position: The resort development would preserve and incorporate important historical sites into a pedestrian network which would be accompanied by educational and cultural interpretative information. Historic sites have been identified, and their protection, restoration, and access are part of the plan for the resort and are considered an important resource. Presence of the resort would stimulate interest in the historic sites and their preservation and restoration and through a Cultural Resource Management Plan, the recommendations of the archaeologist will be implemented. Refer to Appendix A. As noted previously, CBP is continuing to work with appropriate state, county and private agencies in the development of the Cultural Resources Management Plan.

(5) Housing

Goals:

- o Encourage safe, sanitary, and livable housing.
- o Attain diversity of socio-economic housing mix throughout the different parts of the County.
- o Maintain a housing supply which allows a variety of choice.

Policies:

- o Assure that safe, sanitary, and livable housing is available to persons of all ages, income, and ethnic groups, and to provide a choice as to location and types.
- o Promote the volume of construction and rehabilitation of housing to meet growth needs.
- o Encourage construction of specially designed facilities for active, elderly persons.
- o Encourage the use of new housing design and construction and to increase the volume of production through further use of technological innovations.
- o Encourage private programs intended to increase the supply of housing to create a variety for choice.
- o Promote and support the use of turn-key developments and encourage the use of cluster and planned-unit developments.

Chapter VI: Relationship Between Short-Term Uses and Maintenance of Long-Term Productivity

CHAPTER VI

RELATIONSHIP BETWEEN SHORT-TERM USES AND MAINTENANCE OF LONG-TERM PRODUCTIVITY

The principal long-term benefits of the existing site use and existing and requested General Plan designations relate to the provision for resort amenities, multi- and single family residential areas, commercial/recreational areas, open spaces, natural vistas and preservation of environmental features such as coastal and historical/archaeological resources. Added possible benefits accruing to the public are the avoidance of costs associated with improvements to the infrastructure and services to the site.

Benefits of the proposed development include long-term employment and economic opportunities for the residents of Ka'u District and island of Hawaii. Economic benefits would more than offset any public sector costs that may be required to enlarge existing school or other public services and facilities.

Because the project area is unsuited for intensive agricultural activities, future options for alternate uses of the site are limited. Thus, the increased employment and economic opportunities afforded by the proposed project, coupled with the preservation and incorporation of coastal and historical and archaeological resources into the project, ensure that the project would increase the range of beneficial uses of the site and not significantly narrow future options.

As evidenced by this EIS, development of the proposed project does not appear to pose any significant or long-term risks to health and safety, and includes provisions to maintain, enhance or make available to a broader public the long-term benefits associated with existing site use. Measures to ensure coastal resource integrity, including the coastal ponds, Ninole Cove and cultural resources management are integral features of the proposed project.

Existing views of the site and surrounding lands would be improved to the extent that additional areas would be landscaped and maintained. Some mauka views from the shoreline would be impacted, depending upon where the viewer is standing. The open space areas, including the golf course and shoreline area, would be maintained. Access to the beach areas would be improved as would access to the shoreline along the east side of Ninole Cove. All existing public access easements would be retained.

Chapter VII: Irreversible and Irretrievable Commitments of Resources

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The construction and operation of the proposed project would result in the irreversible and irretrievable commitment of certain natural and fiscal resources. Major resource commitments include the land upon which the Resort is located and upon which new facilities would be constructed, money, construction materials, manpower and energy. The impacts of using these resources should be weighed against the economic impacts of the proposed project on the residents of Ka'u District, the county and state, versus the consequences of taking no action.

A majority of the project site (approximately 46 percent) would be devoted to open space. Additionally, landscaping would be planted around all Resort structures and amenities, adding to the open space feeling of the Resort.

Sensitive coastal ponds and historical/archaeological sites would be incorporated into the development plan and would be protected. Water for the Resort would continue to be taken from wells located within the Resort, thereby preserving the ground water resources outside of the project area. It is noted that as a conservation practice, much of the potable water consumed would be reclaimed, treated and used for irrigation of the golf course and landscape areas.

The commitment of resources required to accomplish the project includes building materials and labor, both of which are generally non-renewable and irretrievable. The operation of the Resort would also include the consumption of petroleum generated and, possibly alternate fuel generated, electricity. This too, represents an irretrievable commitment of resources.

The proposed project does not call for a substantial commitment of government supplied services or facilities. The project would, however, add to the recreational and cultural facilities available to the residents of Ka'u District, County of Hawaii and state and to the tax revenues of the county and state.

Chapter VIII: Offsetting Considerations of Governmental Policies

CHAPTER VIII

OFFSETTING CONSIDERATIONS OF GOVERNMENTAL POLICIES

There are inherent conflicts in goals and objectives of land use plans, policies and controls, and the proposed project's relationship to the various policies must be reconciled against those planned elements that most appropriately apply. As indicated in Chapter V, the proposed project would be consistent with the applicable Hawaii County General Plan goals, policies and standards following adoption of the General Plan amendment and rezoning that this action is requesting. Significantly, the proposed project fulfills governmental policies through satisfaction of the Hawaii State Plan policy regarding economic development and employment opportunities. The State Plan states, in part,

> "Planning for the State's economy in general shall be directed toward achievement of the following objectives: (1) increased and diversified employment opportunities to achieve full employment, increased income and job choice, and improved living standards for Hawaii's people...To achieve the general economic objectives, it shall be the policy of this state to:...Encourage labor-intensive activities that are economically satisfying... Promote economic activities, especially those which benefit areas with substantial unemployment problems...Encourage businesses that have favorable multiplier effects within Hawaii's economy."

Significant adverse effects are not expected to result from the proposed project. There may be some minor impacts, but these are thought to be offset by the benefits accruing from the project. State and county plans have encouraged quality resort development on the island of Hawaii and the proposed project is the only quality resort project planned for the southeastern part of the island. The infrastructure required to support the project is mostly in place. Additions that may be required would be provided by the developer or would be funded through the increased tax revenues that the project would generate.

The project development plan is consistent with governmental policies calling for increased access to the shoreline and increased recreational facilities and opportunities.

Analysis of the direct, indirect and induced county revenues versus county expenditures the Resort would generate indicates that the benefit/cost ratio would be favorable and range from 2.8 to 2.3, and the state revenue to expenditure ratio would range from 2.9 to 3.2. As indicated in Chapter II, section 3.3, the net fiscal impacts of Punalu'u Resort development to the county and state are estimated by comparison of the projected revenues and expenditures. The state may expect to net approximately $6.6 million to $9.6 million and the county may expect to net approximately $3.5 million to $4.4 million in additional annual revenues at project completion (in 1986 dollars).

While the above analysis does not quantify environmental costs, the adverse environmental impacts of the proposed project are relatively minor, while the positive environmental impacts appear to be significant. Coastal ponds would be preserved and protected, thereby providing habitat for migratory and resident shorebirds; historical and archaeological sites would be protected and incorporated into the development plan, thereby adding to the cultural resources of the county and state and; needed employment, economic and housing opportunities would be provided.

Generally, as discussed in Chapter V, the plan is consistent with relevant government plans and policies. It would fulfill the goals of the Hawaii County General Plan that calls for economic growth that maintains a desired physical environment and that meets the needs of Hawaii's people.

Chapter IX: Unresolved Issues

CHAPTER IX

UNRESOLVED ISSUES

The developer is aware of concerns regarding the proposed project, as expressed by residents and visitors to the project area. These concerns have centered on access to, and use of, the shoreline areas, property ownership, native Hawaiian rights, and increased population levels in Ka'u District. To resolve these issues the developer is continuing to work with the residents of Ka'u and Hawaii County planning agencies. The following is a summary of the major concerns raised by the residents and users of the shoreline areas and the developer's response to those concerns.

Concern: Development of the Resort as planned would lead to greater numbers of people (visitors and Big Island residents) using the coastline area, thereby increasing competition for limited shoreline and nearshore food resources, such as limu and opihi, and potentially increasing pedestrian traffic in and around archaeological/historical sites.

Response: The Resort would be developed to attract greater numbers of both residents and visitors to the area. As such, the development is in keeping with the economic and recreational development policies of both the State and County as defined in the State's Comprehensive Outdoor Recreation Plan and in the County's General Plan. The proposed project will provide greater access to coastal recreation areas and improve those recreational areas, especially Punalu'u Beach Park and the coastline as described in Chapter IV, Sections 5.1.3 and 7. Therefore, providing for better utilization of these areas and a higher carrying capacity.

It is unlikely that many of the Resort visitors to the coastline areas will be there for fishing or other food gathering purposes. As such, there should not be an increase in competition for limited resources due to the Resort, except for the increased Ka'u resident population.

It is likely that foot traffic will increase along the coastline and to the historic sites. The developer is aware of the need to protect these resources and has performed a full archaeological reconnaissance survey (Appendix A) to identify those sites and to determine the specific measures required to protect and preserve those sites and prepared a draft outline of a Historical Sites Management Plan (Appendix K). It is the developer's intention to follow the recommendations of the archaeologist as specified in Appendix A, and the developer will be working with appropriate state and county agencies to ensure that the significant sites are protected and preserved (see Chapter IV, Section 3). In addition, it is the developer's intention to prepare a booklet explaining the fragile nature of the natural and historic resources of Punalu'u and provide that booklet to all visitors to the Resort. Further, interpretive displays and signs will be provided at appropriate locations, explaining the sites and the need to protect those sites thereby aiding in the educational value of the sites. Environmental protection is the responsibility of both the residents and visitors and the developer plans to do all that he can to ensure that the visitors to the Resort respect the sensitive nature and environment of the project site.

Concern: Increased use of treated sewage for golf course irrigation purposes and increased surface water runoff may adversely affect coastal waters and coastal ponds.

Response: The developer is also concerned about this issue and has had water quality, marine biota and water current studies performed to determine the present conditions so that mitigative measures can be developed and implemented. Based on professional review of all available scientific literature, studies conducted in Hawaii and elsewhere and analysis of the specific characteristics of Punalu'u, it has been concluded that the disposal of secondary treated waste water on the golf course is environmentally benign, cost effective, and reduces the requirement for potable water for irrigation purposes (see Chapter IV, Sections 2.4.1.2 and 2.5.1.2). Water quality monitoring that will be performed as part of the Environmental Protection Plan (Appendix H) will provide a means of periodically checking water quality, identifying problems that may occur in the future and provide a rational, scientific basis on which solutions can be developed.

Concern: Construction of Resort facilities on the bluff would adversely affect the shoreline view from the coastal area.

Response: The proposed facilities to be built on the bluff have been designed to fit in with the surrounding views and topography. Although the facilities have been designed to be low rise type structures, the facilities will protrude above the bluff and will be setback 300 to 600 feet from the shoreline. Similarly, although some view planes mauka from the shoreline/ coastal area would be impacted to a limited extent (depending on where the viewer is standing), others would be unaffected including mauka views of the puu's (see Chapter VI, Section 1.8). Makai views of the coastal area and shoreline from the Belt Highway would similarly be affected to some extent. That is, the majority of the views would be retained while others would be impacted to some extent. Makai views of the shoreline and coastal area from the top of the bluff would be unaffected. Relocation of the 8th and 9th golf holes to the coastal area assures that the open space character of the coastal plain would be retained.

Concern: Access by vehicles to the shoreline will be restricted and increased parking and upgrading the beach park will increase competition for limited resources.

Response: Vehicular access to environmentally sensitive portions of the beach and shoreline areas will be closed to provide for increased usage and enjoyment by all people and to protect the plants, animals, some of which are endangered or protected species, and archaeological features. This closure is needed as a conservation measure and is in the best interest of all concerned. As noted in Chapter IV, Sections 5.1.2 and 5.1.3, a new access roadway and parking area near the east side of Ninole Cove will be provided to allow direct access to the shoreline and all present public, pedestrian access routes will be maintained. The county beach park will be upgraded and it is possible that other Big Island groups may want to use the facilities at times for their activities. The park will have new picnicking facilities, more grassed area and specific overnight camping areas set off from day use areas.

Concern: The present improved road that goes to the park and to Ninole Cove will be closed, thereby cutting off evacuation routes and limiting access to the cove.

Response: Punalu'u Road will not be closed, but will be located at the top of the bluff and will connect directly to the existing beach park parking area. It will not restrict access to the beach park, Ninole Cove or cut off evacuation routes (see Chapter IV, Sections 5.1.2 and 5.1.3). Moving the road mauka to higher ground ensures a more reliable evacuation route. As noted previously, providing increased access to the beach park, Ninole Cove and other coastal areas is in keeping with state and county policies.

Additional concerns regarding the types of jobs that will be available at the Resort, increased population levels, increased affordable housing, other changing conditions in Ka'u and other project related environmental concerns, are addressed in detail in the preceding sections of this EIS and are not repeated in this section (see Chapter IV, Section 4).

Other issues that remain unresolved at this time are permitting and procedural issues that this EIS is designed to help resolve. It is believed that these issues can be resolved without undue difficulty.

Chapter X: References

CHAPTER X

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Consulting Archaeologist

Report 237-112686

FULL ARCHAEOLOGICAL RECONNAISSANCE SURVEY

FOR ENVIRONMENTAL IMPACT STATEMENT (EIS)

PUNALU'U RESORT

Proposed Resort Master Plan Project

Ka'u District, Island of Hawai'i

(TMK:3-9-5-19:Var.; 3-9-6-01,02:Var.)

by

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CONTENTS

ILLUSTRATIONS

CONTENT OUTLINE

The following outline is presented as a preliminary format to be followed during preparation of the Punalu'u Resort Cultural Resources Management Plan.

ILLUSTRATIONS (Cont.)

TABLES

INTRODUCTION

At the request of Mr. Leroy Uyehara, Vice President for Ka'u Projects, C. Brewer Properties, Inc., Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted a full archaeological reconnaissance survey of the Proposed Resort Master Plan project area at Punalu'u Resort, Ka'u District, Island of Hawai'i. This work was done in connection with preparation of a Chapter 343 (Haw. Rev. St.) Environmental Impact Statement (EIS) done in connection with a General Plan Amendment (GPA) application to be made to the Hawaii County Planning Department.

Based on the findings of the preliminary archaeological assessment survey (Haun and Rosendahl 1986) conducted by PHRI in January 1986, and on subsequent discussion of those findings with Ms. Virginia Goldstein--staff planner and historic sites specialist in the Hawaii County Planning Department, and with Dr. Ross Cordy--staff archaeologist in the Hawaii State Historic Preservation Office (SHPO), it was determined that a full archaeological reconnaissance survey of the entire project area would be required by the Hawaii County Planning Department and SHPO for any EIS prepared in conjunction with a GPA application, or any subsequent Special Management Area (SMA) permit or rezoning applications.

SCOPE OF WORK

The basic purpose of an archaeological reconnaissance survey is to identify--to discover and locate on available maps--sites or features of possible archaeological significance. A reconnaissance survey is simply a pedestrian, or walk-through, survey--extensive rather than intensive in scope--conducted to determine the presence or absence of archaeological resources within a specified project area. It is used to determine both the general nature and variety of archaeological remains present, and the general distribution and density of such remains. Such a survey permits a preliminary evaluation of the archaeological resources, and facilitates formulation or realistic recommendations and estimates for such further archaeological work as might be necessary or appropriate. Such work could include intensive survey--detailed recording of sites and features, and selected test excavations; and possibly subsequent mitigation--salvage research excavations, interpretive planning, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

Based on discussions with Ms. Virginia Goldstein and Dr. Cordy, the following specific tasks have been determined to constitute an adequate and appropriate scope of work for the full archaeological reconnaissance survey:

1. Conduct literature review consisting of the review of all relevant archaeological and historical reports and primary data (particularly focusing on original field notes, maps,

Table 1. (Cont.)

BPBM Site No. 50-Ha-	HRHP or PHRI Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	Significance Evaluation R	I	C	Comments
-	T-101	Petroglyph	Petroglyph	M	M	H	Single figure, three concentric circles
-	T-104	Wall	Ranching	L	L	L	-
-	T-107	Terrace	Railroad bed	L	M	L	Two sections
-	T-108	Complex (3+)	Undetermined	H	M	H	Possible burials; trail
-	T-109	Wall	Boundary?	L	L	L	Deteriorated
-	T-110	Complex (3+)	Fishing shrine/ Burials	H	H	H	-
-	T-111	Complex (7+)	Burial	H	M	H	Small cemetery
7361	-	Wharf	Shipping/Commerce	L	M/L	L	Deteriorated

APPENDIX A:

SCOPE OF WORK AND CONTENT OUTLINE

FOR PREPARATION OF

PROJECTED CULTURAL RESOURCES MANAGEMENT PLAN

SCOPE OF WORK

The following Scope of Work outlines the tasks to be completed during the development of a Cultural Resources Management Plan (CRMP) for the the Punalu'u Resort. Tasks are concerned primarily with developing guidelines and standards for dealing with the existing known cultural resources.

<u>Specific Tasks to be Performed</u>

1. Establish appropriate standards, guidelines, and procedures for dealing with identified cultural resources (including identification activities, preliminary evaluations of significance, and protection and preservation methods);

2. Develop framework for evaluating significance of cultural resources within the Punalu'u Resort, including consideration of both value modes (scientific research, interpretive, and cultural values) and evaluation criteria;

3. Establish a Cultural Resource Inventory (for known cultural resources, and with provision for additions) which would summarize all cultural resources within the project area in terms of site number, formal type, probable functional identification, nature of previous archaeological work conducted, bibliographic references to previous work, significance evaluation, and appropriate recommendations for further action; and

4. Prepare a written Cultural Resource Management Plan.

and photographs) from work previously done within and immediately adjacent to the project area;

2. Conduct 100% coverage ground reconnaissance survey (variable intensity) of the entire c. 435 acre project area, with emphasis being given to the relocation, recording, and significance reassessment of all previously identified sites, as well as any newly identified sites that might be encountered;

3. Analyze all background literature and field data, and prepare appropriate reports, including a scope of work and content outline for preparation of a projected Cultural Resource Management Plan; and

4. Coordinate and consult with appropriate personnel and specialists in the Hawaii County Planning Department and the State Historic Preservation Office.

The significance of archaeological resources identified within the Punalu'u Resort project area was to be evaluated in terms of potential scientific research, interpretive, and/or cultural value. Research value refers to the potential of archaeological resources for producing information useful in understanding 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, within the framework for significance evaluation used here, refers to the potential of archaeological resources for the preservation and promotion of cultural and ethnic identity and values.

PROJECT AREA DESCRIPTION

The project area consists of approximately 435 acres in the Lands of Ninole, Wailau, and Punalu'u, Ka'u District, Island of Hawai'i (Figure 1). The area extends along the coast from Punalu'u Harbor to Ninole Cove, and inland across State Highway 11 to the Old Government Road (Figure 2). The area ranges in elevation from sea level to c. 400 ft above sea level.

A large portion of the project area consists of the SeaMountain at Punalu'u Golf Course and other developed resort facilities (restaurant, tennis complex, condominiums). Much of the undeveloped land has been previously grubbed. According to Wally Andrade, who was involved in the grubbing activities in 1974, essentially the "whole area was grubbed so you could drive a 4-wheel drive over it" (Andrade, pers. comm.). This work was part of the initial site grading for the planned development complex. Areas that were not impacted include the immediate coastal area, areas along the northeast and southwest project area boundaries, and those in the vicinity of known archaeological sites.

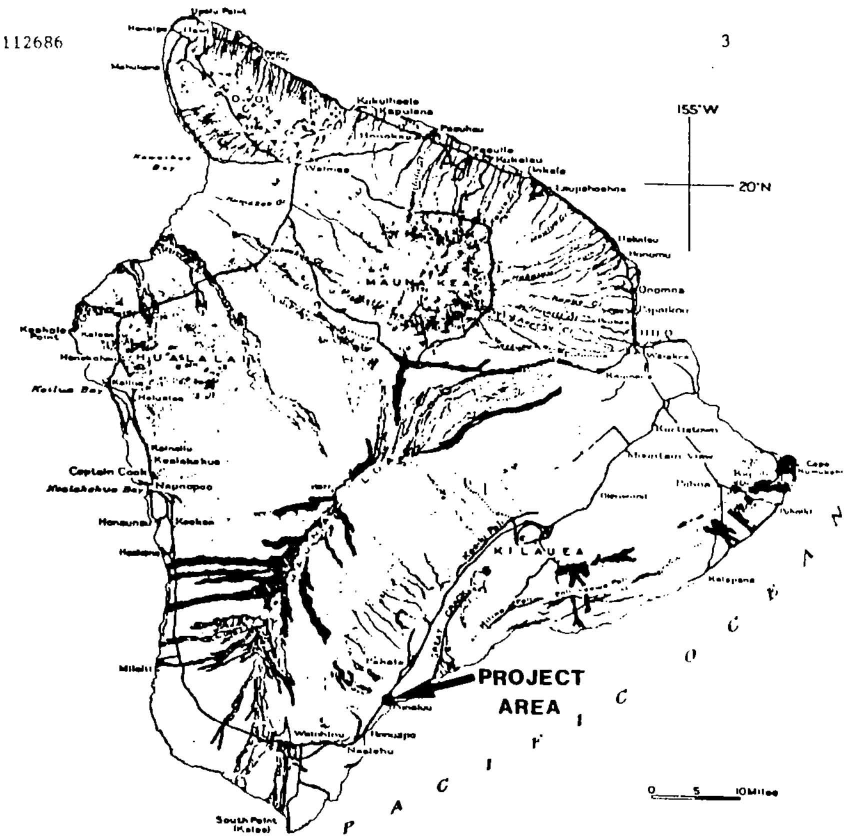


Figure 1. PROJECT LOCATION MAP

Full Archaeological Reconnaissance Survey
Punalu'u Resort
Proposed Resort Master Plan Project
Ka'u District, Island of Hawai'i
(TMK:3-9-5-19:Var.; 3-9-6-01,02:Var.)

PHRI Project 86-237 August-September 1986

(Map taken from Macdonald and Abbott 1970:288.)

Table 1.

SUMMARY OF IDENTIFIED SITES AND FEATURES - PUNALU'U RESORT PROJECT AREA

BPBM Site No. 50-Ha-	HRHP or PHRI Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	*Significance Evaluation R	I	C	Comments
B8-2	3512	Complex (6+#)	<u>Heiau</u>	H	H	H	Lanipao Heiau
B8-3	3513	Petroglyphs (4+)	Petroglyphs	M	H/M	H	Cluster of 4+ figures
B8-5/ B8-37	3515	Terrace	Undetermined	M/L	M/L	L	Other minor features in vicinity
B8-7	-	Complex (5)	Habitation	M/L	M/L	L	-
B8-14	-	Terrace	Habitation	M	M	L	-
B8-15	-	Terrace	Habitation	M	M	L	-
B8-16	-	Enclosure	Habitation	M	M	L	-
B8-31	-	Railroad Bed	Transportation	L	M	L	Predates railroad bed (Site T-107)
B8-32	-	Wall	Undetermined	L	L	L	Built across Site 31
B8-33	-	Platform	Undetermined	M	M	L	Altered; lots of broken glass on surface; supported water tanks
B8-53	-	Platform	Burial?	H	H	H	Identified as possible historic burial

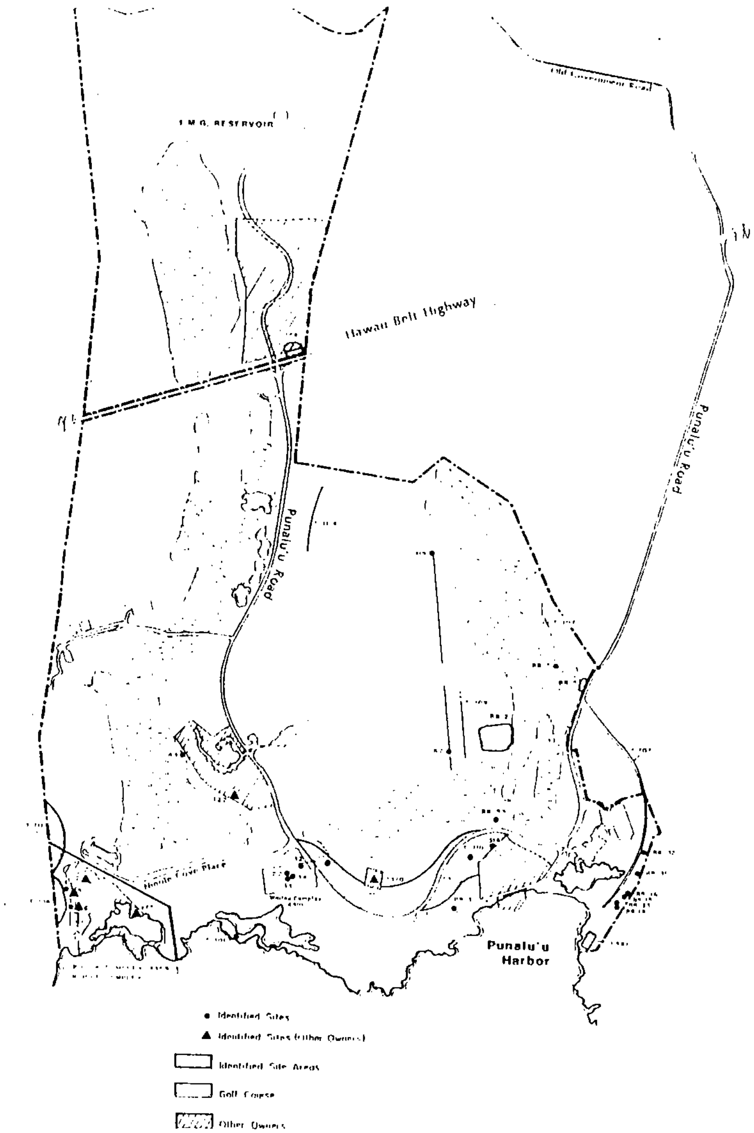
*Significance Evaluation--Nature: R = scientific research, I = interpretive, C = cultural;
Degree: H = high, M = moderate, L = low.

#Number of component features within complex.

A-26

Table 1. (Cont.)

BPBM Site No. 50-Ha-	HRHP or PHRI Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	Significance Evaluation R	I	C	Comments
B9-4	4368/3519	Enclosure	Pen/Corral	M	M	L	Possible habitation use; part of Ninole and Koloa Complexes
B9-7	4368/3522	Complex (2)	School	M	H	M	Old Ninole School; part of Ninole and Koloa Complex
B9-9	4368/3524	Road	Road	L	M	M	Old Government Road; Alanui Aupuni; part of Ninole and Koloa Complex
B9-17	-	Complex (3)	Burial	H	H	H	Cement crypt
B9-22	4310	Mounds (2)	Burials?	M	M	H	Partially bulldozed; cists; part of Wailau Complex
B9-31	4309	Complex (15+)	Habitation/Burials?	M	M/L	H/L	Multiple uses; prehistoric to military
B9-32	4310	Wall	Undetermined	L	L	L	Part of Wailau Complex
B9-33	4310	Terraces (2)	Habitation	M	M/L	L	Part of Wailau Complex
B9-34	4310	Complex (5)	Habitation	M	M/L	L	Part of Wailau Complex
B9-43	4330	Enclosure	Habitation	M	M	L	Adjacent to 18th fairway
B9-62	-	Wall	Ranching	L	L	L	Appears to be portion of B9-119
B9-119	4360	Wall	Ranching	L	L	L	Appears to be portion of B9-62
B9-174	-	Complex (10+)	<u>Heiau</u>?/ Habitation	H	H	H	Poss. <u>heiau</u> complex; site partially within Kalana Subdivision



SITE LOCATION MAP
Punalu'u
KA'U, ISLAND OF HAWAII

FIGURE 2

With the exception of the coast and developed areas, most of the remaining portions of the survey area are densely vegetated. Vegetation in the undeveloped area consists principally of kiawe (Prosopis pallida [Humb. and Bonpl. ex Willd.] HBK.), koa-haole (Leucaena leucocephala [Lamb.] de Wit), Christmas-berry (Schinus terebinthifolius Raddi), lantana (Lantana camara L.), 'ilima (Sida fallax Walp.), and a variety of grasses.

PREVIOUS ARCHAEOLOGICAL WORK

Several archaeological investigations have been undertaken within the Punalu'u Resort project area. The earliest recorded field work was conducted in the early 1900s, when Stokes described the heiau (aboriginal ceremonial sites) located within the project area during his inventory of heiau on the island of Hawaii (Kelly 1980:69-77). Stokes also recorded a petroglyph cluster on the coastal flats between Ninole and Punalu'u village (Cox and Stasack 1970:80-81).

Almost 50 years later, the first systematic surveying and recording of sites was started by Violet Hansen. In 1968, she recorded archaeological sites in the vicinity of Puhau (Ninole Spring) (Hansen Ms.). Much of what is known about the archaeology of Ninole/Wailau and Punalu'u ahupua'a can be directly attributed to the efforts of Violet Hansen. Often working alone, she identified and recorded many sites. She assisted on later survey projects, and was always ready to volunteer her time and knowledge to further the awareness and understanding of Hawaiian archaeology. She worked hard to educate present generations about their responsibilities to the cultural resources within the district. That tanned, gray-haired lady in the palaka shirt is a part of this area's history, and will be fondly remembered.

Barrera and Hommon (1972) report the results of a survey conducted in 1970 and subsequent excavations undertaken in 1971. The work was conducted by the B.P. Bishop Museum for the Ka'u Historical Society, and was funded by C. Brewer and Co. prior to construction of SeaMountain at Punalu'u Resort. The survey was limited to that portion of Wailau/Ninole between the coast and Hawaii Belt Road. The archaeological work was conducted for "...the purpose of locating and salvaging sites of archaeological or historical interest within the boundaries of that area" (Barrera and Hommon 1972:iii).

Barrera and Hommon state that "...one hundred and eleven archaeological sites were found and recorded" (1972:4) during the survey in 1971; however, their serial listing of sites includes 114 sites. Of the sites recorded by Barrera and Hommon in 1970-1971, 108 are situated within the present project area. The sites are comprised of 216 component feature types including; walls, C-shapes, rockshelters, platforms, enclosures, depressions, terraces, midden deposits, mounds, pavements, caches, graves, and an alignment.

Eighteen sites are described by Barrera and Hommon in the section of their report entitled "Sites Excavated During 1971 Excavations" (Sites

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50-HA-B9-18,* 19, 20, 23, 33, 34, 43, 48, 56, 66, 69, 70, 72, 75, 76, 110, 171, and 172); all are located in the present project area. A total of 32 one-meter-square test excavation units were excavated at 15 sites. Surface collections were made at two other sites (B9-18 and B9-19). A description of Site B9-48 is also included in this section of the report; however, there is no mention of surface collections or excavations at the site.

Excavations and surface collections produced a variety of historic and traditional Hawaiian artifacts. Historic artifacts consisted of buttons, metal, glass fragments and complete bottles, leather, crockery, pottery, slate fragments, and recent trash (plastic, rubber, etc.). Traditional artifacts consisted of abraders, a fishhook fragment, pounders, worked wood, volcanic glass flakes, a cowrie shell octopus lure, echinoid spine files, grindstones, and a "phallic stone." Midden materials included marine shell, echinoid remains, charcoal and ash, kukui nut shells, bone, and fish scales.

Based on their survey and excavation results, Barrera and Hommon concluded that most of the sites represent historic period occupation of the area, and suggest the absence of prehistoric sites was due to their probable destruction by the 1868 earthquakes and tidal wave. They also provided the following recommendations:

> The sites recommended for preservation fall into two general categories. One (including B9-21, -23, -43, -48, -73, -82, -121, and -123) consists of habitation-associated features, either particularly well built or typical structures. The preservation, stablization, and integration of these features into an interpretive plan exemplifying the history of Ka'u District would provide a valuable amenity to the resort development to be enjoyed by visitors and residents alike.
>
> The remaining recommended sites (B9-22, -55, -56, -59, and -122) are either definite or probable burials, and in addition to their structural and historic interest, local residents have requested that these features be left undisturbed (Barrera and Hommon 1972:33).

The above recommendations apply to a total of 13 sites. No recommendations are made for the other 111 sites, which implies that no further work was considered necessary. At least 76 of these sites were subsequently destroyed by construction activities.

Crozier and Barrera (1974) describe the results of surveys and test excavations conducted in 1972 and 1973 in three survey areas (two located in the vicinity of Punalu'u Harbor and one area inland of the Hawaii Belt

*B.P. Bishop Museum (BPBM) site designation system: all site numbers prefixed by 50-Ha-B8 or 9- (50=State of Hawaii; Ha=Island of Hawaii; B=Ka'u District; 8=Land of Punalu'u, 9=Lands of Ninole and Wailau).

Road). Crozier (1972) reported the findings of the surveys in a separate report which was later incorporated into Crozier and Barrera (1974). This project was also conducted by the B.P. Bishop Museum for the Ka'u Historical Society and funded by C. Brewer and Co., Ltd. The stated purpose of the work was to identify "...sites of archaeological or historical interest within four areas contemplated for resort and residential development" (Crozier and Barrera 1974:iii).

On the basis of a preliminary survey by Violet Hansen in 1971 and additional survey in 1972, Crozier and Barrera identified and recorded 32 sites given permanent Bishop Museum numbers, and an additional 236 sites assigned temporary numbers. Of the total 268 sites, 14 were situated in the present project area (all sites in the project area were given permanent numbers). The sites consisted of a variety of archaeological features, including enclosures, platforms, terraces, ahu, shelters, a historic railroad bed, and walls. Sites within the present project area were interpreted as habitation complexes (B8-7, B9-173 and B9-174), heiau (B8-2 and B8-36), permanent housesites (B8-14, B8-15, B8-16, B8-33), temporary housesite (B8-32), railroad bed (B8-31), and grave (B8-53). Two sites, B8-8 and B8-52, were described only as platforms that had been severely damaged by recent bulldozing, as had the B8-36 heiau which had been completely destroyed.

Test excavations (12 square meters total area) were conducted at five sites (B8-2, B8-17, B8-27, B8-30, and B9-173). The excavations produced marine shell, echinoid remains, coral fragments, charcoal and ash, bone, waterworn pebbles, and volcanic glass artifacts. Volcanic glass from several sites dated from AD 1520 to 1658.

The Crozier and Barrera report provides little in the way of specific site interpretations, but does provide recommendations. For Survey Area I (most of this area is outside the present project area, on the east side of Punalu'u Harbor), they made the following recommendations:

> 1. Equipment should not be allowed off the existing road ways in Area I; equipment operators, as well as management personnel should be made aware of this policy.
> 2. A full-scale archaeological research program should be carried out in Area I, involving excavation, stablization, and possible restoration of selected sites.
> 3. On completion of excavations a list of those sites that should be preserved should be made (Crozier and Barrera 1974:33).

For Survey Areas II (west side of Punalu'u Harbor) and III (inland of Hawaii Belt Road), preservation was recommended for Sites B8-53 and B8-37; preservation, excavation, stablization, and restoration were recommended for Site B8-2; excavation was recommended for B9-174; and no further work or preservation was recommended for Sites B9-173 and B8-7. No mention is made of Sites B8-8, B8-36, and B8-52, presumably because these sites had

Table 2. (Cont.)

Site Number BPBM	HRHP/PHRI	Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
B9-31	4309	+	-	-	*	+	-	-	*
-	T-108	+	-	-	*	+	-	-	*
Subtotal: 2		2	0	0	2	2	0	0	2
B8-5	B8-37/3515	+	-	+	-	+	-	+	-
B8-14	-	+	-	+	-	+	-	+	-
B8-15	-	+	-	+	-	+	-	+	-
B8-16	-	+	-	+	-	+	-	+	-
B8-31	-	+	-	+	-	+	-	+	-
B8-32	-	+	-	+	-	+	-	+	-
B8-33	-	+	-	+	-	+	-	+	-
B8-53	-	+	-	+	*	+	-	+	-
B9-4	4368/3519	+	-	+	-	+	-	+	-
B9-7	4368/3522	+	-	+	-	+	-	+	-
B9-9	4368/3524	+	-	+	-	+	-	+	-
B9-22	4310	+	-	+	*	+	-	+	-
B9-43	4330	+	-	+	-	+	-	+	-
Subtotal: 13		13	0	13	2	13	0	13	0
B8-7	-	+	-	-	-	+	-	-	+
B9-32	4310	+	-	-	-	+	-	-	+
B9-33	4310	+	-	-	-	+	-	-	+
B9-34	4310	+	-	-	-	+	-	-	+
-	7361	+	-	-	-	+	-	-	+
Subtotal: 5		5	0	0	0	5	0	0	5
B9-62	-	-	+	-	-	-	+	-	+
B9-119	4360	-	+	-	-	-	+	-	+
-	T-104	-	+	-	-	-	+	-	+
-	T-107	-	+	-	-	-	+	-	+
-	T-109	-	+	-	-	-	+	-	+
Subtotal: 5		0	5	0	0	0	5	0	5
Total: 32		27	5	20	11*	27	5	20	12*

*Includes possible burial sites; therefore, a provisional assessment, definite assessment pending further data collection (i.e., testing features for presence/absence of skeletal remains).

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been largely destroyed prior to the time of the survey. As with the previous report, the absence of site-specific recommendations implies no further work was considered necessary, and these sites were subsequently destroyed by construction activities.

At the request of Hawaiiana Investment Co., Inc. (prior name of C. Brewer Properties, Inc.), Violet Hansen conducted several limited reconnaissance surveys during the 1970s (Hansen 1974a, 1974b, 1974c, n.d.). The surveys covered areas generally to the north and west of the current project area. Hansen was also involved in monitoring the grubbing activities in 1974 (Andrade, pers. comm.). Additional correspondence by Hansen included a letter to Dr. Pila Kikuchi concerning the fishponds at Ninole (Hansen 1978). Dr. Yosihiko Sinoto of Bishop Museum also documented his participation on a survey of Ku'ipo, Punalu'u--an area immediately inland of the project area, and included recommendations for further work (Sinoto 1970).

One site within the Wailau Complex, 50-Ha-B9-21, was excavated by Bishop Museum during 1973 (Kaschko 1973). The salvage excavations were conducted for Hawaiiana Investment Co., Inc. According to Kaschko:

> [T]he site was almost entirely excavated and found to be a late-historic-period house site. More than 100 artifacts were recovered, most of them unknown to precontact Hawaii. Midden material collected during excavation presents an interesting composite of indigenous and imported items (1973:1).

Artifacts recovered from Site B9-21 included a hatchet, ground-slate fragments, buttons, bottle glass, buckles, a metal fishhook, rivets, iron nails, brass nails, lead fragments, kerosene-lantern fragments, plastic comb fragments, a harmonica fragment, a pipe-stem, hinge fragments, and other metal objects and fragments (Kaschko 1973:8). Indigenous artifacts were limited to three coral abraders, two hammerstones, a volcanic-glass flake, and one possible lava abrader (Kaschko 1973:8).

In Emory's 1970 "Inventory of Archaeological and Historical Sites in the District of Kona and Ka'u and in Anaehoomalu, South Kohala, Island of Hawaii" (1970), Hawaii State site numbers were given to several of the sites within the project area. Additional site numbers from the Hawaii Register of Historic Places (HRHP) were assigned during the Statewide Inventory of Historic Places in the 1970s. The site designations for the Ka'u district are currently being sorted out by Ms. June Cleghorn, who is under contract to the Historic Sites Division, Department of Land and Natural Resources, State of Hawaii (DLNR).

In 1980, two surveys were conducted adjacent to the project area. Violet Hansen surveyed and mapped six acres east of the project boundary and inland of Punalu'u Nui Heiau (Hansen 1980). Lloyd Soehren conducted a reconnaissance survey of a 90 acre parcel, extending inland of the fifth and sixth fairways to State Highway 11 (Soehren 1980).

A historical sketch of nine Ka'u <u>ahupua'a</u> in the Bishop Museum report "Majestic Ka'u: Mo'olelo of Nine Ahupua'a" (Kelly 1980) includes the <u>ahupua'a</u> of Ninole, Wailau, and Punalu'u, and provides much documentary material on the mythology, early descriptive accounts, Land Commission Awards (LCAw), settlement patterns, and land use of this area. The project was conducted by Bishop Museum for the Ka'u Historical Society. Kelly includes a list of all Land Commission Awards for the <u>ahupua'a</u> of Ninole, Wailau, and Punalu'u in Appendix G (1980:112).

Within the last two years, summaries of previous archaeological work and listings of existing archaeological sites within the Punalu'u Resort project area were prepared by Phillips, Brandt, Reddick & Asso. (Hawaii), Inc. (1984, 1985) for various permit applications. They state:

> Since 1972, considerable development has occurred at Punalu'u..., 47 of the 129 sites are still in existence.... Twenty-two of the sites recommended for preservation in 1972 have been protected; 4 were evidently inadvertently covered during construction or destroyed in recent tsunamis or flooding.... As noted in the resort master plan, the plans are to protect the burials, restore the heiau, and to incorporate the important sites into a pedestrian network with educational and interpretive information (Phillips Brandt Reddick & Associates 1985:Sec.4, Chapter XI-4).

In connection with a pending rezoning request (R85-27) and a Special Management Area (SMA) permit application (SMA 85-13), a preliminary archaeological assessment of archaeological resources was made by Paul H. Rosendahl, Ph.D., Inc. (PHRI) in January 1986 (Haun and Rosendahl 1986). The preliminary assessment field work attempted to relocate a total of 43 sites within the project area, including 22 that had been previously recommended for preservation. The 1984 map prepared by C. Brewer Properties, Inc. had a total of 47 sites plotted on it, which correspond to the sites listed in Table 9A, "List Of All Historic Sites Listed By The Bishop Museum Currently Existing In The Project Area," in "Attachment; Exhibit 1" (Phillips Brandt Reddick 1985:7-11).

All sites listed in Table 9A (Exhibit 1) for inland Ninole/Wailau (B9-174) and coastal Punalu'u (B8-2, B8-7, B8-14, B8-15, B8-16, B8-31, B8-32, B8-33, and B8-53) were relocated. Of the 37 sites listed for coastal Ninole/Wailau, 32 are within the current project area and five (Sites B9-5, B9-6, B9-121, B9-122, and B9-123) are outside the area. Of these 32 sites, only ten were relocated during this inspection. Six sites (B9-57, B9-58, B9-60, B9-61, B9-64, and B9-84) appeared to have been covered and/or destroyed by flooding in the lower portion of Ninole Stream. Three sites (B9-22, B9-23, and B9-48) previously recommended for preservation have been partially or completely destroyed by subsequent construction. Nine sites (B9-18, B9-19, B9-21, B9-95, B9-98, B9-110, B9-119, B9-120, and B9-172) were determined to have been either destroyed or improperly located on the 1984 map. The field team did not attempt to relocate Sites B9-42, B9-62, B9-108, and B9-109. Haun and Rosendahl cautioned that for the six sites along the drainage which empties into Ninole Cove, and for the nine sites thought to have been destroyed or work will be specified in a scope of work to be reviewed and approved by the Historic Sites Section and the County of Hawaii--Planning Department. The archaeological consultant has been contracted to prepare a general scope of work and content outline for preparation of a projected Cultural Resource Management Plan as one task of the current reconnaissance survey project work (Appendix A). It must be emphasized that archaeological work here is not to be archaeological data recovery, but limited gathering of information for interpretation.

The remaining seven of 27 sites requiring futher data collection will either be preserved "as is," with no futher archaeological work or interpretive work, or undergo archaeological data recovery. Data recovery would be in two stages and will include osteological analyses and subsequent reinterments if burials are removed. Again, data recovery plans would be reviewed and approved by the State of Hawaii--Historic Preservation Office and the County of Hawaii--Planning Department, and execution of these plans would be verified by these offices.

Burial sites will be preserved if practical; however, if they cannot practically be preserved in place, they will be disinterred and reinterred according to State Health Department rules and procedures, and in consultation with any documented direct lineal descendents.

The final concern is with the clearing of Ninole Pond. Plans for any work in the general vicinity of the ponds need to be reviewed and approved by the State of Hawaii--Historic Preservation Office, the County of Hawaii--Planning Department, and the U.S. Army Corps of Engineers. This work will have to undergo separate compliance with the U.S. National Historic Preservation Act of 1966 (as amended).

During project area construction grading, all archaeological sites within the area will be adequately flagged, and a sufficient buffer established to protect the resources. Monitoring is recommended for all archaeologically sensitive areas. Should subsurface features be encountered, all site grading in that area will cease, and the applicant will notify the County of Hawaii--Planning Department. Professional archaeologists will be summoned to examine the finds, and recommend appropriate mitigative actions.

Table 2.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS PUNALU'U RESORT PROJECT AREA

Site Number		Significance Category				Recommended Treatment			
BPBM	HRHP/PHRI	A	X	B	C	FDC	NFW	PID	PAI
B8-2*	3512#	+	–	+	+	+	–	+	–
B8-3	3513	+	–	+	+	+	–	+	–
B9-17	–	+	–	+	+	+	–	+	–
B9-174	–	+	–	+	+	+	–	+	–
–	T-101	+	–	+	+	+	–	+	–
–	T-110	+	–	+	+	+	–	+	–
–	T-111	+	–	+	+	+	–	+	–
Subtotal: 7		7	0	7	7	7	0	7	0

General Significance Categories:

A=Important for information content, further data collection necessary (PHRI=research value);
X=Important for information content, no further data collection necessary (PHRI=research value, SHPO=not significant);
B=Excellent example of site type at local, region, island, State or National level (PHRI=interpretive value);
C=Culturally significant (PHRI=cultural value).

Recommended General Treatments:

FDC=Further data collection necessary (intensive survey and testing, and possibly subsequent data recovery/mitigation excavations);
NFW=No further work of any kind necessary, sufficient data collected, archaeological clearance recommended (preservation not essential), no preservation potential (possible inclusion into landscaping suggested for consideration);
PID=Preservation, with some level of interpretive development recommended (including appropriate related data recovery work);
PAI=Preservation "as is," with no further work (NFW), preservation not essential with possible inclusion into landscaping. If further data collection (FDC) is recommended, then the site is to be preserved until work is completed.

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*B.P. Bishop Museum site (BPBM) designation system: all site numbers prefixed by 50-Ha-B8- or B9- (50=State of Hawaii, Ha=Island of Hawaii, B=District of Ka'u, 8=Land of Punalu'u, 9=Lands of Ninole and Wailau).

#Hawaii Register of Historic Places (HRHP) site designation system: all four-digit site numbers prefixed by 50-10-68- (50=State of Hawaii, 10=Island of Hawaii, 68=USGS 7.5' series quad map, "Punalu'u, Hawaii").

T- =Sites recorded by PHRI in 1986.

incorrectly plotted on the 1984 site map, final determination of their current status must await a more intensive attempt to relocate them, using original field records from the earlier archaeological work (1986:7).

Haun and Rosendahl reviewed the recommendations given in previous reports and presented them as follows:

> The recommendations in the Hommon and Barrera report call for preservation of 13 out of a total of 114 sites because the sites are "particularly well built or typical structures" or because "local residents have requested that these features be left undisturbed" (Hommon and Barrera 1972:33). One can only assume the authors believed no further work was necessary for the remaining sites.
>
> The Crozier and Barrera report contains recommendations written by Crozier for Survey Area I and by Barrera for Survey Areas II and III. Crozier appropriately refrains from making any recommendations until the sites in his area are more fully studied (Crozier and Barrera 1974:33). As discussed previously, Barrera provides recommendations which range from preservation to no preservation for six sites of nine sites; presumably the sites which are not discussed are also not recommended for preservation. The bases for Barrera's recommendations purportedly include state of preservation, interpretive potential, and research value (Crozier and Barrera 1974:34-35), but supporting justification is frequently lacking.
>
> Although not explicitly stated, the recommendations contained in the reports are based on criteria which continue to be used today (i.e., scientific research value, interpretive value, and cultural value); however, the practice of giving no specific site recommendation when no further work is considered necessary or appropriate is not acceptable today. In general, the explicit and implicit recommendations for no further work are not appropriate, given the level of site recording and interpretation contained in the 1972 and 1974 reports. Today, recommendations for treatment of archaeological and historical resources must be justified in terms of specific research problems, interpretive themes, and/or cultural values.
>
> During the intervening 10 to 15 years since the earlier work was conducted, there have been many advances in our knowledge of Hawaiian prehistory, and in the techniques and requirements of archaeology. Many of the smaller, less impressive sites, which a decade ago were frequently considered of little scientific value, are now known to contain important information. Coincident with these advances in prehistory and archaeology, various laws and guidelines have been developed and implemented which are designed to insure proper treatment of our cultural resources. These laws and guidelines specify the level of work (intensive survey) necessary to determine significance, and significance criteria (1986:8-9).

In summary, Haun and Rosendahl determined the following: (a) the site recording in the previous archaeological reports (Barrera and Hommon 1972, and Crozier and Barrera 1974) to be incomplete, based upon currently accepted standards; (b) discussions of excavated sites to be insufficient and difficult to follow; and (c) site interpretations and recommendations were limited or lacking (1986:8-9). Based on the one-day field check of 21 relocated sites, a literature review, and consultation with Ms. Goldstein of the Hawaii County Planning Department, an adequate and appropriate scope of work was determined for the subsequent full archaeological assessment.

A field inspection of the area south of Ninole Cove and north of Koloa Beach was carried out in February 1986 by PHRI Supervisory Archaeologist Margaret L.K. Rosendahl (Rosendahl 1986). A segment of a kerbstone trail, with only a short portion entering the project area, was identified.

FIELD METHODS AND PROCEDURES

Reconnaissance field work was carried out from August 25 through September 4, 1986 by PHRI Supervisory Archaeologist Robert Spear and PHRI Assistant Field Archaeologists Richard Gilman, Roy Pua-Kaipo, and Mikele Fager. PHRI Supervisory Archaeologist Margaret L.K. Rosendahl was on-site two days during the initial field work to review progress and meet with informants. Another one-day session with informants was held on September 15, 1986 by M. Rosendahl who, assisted by M. Fager, completed the site evaluations field work on October 2, 1986. As directed by Item 1 of the Scope of Work, PHRI was to use the original field records to evaluate the relocated sites. Two days were spent in Honolulu, at Bishop Museum and the Historic Sites Section office, reviewing all records associated with the Punalu'u Resort project area. Copies of existing forms were made available at the Historic Sites Section. In the case of Bishop Museum, documentary materials relevant to the project were identified and copies requested. PHRI was subsequently notified that museum policy prohibited copying of all the requested field records; therefore, a second request was made for specific site records. The final day of field work involved using copies of the original site records to re-evaluate existing sites. A total of 292 man-hours were expended in carrying out the reconnaissance survey field work. All field records are on file with PHRI in Hilo.

The present PHRI reconnaissance survey consisted of 100% ground coverage by means of a series of pedestrian transects across the undeveloped portions of the project area. Transects of the major survey areas involved walking 20.0 to 30.0 m apart. All sites were flagged with pink flagging tape, and identified with the previously assigned site number or, if a new site, a temporary field number (T-____) was assigned. Each site, or primary feature within a site complex, was marked with an aluminum tag bearing the site number, date PHRI project number (86-237), and the letters "PHRI." Flagging tape with the site number written on it was wrapped around a rock and placed on the structure as an aid to future site identification. After the initial reconnaissance, the area was then resurveyed includes platforms, enclosures, terraces, rock shelters, walls, and petroglyphs--all apparently prehistoric in origin. The historic period is documented by the presence of railroad beds, a wharf, a cement tomb, walls, and enclosures.

The existing sites are generally located in the coastal third of the project area. Only one site, B9-174, is located inland of the Hawaii Belt Highway. Three major clusters of sites identified include: Sites B8-14, B8-15, B8-16, B8-31, B8-32, B8-33, 7361, and T-107 along the northeast boundary; Sites B9-4, B9-7, B9-9, T-108, and T-111 situated on the cliffs overlooking Puhau at the southwest boundary; and a grouping of sites (B8-3, B9-17, B9-22, B9-31, B9-32, B9-33, B9-34, and T-110) located in the central coastal area. Four walls (Sites B9-62, B9-119, T-104, and T-109) remain in the area northeast of Punalu'u Road and inland of the second fairway. Site B8-2, Lanipao Heiau, is located in the vicinity of these walls, inland of the second green and to the southwest of the third fairway. The remaining sites (B8-5, B8-7, B8-53, B9-43, T-101, and an inland remnant of T-107) are located across the coastal portion as isolated sites.

Tentative functional interpretations for the existing sites are based on recent reconnaissance survey findings and information generated by previous studies. One site, B8-2, is a named heiau (Lanipao), while another complex (Site B9-174) has been functionally identified as a probable heiau. This site is partially located within a privately owned lot within Kalana Subdivision. A petroglyph cluster (Site B8-3) and a single figure (Site T-101) are located along the coast. A ku'ula (fishing shrine) (Site T-110) is located south of Punalu'u Bay, and has two known burials immediately inland of it. A burial cave was described as being located beneath the ku'ula and subsequently concealed by rockfall (Hanoa, pers. comm.). During the reconnaissance survey the area was examined and, although no cave entrance was located, the purported existence of the cave has been recorded. Other burials are present at Site T-111 and at the historic tomb (Site B9-17). Site B9-53 has been described as a burial platform and Site B9-22 as a burial crypt. Two sites (B9-31 and T-108) may also contain burials. A suspected burial within Site B9-31 is identified as B9-31A on Figure 2.

Most of the remaining sites appear to be associated with both prehistoric and historic habitation (Sites B8-7, B8-14, B8-15, B8-16, B9-31, B9-33, B9-34, and B9-43), though most are generally associated with historic period activities. Site B9-4, described as a corral, may also have had habitation use. The function of the large terrace, Site B8-5, is undetermined.

Specific sites were identified as a historic school (Site B9-7), wharf (Site 7361), and the Old Government Road (B9-9). Evidence of the railroad (Sites B8-31 and T-107) and ranching (Sites B9-62, B9-119, T-104) are present. Site B8-33, a large platform, includes modifications to support two water tanks, and appears to have been used most recently with the railroad and wharf during the early 1900s. Two walls (B8-32 and B9-32) appear to be associated with adjacent habitation features, whereas the remaining wall (Site T-109) may be an old boundary wall.

EVALUATIONS AND RECOMMENDATIONS

The significance of archaeological resources identified during the reconnaissance survey were evaluated in terms of potential scientific research, interpretive, and 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, within the framework for significance evaluation used here, refers to the potential of archaeological resources for the preservation and promotion of cultural and ethnic identity and values.

Findings, evaluations, and recommendations of the recent PHRI archaeological reconnaissance have been reviewed with Ms. Virginia Goldstein of the Hawaii County Planning Department. Ms. Goldstein concurred with the conclusions and recommendations of the archaeological reconnaissance. Dr. Ross Cordy of the State Department of Land and Natural Resources, has been consulted throughout the recent reconnaissance survey. Dr. Cordy is familiar with the Punalu'u sites, as he initially compiled site information using published reports and State Historic Preservation Office files. This work was done for the 1984 "Request for a Change of Zone and Special Management Area Permit."

Based on the findings of the full reconnaissance survey, archaeological sites within the Punalu'u Resort project area appear to be, for the most part, of moderate to high significance in terms of potential scientific research, interpretive, and cultural values (see Table 1). This conclusion is in part due to the paucity of remaining archaeological sites existing within the project area. Most of the previously recorded sites not identified for preservation during the 1970s field work have been destroyed. Twenty of the 32 existing sites have been recommended for preservation. Fourteen of these sites had been recommended for preservation by Barrera and Hommon (1972), and by Crozier and Barrera (1974).

To facilitate outside review, general significance assessments and recommended general treatments for all existing sites within the Punalu'u Resort project area are summarized in Table 2. Based on findings of the 1986 PHRI reconnaissance survey, it is believed that all sites present within the project area have been identified and evaluated. At present, 20 sites are recommended for preservation with some level of interpretive development. The remaining 12 sites have been given a preservation "as is" recommendation. A tentative recommendation of preservation "as is" has been given to the two remaining sites suspected of being burials.

Twenty of the 27 sites requiring further data collection are recommended for preservation with some level of interpretive development. Additional archaeological work will occur at these sites to aid interpretation. The plans for the archaeological work and interpretive in greater detail while recording all information on standard PHRI site survey record forms. Site locations were plotted on a black-and-white photograph (R.M. Towill Corp., Photo No.8120-2, 1"=200' scale, 1/4/82)

As outlined in the scope of work, the focus of the field work was to identify all sites and features within the survey area. This work involved relocation of previously identified sites, and identification and brief description of all previously unidentified sites. In addition, all newly identified sites were photographed in 35 mm black-and-white (PHRI Rolls No. 514, 515, and 529. Scaled plan maps (tape and compass) were drawn of Sites B9-17, B9-31 (portion), B9-43, T-108 (U-shape), and T-111.

FINDINGS

A total of 32 sites (83+ component features) were identified within the overall project area. Of these, 25 sites (66+ features) had been previously recorded and seven sites (17+ features) were newly identified. Formal types encountered include platforms, enclosures, terraces, rock shelters, walls, and petroglyphs. Table 1 (at end) summarizes identified sites with respect to formal type, tentative functional interpretation, and preliminary evaluation of site significance. Site locations are indicated on Figure 2.

Site descriptions are given for individual sites and, in the case of three clusters of sites, the descriptions are presented as part of these groupings. The three site clusters include two complexes of sites (Koloa Complex, 4368*; and Wailau Complex, 4310) formally consolidated during the Statewide Inventory of Historic Sites conducted during the 1970s, and sites in close geographical proximity that appear to be temporally related (Punalu'u Harbor Complex).

In many cases, sites have been previously assigned both a Bishop Museum (BPBM) site designation and a Hawaii Register of Historic Places (HRHP) site number. Wherever possible, correlations are made and any discrepancies are clarified.

SITE DESCRIPTIONS

B8-2 (3512) Complex

This complex is the largest and most impressive site within the project area. Crozier and Barrera provided the following background information:

> ...Lani means having a heavenly or holy character, and pao is arch of a bridge or the bridge itself [one of many definitions] (Andrews, 1922). This heiau is said to have been built by Laka, of Kauai (Stokes, 1919:6). Although we have no definite evidence that the heiau was constructed by Laka, we do have a reference by Kamakau (1964:41) that Laka, the son of the famous ancient chief Wahieloa, brought his father's bones from this area, Punalu'u, in Ka'u on Hawaii and buried them along with the bodies of other famous chiefs in a cave at Papaluana, near the village of Kipahulu, Maui (1974:11).

*Hawaii Register of Historic Places (HRHP) site designation system: all four-digit site numbers prefixed by 50-10-68- (50=State of Hawaii, 10=Island of Hawaii, 68=USGS 7.5' series quad map [Punalu'u, Hawaii]).

Lanipao Heiau is comprised of a minimum of six component features. A standing wall encloses the north, west, and south limits of the complex, and measures a maximum of 2.0 m high and 1.5 to 2.5 m in width. In general the interior walls are also quite massive, measuring 1.0 to 2.0 m in width and 0.4 to 1.0 m high. Interior features include an enclosure with overall dimensions of 24.0 by 24.0 m; a smaller enclosure off the west wall of the central enclosure measuring 7.0 m on a side; a triangular platform with a 23.0 m front, located in the north corner of the enclosing wall; a C-shape with a 5.0 m opening; an 'ili'ili and coral paving measuring approximately 12.0 m in diameter; and another paved area of comparable size comprised of small aa.

The site was initially described by Stokes (Crozier and Barrera 1974: 11); then field checked by Hansen (Ms.) in 1971. The site was mapped and tested during the Crozier and Barrera survey (1974:11-15). At that time, four test pits excavated in the site revealed a 15 to 20 cm thick pavement, documenting the contemporaniety of the two smaller dwelling features (Crozier and Barrera 1974:11-15). The site presently under dense vegetation and in good condition, is recommended for preservation and interpretive development.

B8-3 (3513) Petroglyphs

Figure 3

This cluster of petroglyphs is located immediately north of the Punalu'u Beach Park parking lot. The figures are located on a relatively flat pahoehoe surface measuring 10.0 by 7.0 m. A minimum of four figures were visible, though additional figures can be seen under optimum viewing conditions. The four figures include three human figures with a triangular body type and another human figure in the "simple, lineal, angular" style (Cox and Stasack 1970:49). Each figure measures approximately 50 to 60 cm in diameter.

This site appears to be the remnant of a petroglyph cluster initially described by Stokes in the early 1900s (Cox and Stasack 1970:81) as a cluster of approximately 25 figures including "linear figures, curved arms and legs, family groups--fish(?)--dots-circles" (1970:81). It appears that a portion of the outcrop likely containing the majority of the petroglyphs was removed during parking lot construction. This site is recommended for preservation and interpretive development.

Figure 16. SITE 7361, CLOSE-UP OF INSCRIPTION. View to east. (PHRI Neg.514-31A)

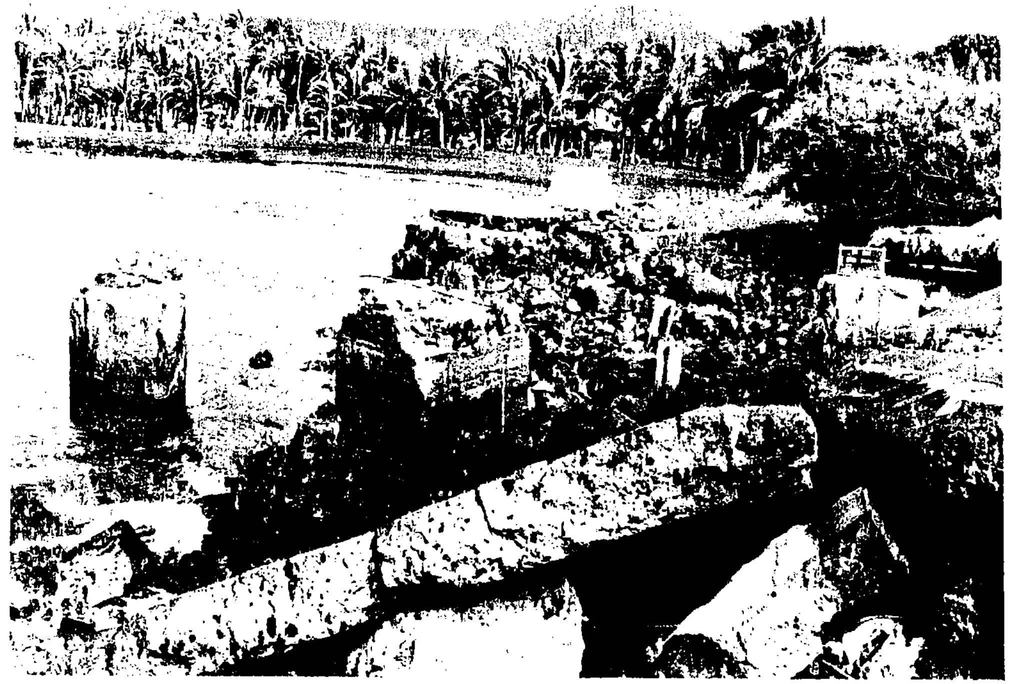


Figure 17. SITE 7361, WHARF OVERVIEW. View to east. (PHRI Neg.514-33A)

Figure 3. SITE B8-3, PETROGLYPHS. View to north.
(PHRI Neg.529-2A)

Site B8-5 (B8-37/3515) Terrace

Site B8-5 was initially described by Hansen (Ms.) and assigned site number B8-5 during the 1972 survey by Crozier (1972:17). The site was given another site number, B8-37, in the Crozier and Barrera report (1974:19). The site, comprised of a terrace measuring approximately 17.0 by 25.0 m, is intact along the south and east faces. The terrace paving is mostly small as pebbles with some 'ili'ili, coral, and shell. Much of the feature appears to cover an existing outcrop. Additional minor features were noted in the vicinity.

This site, recommended for preservation by Crozier and Barrera (1974:34), is under dense koa-haole and situated north of the SeaMountain at Punalu'u Golf Course sixth fairway, and remains in fair condition.

B8-7 Complex

This site, in the middle of the SeaMountain at Punalu'u Golf Course sixth fairway, has been preserved. The site periphery appears to have been bulldozed during golf course construction, although the interior portion remains intact. The features are located on an uplifted pahoehoe outcrop, and include a minimum of two crude platforms and two enclosures. The platforms measure approximately 2.0 to 3.5 m on a side and 0.5 to 0.8 m high. The enclosures incorporate existing large boulders and have overall measurements of 2.5 to 3.0 m on a side. The enclosure walls average 0.7 to 0.8 m high and 1.0 to 1.5 m wide. It appears the dense vegetation cover obscures additional features. Crozier and Barrera briefly described and mapped the site (1974:18).

Punalu'u Harbor Complex

Sites B8-14, B8-15, B8-16, B8-31, B8-32, and B8-33 comprise a complex of features located immediately north of the wharf (Site 7361) along the northern boundary of the project area. The sites appear to be associated with historic period shipping activities. In Kelly (1980:Fig.28), Figure 28, "Map Showing Kuleana Awards," illustrates the railroad course (Site T-107) that leads to the wharf and associated structures. These sites appear to be within an area (L.C.Aw. 2564:4) awarded to Nakahuna. Another illustration, Figure 6 (Kelly 1980:Fig.6), "Punalu'u Landing (c. 1880), Showing Portion of Village," shows a cluster of homes, a warehouse, and a cart road in the vicinity of Punalu'u fishpond and immediately south of this complex of sites. These sites likely were part of this village, as it appears shipping activities were the primary impetus for the village itself. According to Kelly:

> Punalu'u harbor (Fig. 6) was called the "port town for the district" in 1880 [Bowser 1880:555]. It mainly served the communities of Ninole, Punalu'u, and the sugar plantation of Pahala. It also served for a while as a landing for visitors going to the volcano area. A warehouse at the site stored cargo between steamers, which stopped about every two weeks (1980:18).

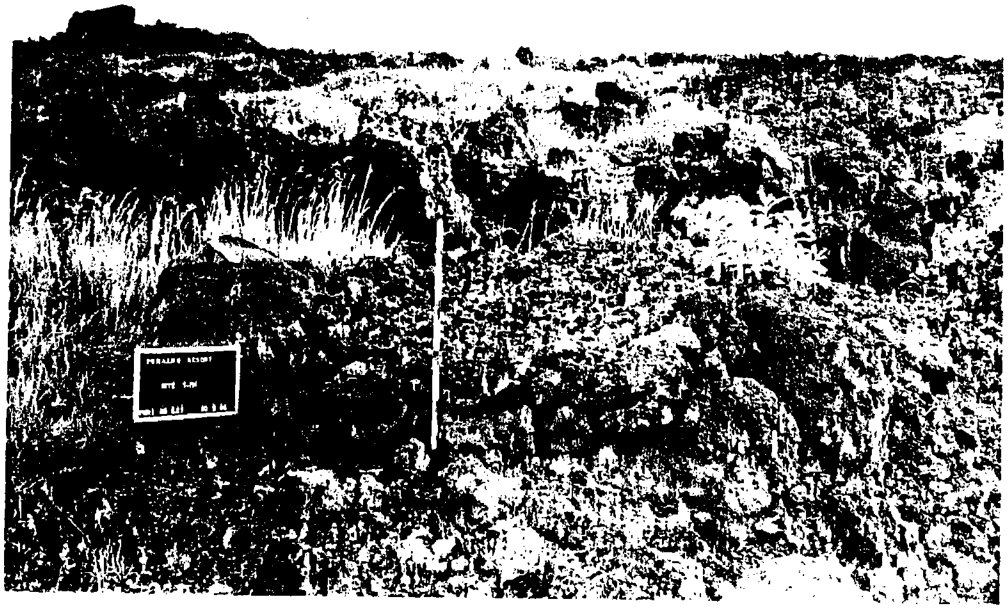
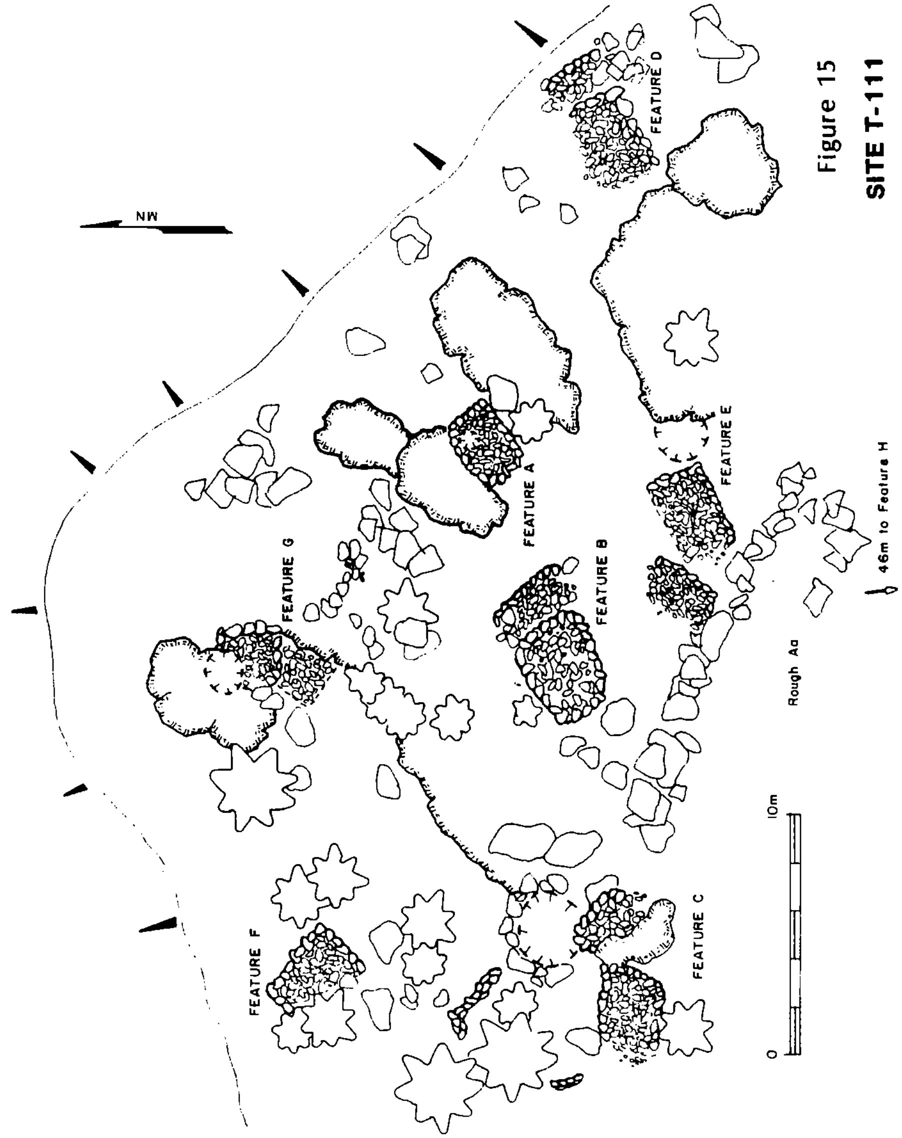


Figure 14. SITE T-111, PLATFORM. View to southwest.
(PHRI Neg.529-18A)



These sites have remained intact due to their protected location inland of Punalu'u Harbor and east of the railroad bed (Site T-107), and due to the dense vegetation that discourages pedestrian travel. The sites are situated within this narrow stretch of land, and document historic period activities at Punalu'u Harbor. This area was mapped and briefly described by Hansen (Ms.) in 1971, and a map of the sites was included in the Crozier and Barrera (1974:Fig.4) report. For the most part, the sites are in fair to good condition. Dense vegetation covers the area, obscuring the archaeological sites and minimizing the destruction of the features. Additional minor features such as terraces and walls were also noted throughout the area.

B8-14 Terrace. Site B8-14 is a partially walled terrace located immediately adjacent to and southeast of Site B8-15. The site measures approximately 30.0 by 16.0 m, with a 1.0 m high and 0.7 m wide wall along the north and northwest perimeter of the terrace. The feature is in good condition and has a paving of 'ili'ili with midden and ceramic fragments on the surface.

B8-15 Terrace. Site B8-15 is similar to Site B8-14, though substantially larger. It measures approximately 35.0 by 25.0 m, with a wall partially extending along the north limits of the feature.

B8-16 Enclosure. Site B8-16, situated east of Site B8-33, is an enclosure measuring 10.0 m in diameter. The walls are approximately 1.5 m high and 0.7 m wide.

B8-31 Railroad Bed. Site B8-31 appears to be a section of an old railroad bed that is approximately 5.0 m wide. The railroad bed leads in from the north and continues down a steep slope toward Punalu'u Harbor. It has been speculated that this could have been one of the first attempts to construct the railroad bed down the steep cliff face (Hansen Ms.).

B8-32 Wall. A crude wall measuring approximately 15.0 m long, 0.6 m wide, and 0.9 m high has been designated Site B8-32. The wall is oriented upslope.

B8-33 Platform. The remaining site in the complex is Site B8-33. This site is comprised of a large platform measuring roughly 12.0 m on a side, and has two water tank foundations on its surface. Water was apparently pumped up from the waterhole (B8-11) into the water tanks, then gravity fed (Hansen Ms.). The waterhole appears on a map to be situated north of the project area, and was not relocated during the reconnaissance survey. Its existence in the general vicinity of Site B8-33 has been described by Hansen (Ms.).

Site B8-33 is fairly open, and the platform surface has been used extensively for smashing recent beer bottles. Additional modifications were noted on the surface of the platform, as well as in the general vicinity.

B8-53 Platform

Site B8-53 is a low platform measuring 4.4 by 6.0 m and 0.4 to 0.7 m high. It originally had "worn koa haole posts, resembling fence stakes, [which] line[d] the perimeter of the site and indicate[d] that the grave is historic" (Crozier and Barrera 1974:17). Crozier and Barrera described and mapped the site, and recommended it for preservation (1974:17-18, 34-35). The fence posts have since disintegrated, and may have been a protective measure initiated during the historic period. The site may be a prehistoric burial based on the feature type and lack of associated midden and surface artifacts. The site is located at the south edge of the SeaMountain at Punalu'u Golf Course eighth tee, and has been set aside for preservation.

Koloa Complex

Three sites, B9-4 (3519), B9-7 (3522), and B9-9 (3524) are included in the Koloa Complex (4368), which extends south from the north side of Puhau and includes the previously documented Ninole coastal sites. The site number designation, 4368, was also given to the Ninole Complex, which appears to have the same boundaries as the Koloa Complex. These sites were initially recorded by Hansen (Ms.) in 1968. A section of kerbstone trail located during an inspection by M. Rosendahl (1986) is within the overall limits of the Koloa Complex, and may possibly extend 1.0 to 2.0 m into the project area. The project area boundaries need to be surveyed in order to determine the inclusion of this feature.

There are two newly identified sites, T-108 and T-111, that are within or partially extend into the Koloa Complex. These sites were not initially included within the Koloa Complex. These site descriptions are included later in text.

In addition to the three previously identified sites located within the Koloa Complex area, there are four other sites located on State of Hawaii property and within the limits of the project area boundaries. Sites B9-5 (3520, enclosure), and B9-6 (3521, trail) appear to be situated immediately within the State of Hawaii property, based on the boundaries given on the Project Area Map (blueline topographic map;1"=200') provided by Phillips, Brandt, Reddick & Asso. Site B9-175, a petroglyph, is near the north edge of the existing pond. The remaining site, B9-2 (3517), identifies Ninole Pond, a large pond that was historically used as a fishpond. The fishpond wall no longer exists, and the pond itself was filled in during the 1980 floods. This pond would be restored as part of the development of the Ninole Cove Hotel (Phillips, Brandt, Reddick & Asso. [Hawaii] Inc. 1986:II-26-27), and therefore the following background information is presented.

Figure 13. SITE T-110, KU'ULA WITH PLATFORM IN FOREGROUND. View to southeast. (PHRI Neg.529-10A)

Besides being described as ku'ula, the stone was referred to as ko'a nui. In this context, ko'a nui could be interpreted to be "important shrine" based on the meanings presented in Pukui and Elbert (1965:144, 250-251).

Hanoa also described a burial cave located beneath the ku'ula which was subsequently concealed by rockfall (Hanoa, pers. comm.). This area was examined and although no cave entrance was located, purported existence of the cave has been noted.

T-111 Complex Figures 14, 15

This complex consists of a series of platforms and terraces located on a bluff overlooking the golf course driving range. The features measure 2.5 to 4.2 m on a side and 0.3 to 1.45 m in height, and are situated on an open aa flow. They appear to be burial features, and are in good condition. A portion of the complex is located within the limits of the Ninole Complex (4368), and it was not initially included in the complex.

7361 Wharf Figures 16, 17

This site identifies remnants of the most recent wharf to occupy the northeast side of Punalu'u Harbor. An existing cement pillar has the inscribed "Built-1916 by KISHII" on it, and according to Ineneo Hanoa the structure was severely damaged during the 1940s when the military forces occupied the area and shot down the walls (I. Hanoa, pers. comm.). The site appears to have undergone further deterioration as a result of high seas.

The site was given a site number during the Statewide Inventory of Historic Sites survey during the 1970s, and no further documenting evidence is present. The existing structural remnants include portions of a large cement platform and cement pilings.

CONCLUSIONS

DISCUSSION

A total of 32 sites (with a minimum of 83 component features) was identified within the overall project area. Table 1 (at end) summarizes the identified sites with respect to formal type, tentative functional interpretation, and preliminary evaluation of site significance. Site locations are indicated on Figure 2.

Of the 32 historic and archaeological sites and site complexes, 25 had been previously recorded and seven sites were newly identified (T-101, T-104, T-107 thru T-111). The range of formal feature types encountered

Puhau, a freshwater spring, is located at the inland edge of the pond. The meaning of "Puhau" is given as "icy spring" (Pukui, Elbert, and Mookini 1974:192). Local informant Pele Hanoa stated that "Puhau" also identified the pond, and that this was a male pond (Hanoa, pers. comm.). Pukui, Elbert, and Mookini give another name, "'Ilo'i", meaning "supreme pond" to the larger pond (1974). According to Hanoa, the smaller pond to the northeast was the female pond, and its name is given as "Kauwale", meaning "useless" (Hanoa, pers. comm.).

These ponds appear to have been utilized as a fishpond during the 1800s. During the Mahele, the fishpond was retained as government land (Kelly 1980:26, 29), and at this time the Alanui Aupuni (Old Government Road) probably was located seaward of the pond. Kelly provides the following information:

> In an interview of January 31, 1972, Mr. William Meinecke, a long-time resident of Ka'u, stated that it was traditional knowledge that there had been a road makai of Ninole Pond and that it had disappeared in 1868 at the time of the volcanic and tsunami action in the area. He further stated that, as far as he knew, there had always been a Ninole spring at the place where the spring is presently located, and that there had always been a pond area just makai of the spring. However, he said there was once more land along the shoreline. It was there that the old road came down off the aa lava flow onto the Ninole plain and along the coast.... After the 1868 volcanic and tsunami disaster the road was gone and its disappearance has been laid to subsidence of the land (1980:107).

The fishpond was rebuilt after the 1868 disasters and, according to Kikuchi, was a loko kuapa (fishpond having no discernable sluice gate) (Hansen 1978). Nothing remains of the fishpond and, as previously stated, the pond is completely filled in with debris washed down during the 1980 floods. This property is owned by the State of Hawaii, yet is considered to be within the project area.

B9-4 (3519) **Enclosure**. Site B9-4 is an enclosure constructed against a cliff face, and measures approximately 25.0 m in length and 10.0 m wide. The walls are a maximum of 2.0 m high and 1.0 m wide. Interior walls divide the enclosure into "two stalls" from the remaining portion of the enclosure (Hansen Ms.). The feature was initially described by Hansen (Ms.) as a corral and pen though the presence of 'ili'ili may suggest habitation use. The feature is presently covered by dense vegetation.

B9-7 (3522) **Complex**. Site B9-7 has been identified as a historic school site (Hansen Ms.). The site is comprised of a platform with an enclosing wall. Hansen gave the following description:

> School-site, about 66' SE of Site 5. Reported to have been the Ninole School. Rectangular in shape, stone walls enclosing a platform.

> Entrance on the NW side with two steps up from trail (B9-6) onto a ili'ili paved walk-way connected with the platform is 6' wide, 16' long and 2'6" high. Another entrance is on the SE side having one step up and down.
>
> The stone walls with the exception of the SE wall show various widths particularly the NE wall and also the heights appear to vary. Condition of walls are relatively good with the exception of the west half of the SW wall and the west half of the NW wall here a great deal of disturbance has taken place though not beyond restoration.
>
> Platform, average height 2'6", ili'ili paving except for about 2' around the outer edges here the paving is of rougher rock. A thick growth of na[u]paka center of platform and which conceals a fire-place. Not wanting to expose more than was necessary center of platform was not fully seen. Water-worn stone steps down from platform to yard on the SE side. Overall condition of platform fairly good. Along the NE wall 19' from the north inside corner large lava boulders have been utilized in the making of a wall connnecting the NE wall to platform.
>
> A low stone wall 2' high, 2' wide from the south corner of platform to about the center of the SW wall, 12' further to the NW is a short section of stone wall 8'6" long, 2' wide and 2' high. Parallel with and between the platform and the SW wall is another wall about 12' long, 2' wide, 2' high and much disturbed. Outside the SE wall, 11' left of the entrance is a fire-place. Faint evidence of the platforms in this area (Hansen Ms.).

B9-9 (3524) **Old Government Road (Alanui Aupuni)**. The Old Government Road has been designated Site B9-9. It measures approximately 4.0 m in width, and is constructed of large boulders aligned along the outside edge. Much of the road is paved with 'ili'ili. The road ran from Honuapo to Punalu'u, and was said to have been built by Reverend William Cornelius Shipman in the 1850s (Hansen Ms.). Kelly (1980:107-110) has documented the two different routes the road took around Ninole Pond (Puhau). It appears the initial road passed on the seaward side of the Ninole Fishpond and continued southwest toward Koloa Beach, where it ascended the slope (Kelly 1980:107-108). This route roughly corresponds with the existing 4-wheel drive road. The road appears to have been re-routed after 1868 to go around the inland side of the fishpond and then up the incline toward Hilea and Honuapo (Kelly 1980:109-110). The segment on the southwest side of Puhau is all that remains of the Old Government Road within the project area. During a recent survey of the coastal area, no evidence of the Old Government Road could be found northeast of Puhau (Rosendahl 1986).

wide, with a fairly level interior. The remaining feature is a U-shaped wall with overall dimensions of 4.5 by 2.7 m. The wall measures 0.7 high by 0.7 m wide, and is crudely constructed of boulders. There is sparse 'ili'ili within the feature.

In addition to these three main features, it appears there may be crude terraces on the aa. The approximate limits of the complex are shown on Figure 2, and some of the features included in this site designation may actually be southwest of the project boundary. This site is within the limits of the Ninole Complex (4368), though it was not identified and included as a component of the complex.

T-109 Wall

This wall runs parallel to another wall (Site B9-62) at a distance of 23.0 m to the northeast. Site T-109 is in generally deteriorated condition, with the seaward 10.0 to 15.0 m portion being the most intact. The wall averages 1.0 m wide and 1.0 m high, and is constructed of small to large boulders. Sections of the wall appear to be core-filled.

T-110 Complex Figures 12, 13

Site T-110 is comprised of a fishing shrine (ku'ula) and two features identified as burials that are located on the crest of a bluff overlooking the southwest end of Punalu'u Harbor. The ku'ula is a raised aa protrusion measuring 1.9 m high, 1.8 m wide, and 1.0 m thick, and having loose, small boulders around its base. The other features are located immediately inland of the ku'ula, and all features are within an area approximately 7.0 m in diameter. One feature is a platform measuring 2.4 m on a side and 0.3 m high, while the other feature is a paved area, 2.5 by 2.0 m, and 0.2 m high. The low platform has a periphery of large boulders with cobble fill, and the paved area has the large boulders set into the ground with similar cobble fill.

Two local informants, Pele Hanoa and Chris Bangay, provided the documentation on this site. Having been raised on the property, they remember their father using the stone as a marker on the shoreline to guide his fishing boat into Punalu'u Harbor. The stone was said to have glowed at night--being light on very dark nights, and very dark on light evenings (Hanoa and Bangay, pers. comm.). They also recall placing a lantern on the stone to guide boats onshore.

According to Pukui and Elbert, the word, ku'ula, means:

> Any stone god used to attract fish, whether tiny or enormous, carved or natural, named for the god of fishermen; open altar near the sea for worship of fish gods; hut where fish gear was kept with ku'ula images so that gear might be impregnated with ku'ula mana, usually inland and very taboo (1965:172).

Figure 12. SITE T-110, KU'ULA. View to north.
(PHRI Neg.529-7A)

B9-17 Complex Figure 4

Site B9-17 is comprised of two enclosures and a cement tomb. The larger enclosure measures approximately 11.0 by 5.25 m, with a maximum wall height of 1.3 m and width of 0.8 m. A smaller enclosure, located off the southwest end, measures 2.9 by 2.6 m. A cement tomb measuring 2.54 by 1.76 m and 0.76 m high is situated within the larger enclosure. The site, in good condition, is located on the same bluff and west of a small historic church and cemetery (Site 7370) (Hawaiian Evangelical Association cemetery). The cement tomb is similar to other burial features located within the church's graveyard. The approximately one acre parcel that contains the church and adjacent graveyard is privately owned and not part of the Punalu'u Resort survey.

Wailau Complex

Four sites (B9-22, B9-32, B9-33, and B9-34) remain of the Wailau Complex (4310), identified as a historic complex. Much of the inland portion has been destroyed by land modification activities. The wall of Site B9-23, an enclosure, no longer exists, though associated surface artifacts and midden are still present. Site B9-21, a historic house site, was the focus of salvage excavations (Kaschko 1973) due to its location within a proposed roadway corridor, and consequently is no longer in existence. The remaining sites are in fair condition, and are currently under very dense vegetation.

B9-22 Mounds. Site B9-22 is comprised of two mounds identified as probable burial cysts by Barrera and Hommon (1972:8). The following description was given by Barrera and Hommon:

> Probable burial cists.... The opened cist was apparently constructed by first digging a pit of the desired size in the ground, and then walling up the sides and roofing over the top. An adjacent low mound with 'ili'ili paving on top is probably an unopened cist.
>
> Opened cist, exterior L=3.1 meters W=2.5 meters
> interior L=2.5 meters W=50 cm H=60 cm
> Unopened cist: L=3.4 meters W=2.2 meters
> This site is recommended for preservation (1972:8).

The opened cyst is in fair condition, and the unopened cyst appears to have been impacted by dozing activities.

B9-32 Wall. Site B9-32 identifies a stacked stone wall that runs in an east-west direction. It follows the crest of a bluff and descends the steep slope to the east. The eastern extensions of the wall no longer exist, as it appears that land modification activities have resulted in reduction of the wall. The wall measures a maximum of 1.2 m high and 0.8 m wide, and is generally in good condition.

Figure 4. SITE B9-17, CRYPT. View to northeast.
(PHRI Neg.515-4)

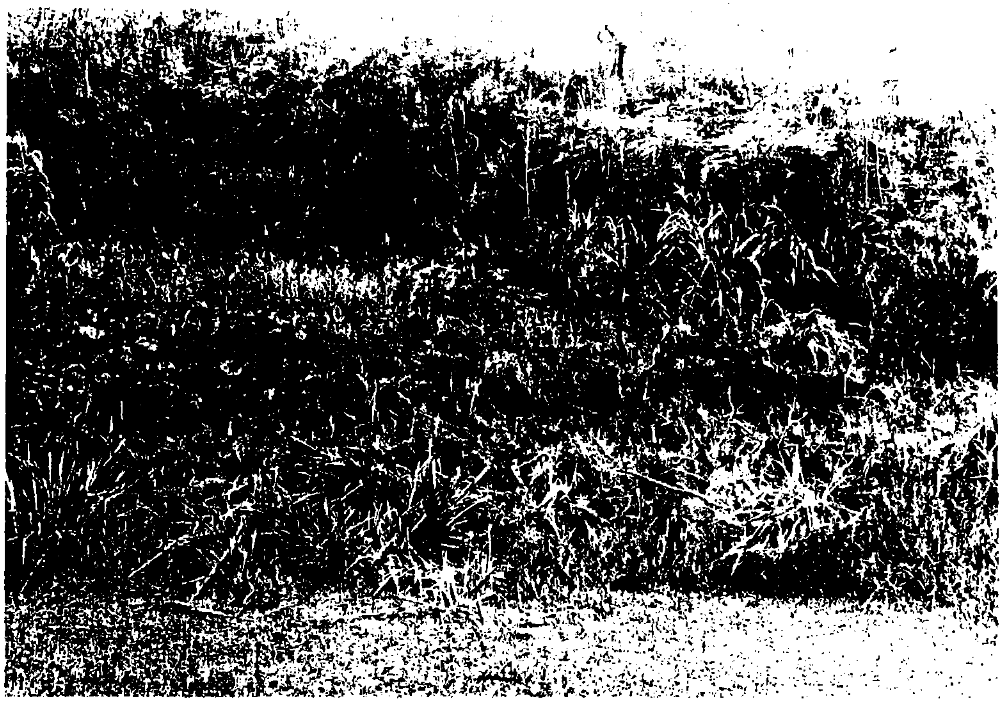


Figure 10. SITE T-107, RAILROAD BED. View to east.
(PHRI Neg.514-10A)

Figure 11. SITE T-108, PLATFORM. View to south.
(PHRI Neg.529-7A)

B9-33 Terraces. Site B9-33 is comprised of two terraces constructed against the base of a steep bluff and measuring 2.4 by 3.5 m and 2.5 by 5.0 m, respectively. The terraces front natural sheltered areas in the cliff face. Four test units were excavated at this site; one in each terrace and the remaining two in the open area (Barrera and Hommon 1972:20-22). Analysis of material from two of the excavation units revealed sparse shell midden, considerable bone material, and few historic-period artifacts (glass fragments, slate (?), metal fragments) (Barrera and Hommon 1972:39). Forty-eight pieces of volcanic glass were recovered from one excavation unit and an additional eight pieces from another (Barrera and Hommon 1972:39). The findings suggest limited habitation use.

B9-34 Complex. Site B9-34 (Figure 5) is comprised of five features and was described by Barrera and Hommon as follows:

> This site consisted of five features. Feature A was a rock shelter 8 meters long, 1.8 meters deep, and about 75 cm high. Feature B was also a rock shelter, 4.3 meters long, 1.4 meters deep, and about 75 cm high. Feature C was a crude platform located in front of Features A and B, that measured about 8.7 meters from end to end, between 1.4 and 1.7 meters from front to back (at which point it abutted the steep rock face in which Features A and B were located). Feature D was a wall consisting of two outer alignments of large (75-to-100-cm-diameter) rocks with a core-fill of smaller ones. Feature E was a 5-by-5.4-meter mound of jumbled rocks, one end of which abutted Feature D.
>
> A single square was excavated to a depth of 20 cm in Feature A. The fill of this pit was composed of fine brown dirt. Only a very sparse amount of material was recovered.... The base of a glass bottle dating from between 1840 and 1880 was found on the surface a few meters to the S of the site.

B9-31 (4309) Complex Figure 6

In addition to a wall originally identified as Site B9-31, features located on the same bluff are included in this site designation. The bluff area extends northeast from immediately seaward of the eighth green and terminates just inland of the Punalu'u Beach Park. The complex is primarily comprised of a series of small terraces and leveled areas located along the crest of the bluff. Several of the features have black sand fill which may have been added to existing features during the 1940s. According to a local informant, Pele Hanoa, gun implacements were located along this bluff during World War II (Hanoa, pers. comm.). In contrast to this recent use, the presence of an adz fragment, volcanic glass flakes, and shell midden on the surface of these features suggests an indigenous use.

Figure 5. WAILAU COMPLEX (4310), SITE B9-34, COMPLEX. View to northeast. (PHRI Neg.514-6A)

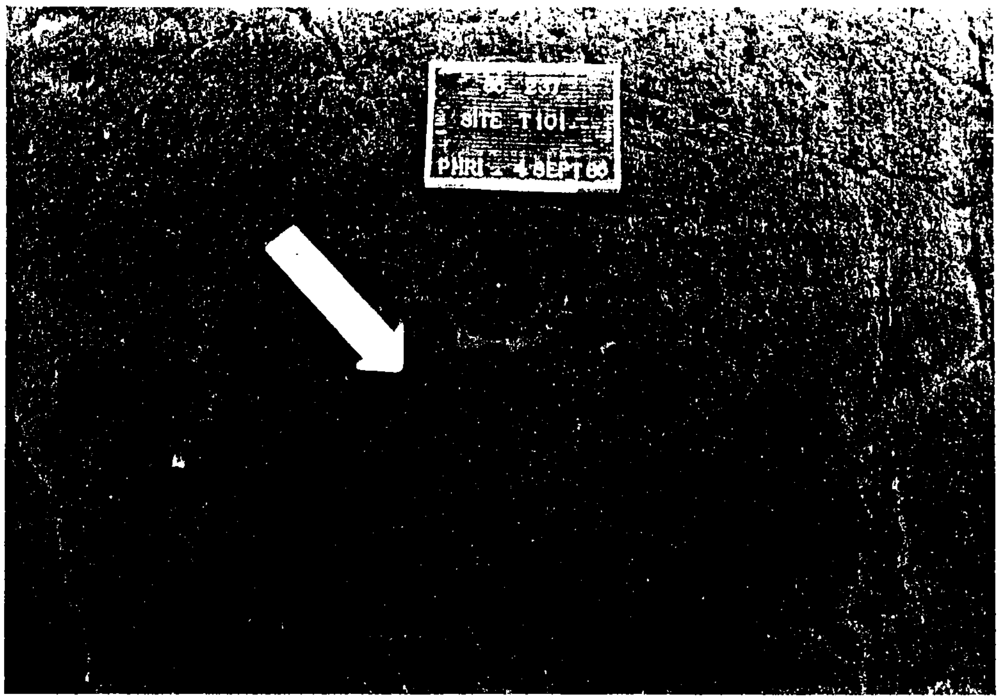


Figure 8. SITE T-101, PETROGLYPH. Overview.
(PHRI Neg.515-10)

Figure 9. SITE T-104, WALL. View to south.
(PHRI Neg.514-29A)

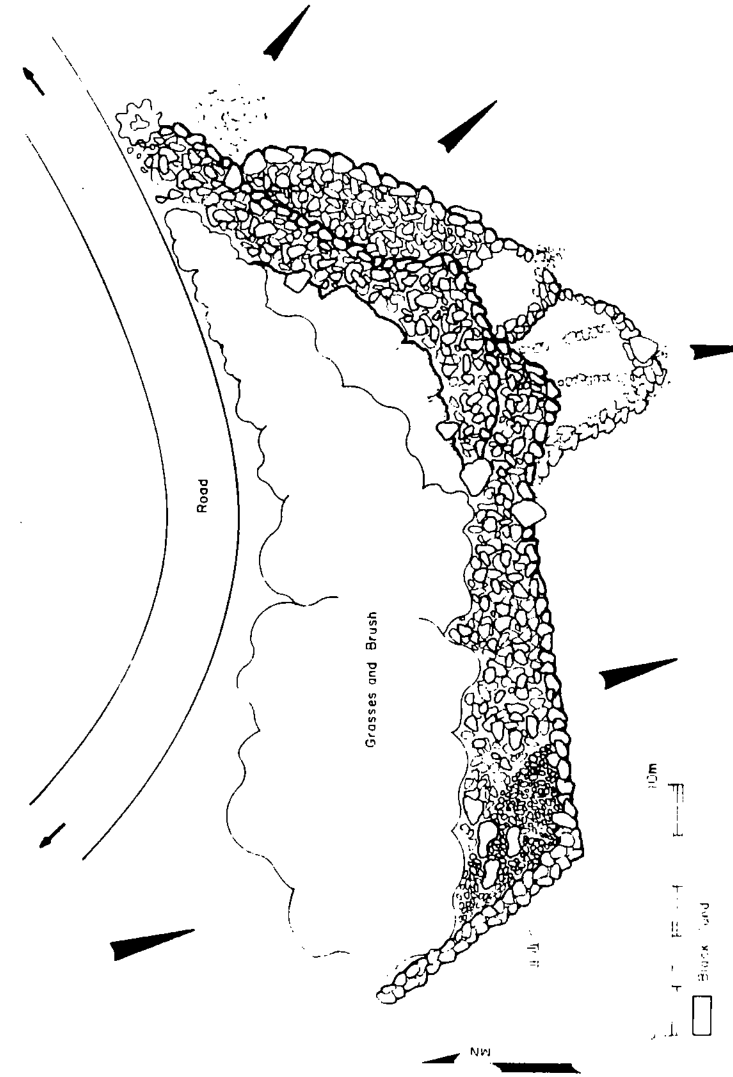


Figure 6
SITE B9-31

A low platform located at the eastern limits of this site appears to be a burial feature. It is similar to the two burial features identified with the ku'ula, Site T-110, and has been designated Feature A (see Figure 2). This area is under koa-haole while the central portion of the bluff is fairly open. The western portion is extremely overgrown with scrub Christmas-berry which may obscure additional features. There appears to be a minimum of 15 features within the site limits. In general, the features located on the bluff appear to have been used for habitation with the exception of Feature A, a suspected burial feature.

B9-43 (4330) Enclosure   Figure 7

This site is a rectangular enclosure measuring approximately 11.8 by 18.0 m, with core-filled walls measuring a maximum of 2.2 m in height and 1.4 m in width. The enclosure is in good condition. Barrera and Hommon reported that the four excavation units revealed 40 to 50 cm thick ash deposits on bedrock, and that the recovered materials included sparse midden, moderate quantity of bone, and glass and metal fragments (1972:22).

B9-62 Wall

Barrera and Hommon initially described this wall as 8.0 m long, 0.8 m wide, and 0.8 m high (1972:11). It appears they located a segment of the wall which actually extends inland toward the abandoned feed lot. At this point, a dirt road truncates this wall. The continuation of this wall on the inland side of the road corridor has a different site designation (B9-119). The wall is in good condition and is actually larger than originally described, with a maximum height of 1.25 m. The wall is constructed of stacked small to large boulders.

B9-119 (4360) Wall

The inland extension of Site B9-62 has been designated B9-119. It appears the seaward and inland extents of this wall were located during the Barrera and Hommon survey (1972:11), and the nature of that survey did not afford sufficient time to follow out the extent of the wall. The wall is approximately 0.8 m wide and a maximum of 1.25 m high, and is in good condition.

B9-174 Complex

This complex is located just inland of State Highway 11 and extends west on to a privately owned lot within Kalana Subdivision. Only a small portion of this complex is within the project area. Crozier and Barrera provide the following overall description of the complex:

> Hidden beneath dense vegetation of koa haole just 10 meters W of State Highway 11 is a site of considerable size and

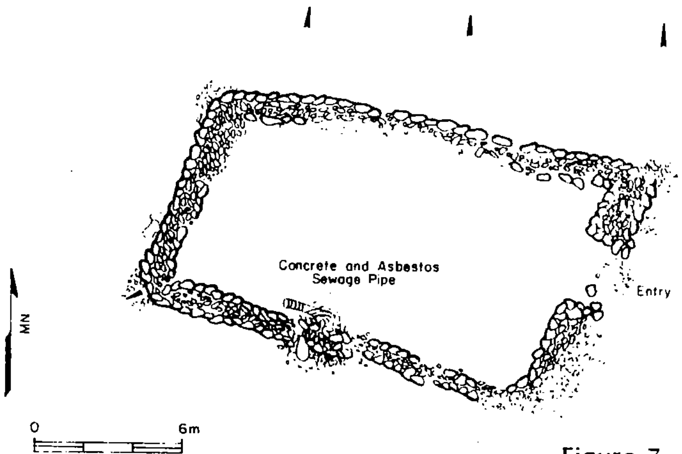


Figure 7

SITE B9-43

complexity.... Because of the complexity of the features and the extreme variance of preservation, it appears that the area was occupied and abandoned at least several times over the centuries. Roving cattle and exotic vegetation have contributed to the now vague delineation of several mounds and platforms--it is not always possible to distinguish where one feature ends and another begins.

The stepped enclosures and interrelated platforms near the W portion of the site are two of the better-preserved features; large waterworn stones were incorporated in their construction.... The walls--ranging from 45 to 75 cm in height and 50 to 70 cm in width--of the enclosures are bifacial and filled with an aa core. Several upright stones were utilized in the wall alignment. The pavements throughout the site consist of small aa stones interspersed with larger aa rocks... We recorded six mounds or small paved areas, which are generally round in shape, 20 to 50 cm high, and range from 2 to 5 meters in diameter.

To the SW of this complex we found evidence of disturbed terracing, and the scattered stones plus surface midden material indicate that several more features may have been interrelated to the overall settlement pattern of the complex.

It appears that, during the course of extensive occupation, stones were taken from earlier abandoned features and used for later construction....(1974:24).

The site is in fair to poor condition and under dense vegetation. The site was mapped and briefly described during the previous project (Crozier and Barrera 1972:24-25); therefore, only the surface architecture is known. Based on site complexity and feature density, it appears that this complex may have had ceremonial use in addition to habitation use.

<u>T-101</u> <u>Petroglyph</u> Figure 8

This site is an isolated petroglyph consisting of three concentric circles with a maximum diameter of approximately 20 cm. It is located south of a pond on reddish-colored pahoehoe.

<u>T-104</u> <u>Wall</u> Figure 9

This wall measures approximately 1.0 m high and 1.0 m wide, and runs parallel to the entrance road, Punalu'u Road, at a distance 30.0 m to the northeast. The wall is four to six courses high, and constructed primarily of small boulders and large cobbles. Portions of the wall are collapsed.

<u>T-107</u> <u>Railroad Bed</u> Figure 10

Two segments of this feature are present within the northeast portion of the project area. A 50.0 m segment adjacent to the sixth fairway, measures approximately 7.2 m wide and 2.0 m high, and is a well-faced bed with a level surface. The roadway leading to the east side of Punalu'u Harbor appears to be the continuation of this railroad bed. It is the same width, though substantially more elevated as it crosses a gulch just before entering the Punalu'u Harbor area. Hansen (1974b) includes a sketch map of Punalu'u showing the course of the railroad, which originates at the harbor and continues inland, with a gentle curve to the northeast and another to the southwest (the inland railroad bed segment), and then continues on a straight northerly route toward Pahala. The railroad bed is in good condition.

<u>T-108</u> <u>Complex</u> Figure 11

Located on the aa bluff overlooking Puhau, this complex is comprised of three major features. A 1.0 m wide trail crosses the area and appears as a roughly leveled surface oriented inland across an irregular and very rough surface. Another feature is an enclosure measuring approximately 14.0 by 10.0 m, with crudely stacked aa boulder walls. The wall incorporates existing bedrock outcrops, and is generally 0.8 m high and 0.9 m

Appendix B: Terrestrial Botanical And Vertebrate Fauna Reconnaissance Survey

TERRESTRIAL BOTANICAL AND VERTEBRATE FAUNA RECONNAISSANCE SURVEY

Prepared for: Phillips, Brandt, Reddick & Assoc. (Hawaii), Inc.

Prepared by: Char & Associates, Honolulu

October 1984

coastal area, over brackish ponds and near shore areas. Roosting sites may be some distance away, although information on the movements of this species are scarce. It is possible that portions of the upper section of the study site are used for roosting, particularly areas adjacent to Ninole Stream.

D. RECOMMENDATIONS

The only habitat of significant concern regarding the impact of future development within the study area is the coastal habitat between Ninole Cove and Punalu'u Harbor. Areas of concern include not only the coastal zone itself but also the numerous brackish ponds nearby. These areas have potential as wetland habitats for waterbirds, although they are only marginally used at this time. The scarcity of such habitats on the island of Hawai'i adds to the importance of their future preservation. Ideally, these portions of the study area should be maintained as intact as possible. However, if they are to be modified the following recommendations apply:

1. A buffer zone should be maintained between the ponds and existing or proposed facilities to discourage human disturbance or harassment. This buffer zone may be in the form of an actual barrier, or simply thick vegetation to prevent vehicular traffic.

2. Cover for waterbirds at the margins of the ponds should be maintained if future waterbird use of these habitats is to be encouraged.

3. Use of these habitats by migratory and native wetland species may be further enhanced by the construction of small islets in the larger ponds to provide predator protection from mongooses. Control of Water Hyacynth in the Punalu'u Spring is also to be encouraged.

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TERRESTRIAL BOTANICAL RECONNAISSANCE SURVEY
by Winona P. Char

INTRODUCTION

The SeaMountain Resort study site consists of approximately 300 acres located in Punalu'u, Ka'u District, island of Hawai'i. Elevation within the study site ranges from sea-level to roughly 370 feet at the upper boundary near the old county road. Annual rainfall within the study site is about 40 inches/year (State of Hawaii 1973). Soil types (USDA 1973) within the study site consists of Punalu'u extremely rocky peat, 6 to 20 percent slopes (rPYD) - found in the area above the State Highway; very stony land (rVS) - found in the area below the State Highway; lava flows, pahoehoe (rLW) - along the coast; and lava flows; 'a'a (rLV) - on the western boundary.

Much of the site has already been developed. A golf course and several clusters of dwellings occupy most of the developed areas. The undeveloped vegetated areas are used or have been used in the past for grazing cattle.

Future plans for SeaMountian Resorts calls for expansion of existing facilities. Vegetation on undeveloped areas would be directly impacted by these plans. Thus, a botanical survey to inventory the flora and search for rare and endangered species within these undeveloped areas was conducted on October 25th and 26th, 1984. The walk-through survey employed two botanist; a total of 24 man-hours was spent at the study site. Notes were made on the major vegetation types and species present. Species which could not be positively identified in the field were collected for later determination in the herbarium and laboratory.

A. RESULTS

The flora within the study site is composed largely of exotic species. One-hundred fifty (150) species of plants were identified; of these, 107 species (71.3%) were exotic (or introduced), 31 species (20.7%) were indigenous, 8 (5.3%) were endemic, and 4 (2.7%) were of Polynesian introduction. Koa-haole scrub is the most common vegetation type. The only portion of the study site where native plants form the dominant cover is along the coast.

Four broadly defined vegetation types can be found in the study site. These vegetation types are open scrub, Koa-haole scrub, wetland, and strand.

Only the wetland vegetation has been surveyed to any great extent. Elliott and Hall (1977), in their inventory of the wetlands of the Hawaiian Islands, provided short descriptions and species checklists for the wetlands at Punalu'u (Site 57) and at Ninole (Site 58).

1. Koa-haole Scrub (K)

Koa-haole (*Leucaena leucocephala*) scrub is the most commonly observed vegetation type on the project site and adjacent areas. It occurs in rather dry to moderately wet areas at low to middle elevations. Koa-haole forms dense stands. However, the majority of the plants during the time of this survey had almost no leaves. The defoliation is probably the result of the abnormally low rainfall received this year and the recent introduction of an insect (psilid? aphid?) which feeds on *Leucaena*.

The soil type (or substrate) on which Koa-haole scrub grows has a great affect on the structure and composition of this vegetation type. Two types of Koa-haole scrub recognized within the study site are:

a. Tall-stature Koa-haole scrub with Guinea grass (KG):

This vegetation type occurs in the area above the State Highway (mauka parcel) and the central portion of the makai parcel (below the State Highway) behind the tennis courts. The substrate consists of a rocky, orange-brown soil similar to Pahala ash. The Koa-haole scrub is dense and 3 to 6 m tall. Guinea grass (*Panicum maximum*), 1 to 2 m tall, covers roughly 90 to 95 percent of the ground under the Koa-haole. A few large monkeypod trees, 6 to 10 m tall, are scattered through the scrub. In the areas which are grazed (western boundary of mauka parcel) the Koa-haole scrub is more open, there is more lantana (*Lantana camara*) and, although Guinea grass is abundant, a number of other grasses such as sourgrass (*Tricachne insularis*) and Natal redtop (*Rhynchelytrum repens*) are more commonly observed. Where this vegetation type borders the Ninole Gulch streambed in the mauka parcel a number of species which require moister environmental conditions, such as Java plum (*Eugenia cuminii*) and Kukui (*Aleurites moluccana*), are found.

b. Short-stature Koa-haole scrub with Natal redtop (KN):

This vegetation type is found in the area between the State Highway and the Aspen Institute. The substrate consists of very stony land. The Koa-haole scrub is rather dense, 2 to 4 m tall, with a groundcover composed largely of Natal redtop (*Rhynchelytrum repens*). Groundcover varies from 50 to 60 percent; there are patches or piles of rocks in many areas. A number of native plants such as *Peperomia* sp., huehue (*Cocculus ferrandianus*), 'a'ali'i (*Dodonaea sandwicensis*), and alahe'e (*Canthium odoratum*) are frequently found in these rocky areas.

commonest bird species in the study area. It is very abundant in all of the remaining habitat types, particularly in portions of the resort habitat with good tree cover (for example, portions of the Aspen Institute, and in the vicinity of Punalu'u Harbor. This species is also present in high numbers along the margins of the golf course, and in the wooded parts of the Ninole Stream bed.

Family STURNIDAE

Acridotheres tristis (Common Myna) A

The Myna is the most widespread and abundant bird species in the study area. It was found in high numbers in all habitat types during the survey, and appears to be particularly common in the resort areas, the golf course, and in coastal habitats.

Family PLOCEIDAE

Lonchura punctulata (Nutmeg mannikin, Ricebird) A

This species was found in great numbers in grassland habitats, and along grassy road margins in other habitat types. This species typically occurs in large feeding flocks.

Passer domesticus (House Sparrow) A

The House Sparrow was relatively rare in the study site, occurring in low numbers in resort areas and in the vicinity of buildings in other habitats.

Family FRINGILLIDAE

Cardinalis cardinalis (Northern Cardinal) A

The cardinal is most common in forested habitats, where it is fairly abundant. Far fewer individuals were observed during this survey along golf course margins, in resort areas, and along the coast.

Carpodacus mexicanus (House Finch) A

The House Finch is a relatively scarce species in the study area. It occurs in high numbers only in the Koa-haole/Monkeypod habitat, and in some portions of the resort area near the Aspen Institute.

Class Mammalia

Family VIVERIDAE

Herpestes auropunctatus (Small Indian Mongoose) A

Individuals were observed commonly in coastal and forested habitats. They are undoubtably abundant in many portions of the study area.

C. QUESTIONABLE AND ABSENT SPECIES

The list below includes discussions of those species that were either absent from the study area because of the time of year in which the survey took place (e.g., seabirds and gamebirds), or that where expected but not observed. Also included is one species whose sighting during the survey was of a questionable nature.

Class Aves

Families FREGATIDAE and STERNIDAE

Members of these two families such as frigatebirds and terns are among the more common seabird species along the Puna and Ka'u coasts. Their absence during this survey is probably the result of the absence of these species from land during the winter months.

Family Rallidae

Fulica americana alai (Hawaiian Coot, Alae ke'o-ke'O) E*

A possible sighting of this species occurred in the ponds near Ninole Cove. This record is unconfirmable due to our inability to clearly observe the bird through the dense vegetation surrounding the pond. Coot-like vocalizations were heard in the same area.

This sub-species of the common American Coot is endemic to the Hawaiian Islands and is classified as an endangered species. Ponds such as those in the study site are excellent Coot habitat, as this species prefers expanses of open water with good peripheral cover. While normally quite shy, this species often occurs in areas where human activity levels are high (e.g., Kaelepulu Canal, Kailua, Oahu, and Ukoa Pond, Haleiwa, Oahu).

Class Mammalia

Family VESPERTILIONIDAE

Lasiurus cinerius semotus (Hawaiian Hoary Bat) E*

None of these animals was observed in the study area, in spite of the presence of excellent feeding habitat, and their known occurrence in nearby areas (Honu'apo, pres. obs.).

This species is nocturnal, moving between feeding and roosting sites at dusk and dawn. Favored feeding habitats are in

2. Open Scrub (os)

The open scrub occupies only a small portion of the study site. It occurs on the 'a'a lava flow west of Ninole Cove. The 'a'a flow is 85 to 95 percent bare; small patches of scrub usually consisting of the shrubs Pluchea odorata and Schinus terebinthifolius and grasses and herbs such as Natal redtop and 'ihi (Portulaca cyanosperma) are scattered over the flow. A few shrubs of the native false sandalwood or naio (Myoporum sandwicense) are found in this vegetation type. In between the large 'a'a boulders where some organic material has settled and where it is moister, the sword fern or kupukupu (Nephrolepis multiflora) and 'iwa'iwa fern (Doryopteris decora) are frequently found.

3. Strand (S)

The strand vegetation is found along the shore where it is subject to varying amounts of salt-spray and wind exposure. The largest numbers of native species occurs in this vegetation types. Close to the water's edge on the pahoehoe lava, low mat-forming species such as 'akulikuli (Sesuvium portulacastrum), nehe (Lipochaeta integrifolia), 'ilima (Sida fallax), Fimbristylis pycnocephala and 'ihi (Portulaca cyanosperma) occur. Further inland where exposure is less shrubs of naupaka (Scaevola taccada), noni (Morinda citrifolia), and tree heliotrope (Messerschmidia argentea), as well as vines such as kauna'oa (Cuscuta sandwichiana) and nanea (Vigna marina) are found.

4. Wetland (W)

The wetland vegetation occurs along the coastal margin where there are a number of springs; the water varies from fresh to slightly brackish. Water is the major factor controlling the development of soils and vegetative cover. The soils are waterlogged and composed often of organic matter. The vegetation consists of hydrophyte (waler-loving) species. Only the wetland vegetation around the Ninole Springs area was surveyed. The area around the Punalu'u Spring was not surveyed as it has been greatly modified and consists largely of landscape plantings. Elliot and Hall (1977) did an intensive survey of both areas. The smaller ponds near Ninole Cove have a vegetative cover that consists of low growing species such as seashore beachgrass (Paspalum vaginatum), honohono (Commelina diffusa), and Eleocharis geniculata. The two large ponds, closer to Punalu'u Park, have taller growing vegetation such as bulrush (Scirpus validus) and makai (Sceirpus paludosus) and supports a denser growth of honohono, waterfern (Azolla filiculoides), ung-choi (Ipomoea aquatica), and California grass (Brachiaria mutica). A thicket of Pluchea odorata and California grass borders the landward perimeter of these wetlands.

B. LIMITATIONS OF THE SURVEY

Only the undeveloped areas within the study site were surveyed. Developed areas were not surveyed as these areas have been greatly modified and support a number of ornamental species.

The species found during the course of this survey are indicative of the season and conditions under which this survey was taken. Other surveys taken at different times will no doubt yield slight variations in the species present.

C. DISCUSSION AND RECOMMENDATIONS

The majority of the species encountered are introduced (71.3%) and Koa-haole, an introduced species, forms the most commonly occuring vegetation type on the study site. No rare, threatened or endangered species of plants were found. The native plants found on the study site also occur scattered throughout this region. Development of the areas with Koa-haole scrub and open scrub will not pose any serious environmental threats. It is recommended that any proposed improvements within the strand and wetland areas be limited to minimize the impact on the strand and wetland areas. The proposed golf course construction adjacent to the strand and wetland areas should utilize the vegetation types characteristic of the zone so that these areas remain in their natural state. Any proposed improvements within the designated wetlands will require approval from the U.S. Army Corps of Engineers, Honolulu District under the authority of the U.S. Clean Water Act, Section 404. Certification of consistency with the State Coastal Zone Management Office would also be necessary.

E endemic: native and found only in the Hawaiian Islands

* threatened or endangered species

Class Reptilia

Family GEKKONIDAE

Lepidodactylus lugubris (Mourning Gecko) A

Two individuals found hiding in a large piece of driftwood between Ninole Cove and Punalu'u Harbor. This species and the four other Hawaiian Gecko species are probably quite common throughout the study area.

Family CHELONIIDAE

Chelonia mydas agasizi (Green Sea Turtle, Honu) I*

Four individuals were observed swimming close to the shoreline, one near Ninole Cove, and the other three in Punalu'u Harbor. All sightings were of small subadult individuals.

The Green Sea Turtle is the most common of the five species of sea turtle that occur in Hawaiian waters. Adults of this species characteristically migrate from feeding areas in the main Hawaiian Islands to nesting areas in the northwest Hawaiian Islands. Green Sea Turtle nests are unknown from the main chain, although the rarer Hawksbill Turtle has been known to nest on Moloka'i and Hawai'i.

Since 1978, the Green Sea Turtle has been classified as threatened by the U.S. Department of the Interior.

Class Aves

Family ARDEIDAE

Nycticorax nyctycorax hoactli (Black-crowned Night Heron) I

One adult bird was seen flying from the large pond between Punalu'u Harbor and the Punalu'u Black Sand restaurant complex. None were observed at the smaller ponds between the Punalu'u Beach Park and Ninole Cove, although these provide fairly good feeding habitats for the Night-heron.

Family CHARADRIIDAE

Pluvialis dominica (Golden Plover) I

This species is common in several different habitats. It is most abundant in the coastal areas, but it is also very common in any part of the study area where lawns are present, both on the golf course and in the resort complex. This species is a regular migrant to the Hawaiian Islands, arriving from its Arctic breeding grounds in August and leaving in May. Many wintering individuals are territorial, and return to the same winter feeding territories for years in succession.

Family SCOLOPACIDAE

Heteroscelus incanus (Wandering Tattler, 'Ulili) I

A number of thses birds were found in the coastal portion of the study site. This species is migratory in a manner similar to the Golden Plover. Unlike the Plover, however, this species has not adapted to developed areas and is found only wetlands or on horelines in relatively undisturbed habitats.

Family ANATIDAE

Domestic Goose, Domestic Duck (Various genera) A

Three domestic geese were observed on the golf course adjacent to the main entry road. Two domestic ducks were in the same area.

Family COLUMBIDAE

Columbia livia (Rock Dove) A

One domesticated individual was seen on the golf course in the same area as the geese and the ducks. All of the domesticated birds were found to be quite tame.

Streptopelia chinensis (Spotted Dove) A

This species is relatively uncommon in the study area, although it was found in low numbers in all portions of the study site except the grassland habitat. It is most abundant in the Koa-haole/Monkeypod habitats on the mauka side of the Hawaii Belt Highway.

Geopelia striata (Barred Dove) A

The Barred Dove is an exceedingly common bird in the golf course habitats, where it often occurs in large flocks. It was found in all other habitats in lower numbers.

Family ZOSTEROPIDAE

Zosterops japonica (Japanese White-eye) A

While rare in the coastal habitats, and absent altogether from grassland habitats, the Japanese White-eye is one of the

CHECKLIST OF VASCULAR PLANTS
SEAMOUNTAIN RESORT, PUNALU'U, HAWAI'I

Families are listed alphabetically within each of three groups: Ferns, Monocotyledons (flowering plants), and Dicotyledons (flowering plants). Genera and species are also arranged alphabetically. Names used in the fern group follow an unpublished checklist prepared by C.H. Lamoureux (Botany Department, U.H.); names of flowering plants follow St. John (1973). Hawaiian names used follow St. John (1973) or Porter (1972).

For each species the following information is provided:

1. Scientific name (with author citation).
2. Common or Hawaiian name, when known.
3. Biogeographic status of each species:

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

    I = Indigenous = native to the Hawaiian Islands and also occurring in one or more geographic areas.

    P = Polynesian introduction = plants brought by the Polynesians prior to Cook's discovery.

    X = exotic or introduced = not native to the Hawaiian Islands; brought here by man, intentionally or unintentionally.

Taxa	Common Name	Status	Vegetation type(s)
FERNS			
ATHYRIACEAE			
Athyrium sp.		I	KG
NEPHROLEPIDACEAE			
Nephrolepis multiflora (Roxb.)Jarrett ex Morton	Kupukupu	X	KG,os
HEMIONITIDACEAE			
Pityrogramma calomelanos (L.) Link	Gold fern, silver fern	X	KG
POLYPODIACEAE			
Phymatosorus scolopendria (Burm.) Pichi Sermolli	Laua'e, lauwa'e	X	S
SALVINIACEAE			
Azolla filiculoides Lam.	Azolla, water fern	X	W
SINOPTERIDACEAE			
Doryopteris decora Brack.	'Iwa'iwa	E	KG,KN,os
THELYPTERIDACEAE			
Christella dentata (Forsk.) Brownsey & Jermy	Downy wood fern	X	KG
MONOCOTYLEDONS			
COMMELINACEAE			
Commelina diffusa Burm.	Honohono	X	KG,W
CYPERACEAE			
Cyperus cyperoides (L.) Ktze.		I	W
Cyperus javanicus Houtt.	'Ahu'awa	I	S,W
Cyperus laevigatus L.	Makaloa	I	W
Cyperus polystachyus Rottb.		I	KG,W
Cyperus rotundus L.	Nut grass, Kili'o'opu	X	KG
Eleocharis geniculata (L.) R. & S.		X	W

VERTEBRATE FAUNA RECONNAISSANCE SURVEY

by Maile S. Kjardgaard

INTRODUCTION

The Punalu'u region has been utilized by man since early in the pre-contact period. It is notable as an ancient surfing area, and for its heiau and fishponds (Newman 1970, Griffin 1973). In spite of this long usage, there has been very little information published about the fauna of the area. General works such as Schwartz and Schwartz (1949), Berger (1983), and Shallenberger (1984) provide a hazy picture of the avifauna of the region. In a similar manner, Tomich (1971) and Kramer (1971) provide an overview for mammals. Only one of the above publications (Schwartz and Schwartz 1949) provides specific maps of species distributions; unfortunately, this publication is quite out of date.

The purpose of the following report is to provide up to date information regarding the fauna of the Punalu'u area. It is based on a one day survey of about 300 acres of Punalu'u SeaMountain Resort lands. Particular attention was paid to the less disturbed portions of the study area and to areas of potential interest regarding bird and mammal populations. While the above groups were the main focus of the survey, reptile species were also noted when they were observed. The brief duration of this survey renders the information in this report somewhat incomplete. Certain species will be discussed in this regard below.

A. FAUNAL HABITATS AND COMMUNITIES

Five basic faunal habitat types occur within the study area. Each of these was defined in part by the plant species in the area, and each tends to have characteristic animal species associated with it. The habitat types may be defined as follows:

1. Koa-haole/Monkeypod Scrub

   This habitat comprises the major portion of the study site above the Hawaii Belt Highway, and also occurs to a lesser extent on the makai side of the road. A broken canopy of Monkeypod (*Samanea saman*) is present, with an understory dominated by Koa-haole (*Leucaena glauca*) and several non-native grass species. Characteristic bird species in this habitat include the Japanese White-eye (*Zosterops japonica*), both Barred (*Geopelia striata*) and Spotted (*Streptopelia chinensis*) Doves, and the House Finch (*Carpodacus mexicanus*). Other species are present in smaller numbers.

2. Golf course habitats

   Bird species present in large numbers in the golf course portions of the study area include the Barred Dove (*Geopelia striata*), the Golden Plover (*Pluvialis dominica*), and the Common Myna (*Acridotheres tristis*). Other species present included domestic varieties of goose, duck, and pigeon.

3. Resort Areas

   Habitats such as these include landscaped areas in the vicinity of resort buildings and other developed areas. The Common Myna (*Acridotheres tristis*) is especially common here, as are the Japanese White-eye (*Zosterops japonica*) and the House Finch (*Carpodacus mexicanus*). Present in smaller numbers were the Northern Cardinal (*Cardinalis cardinalis*) and the Nutmeg Mannikin (*Lonchura punctulata*).

4. Grasslands

   Several small open grassy areas are present in the study area. The largest of these occur in the Ninole Cove area, and adjacent to the golf course in the northern portion of the study area. Unlike the grasses in golf course habitats, those in grassland habitats are unmaintained and are allowed to grow to maturity. Large numbers of Nutmeg Mannikins (*Lonchura punctulata*) are attracted to the flowering heads of these plants. The Mannikins may be found in flocks of 75 or more individuals in these areas.

5. Coastal Zone and Brackish Ponds

   These habitats, stretching from Ninole Cove to Punalu'u Harbor are of great intrinsic biological interest as they provide habitat for both migrant shorebirds and native waterbird species. Coastal ponds such as those in the study area also provide favored feeding areas for the endangered Hawaiian Hoary Bat (*Lasiurus cinerius*).

B. ANNOTATED SPECIES LIST

The list that follows includes those species that were observed in the course of the survey. They are discussed in taxonomic order; abbreviations following species names indicate status as follows:

A alien: introduced to the Hawaiian Islands by man

I indigenous: native to the Hawaiian Islands, also found elsewhere

Taxa	Common Name	Status	Vegetation type(s)
Fimbristylis pycnocephala Hbd.		I	S
Scirpus paludosus A.Nels.	Makai	I	W
Scirpus validus Vahl.	Great bulrush, 'aka'akai	I	W
GRAMINEAE			
Andropogon pertusus (L.) Willd.		X	KG,KN,os
Andropogon virginicus L.	Broomsedge	X	KG
Brachiaria mutica (Forsk.)Stapf	Californiagrass	X	KG,W
Cenchrus echinatus L.	Common sandbur, 'ume'alu	X	KG,os
Chloris inflata Link	Swoleen fingergrass mau'ulei	X	KG,os
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	KG,S
Dactyloctenium aegyptuim (L.) Willd.	Beach wiregrass	X	KG,KN,os,S
Digitaria adscendens (HBK.)Henr.	Henry's crabgrass	X	KG,KN,S
Digitaria violascens Link	Kukaipua'a-uka	X	KG
Digitaria sp.		X	KG,KN
Echinochloa colona (L.) Link	Jungle rice	X	KG
Echinochloa crusgalli (L.) Beauv.	Barnyard grass	X	W
Eleusine indica (L.) Gaertn.	Wiregrass	X	KG,KN
Eragrostis tenella (L.) Beauv. ex R. & S.	Japanese lovegrass	X	KG
Melinis minutiflora Beauv.	Molassesgrass	X	KG
Panicum maximum Jacq.	Guinea grass	X	KG,KN,os,S
Paspalum urvillei Steud.	Vaseygrass	X	W
Paspalum vaginatum Sw.	Seashore paspalum	X	W
Paspalum sp.		X	KG
Poa annua L.	Annual bluegrass	X	KG
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X	KG,KN,os
Setaria verticillata (L.) Beauv.	Bristly foxtail	X	KG

Taxa	Common Name	Status	Vegetation type(s)
Tragus berteronianus Schult.	Burgrass	X	os
Tricachne insularis (L.) Nees	Sourgrass	X	KG,KN
PALMAE			
Cocos nucifera L.	Coconut, niu	P	S,W
POTAMOGETONACEAE			
Potamogeton foliosus Raf.	Leafy pondweed	X	W
DICOTYLEDONS			
AIZOACEAE			
Sesuvium portulacastrum (L.) L.	'Akulikuli	I	S
AMARANTHACEAE			
Amaranthus spinosus L.	Spiny amaranth, pakai-kuku	X	KG,KN
Amaranthus viridus L.	Slender amaranth, pakai	X	W
ANACARDIACEAE			
Schinus terebinthifolius Raddi	Christmas berry, wilelaiki	X	KG,KN,os,S,W
APOCYNACEAE			
Catharanthus roseus (L.) G. Don	Red periwinkle	X	KG,os,S
ASCLEPIADACEAE			
Gomphocarpus physocarpus E. Mey.	Ballon plant	X	KN
BASELLACEAE			
Boussingaultia gracilis Miers.	Madeira vine, 'uala-hupe	X	KG
BIGNONIACEAE			
Spathodea campanulata Beauv.	African tulip tree	X	KG

Taxa	Common Name	Status	Vegetation type(s)
ONAGRACEAE			
Ludwigia octivalvis (Jacq.) Raven	Primrose willow, kamole	I	W
OXALIDACEAE			
Oxalis corniculata L.	Yellow wood sorrel, 'ihi	I	KG
PAPAVERACEAE			
Argemone glauca Pope	Pua-kala	E	KG
PASSIFLORACEAE			
Passiflora edulis f. flavicarpa Deg.	Yellow lilikoʻi	X	KG
Passiflora foetida L.	Scarlet-fruited passionflower, pohapoha	X	KN
Passiflora suberosa L.	Huehue-haole	X	KG,KN
PIPERACEAE			
Peperomia sp.	Ala'ala-wai-nui	I	KN,os
PLANTAGINACEAE			
Plantago major L.	Common plantain, lau-kahi	X	W
PLUMBAGINACEAE			
Plumbago zeylanica L.	Ilie'e, hilie'e	I	KG,os
POLYGONACEAE			
Antigonon leptopus H.& A.	Mexican creeper	X	S
PORTULACACEAE			
Portulaca cyanosperma Egler	'Ihi	E	KG,KN,os,S,W
Portulaca oleracea L.	Common purslane, 'ihi	X	KG
RUBIACEAE			
Canthium odoratum (Forst. f.) Seem.	Alahe'e, walahe'e	I	KG,KN,os
Morinda citrifolia L.	Noni	P	os,S
SAPINDACEAE			
Dodonaea sandwicensis Sherff	A'ali'i	E	KN

Taxa	Common Name	Status	Vegetation type(s)
SCROPHULARIACEAE			
Bacopa monnieria (L.) Wettst.	Water hyssop	I	W
SOLANACEAE			
Nicandra physalodes (L.) Gaertn.	Apple-of-Peru	X	KG
STERCULIACEAE			
Waltheria indica var. americana (L.) R. BR. ex Hosaka	Hi'aloa, 'uhaloa	I	KG,KN,os,S
Indet. sp.		X	KG,KN
UMBELLIFERAE			
Centella asiatica (L.) Urban	Asiatic pennywort, pohekula	X	W
Hydrocotyle verticillata Thumb.	Whorled marsh pennywort, pohepohe	X	W
VERBENACEAE			
Lantana camara L.	Lantana, lakana	X	KG,KN,os,S
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi,oi	X	KG

Taxa	Common Name	Status	Vegetation type(s)
BORAGINACEAE			
Heliotropium curassavicum L.	Nena, kipukai	I	S
Messerschmidia argentea (L.f.) Johnston	Tree heliotrope	X	S
CACTACEAE			
Opuntia megacantha Salm-Dyck	Prickly pear, panini	X	KN,os
CARICACEAE			
Carica papaya L.	Papaya, mikana	X	KG
CASUARINACEAE			
Casuarina equisetifolia Stickm.	Common ironwood	X	S,W
CHENOPODIACEAE			
Chenopodium sp.		X	W
COMBRETACEAE			
Conocarpus erectus L.	Buttonwood	X	S
COMPOSITAE			
Bidens cynapifolia HBK.	West Indian beggar's tick	X	KG,KN
Bidens pilosa L.	Spanish needle, ko'oko'olau	X	KN
Bidens pilosa var. minor (Bl.) Sherff		X	KG
Eclipta alba (L.) Hassk.	False daisy	X	W
Emilia fosbergii Nicol.	Red pua-lele	X	KG,os
Erigeron bonariensis L.	Hairy horsewed, ilioha	X	KG,os
Lipochaeta integrifolia (Nutt.) Gray	Nehe	E	S
Pluchea odorata (L.)Cass.	Pluchea, shrubby fleabane	X	KG,KN,os,S,W
Sonchus oleraceus L.	Sow thistle, pua-lele	X	KG,os,W
Syndedrella nodiflora (L.) Gaertn.	Synedrella	X	KG
Vernonia cinerea (L.) Less.	Ironweed	X	KG
Wedelia trilobata (L.) Hitchc.	Wedelia	X	W

Taxa	Common Name	Status	Vegetation type(s)
CONVOLVULACEAE			
Cuscuta sandwichiana Choisy	Kauna'oa	E	S
Ipomoea aquatica Forsk.	Swamp cabbage, ung-choi	X	W
Ipomoea congesta R. Br.	Koali-'awahia	I	KG,KN
Ipomoea obscura (L.) Ker-Gawl		X	KG,KN
Jacquemontia sandwicensis Gray	Pa'u-o-hi'i-'aka	E	S
Merremia aegyptia (L.) Urban	Hairy merremia, Koali-kua-hulu	I	KG
Stictocardia tiliaefolia (Desr.) Hallier f.	Stictocardia, pili-kai	X	W
CRASSULACEAE			
Kalanchoe pinnata (Lam.) Pers.	Airplant, 'oliwa-ku-kahakai	X	KG
CRUCIFERAE			
Nasturtium microphyllum Boenn. ex Reichenb.	Watercress, leko	X	W
CUCURBITACEAE			
Momordica charantia var. pavel Crantz	Balsam apple, peria	X	KG,KN
EUPHORBIACEAE			
Aleurites moluccana (L.) Willd.	Kukui	P	KG
Euphorbia geniculata Ortega	Wild spurge, kaliko	X	KG,KN
Euphorbia glomerifera (Millsp.) L.C. Wheeler		X	KN
Euphorbia hirta L.	Garden spurge, koko-Kahiki	X	KG,KN
Ricinus communis L.	Castor bean, koli	X	KG,W
GOODENIACEAE			
Scaevola taccada (Gaertn.) Roxb.	Naupaka-kahakai	I	os,S,W

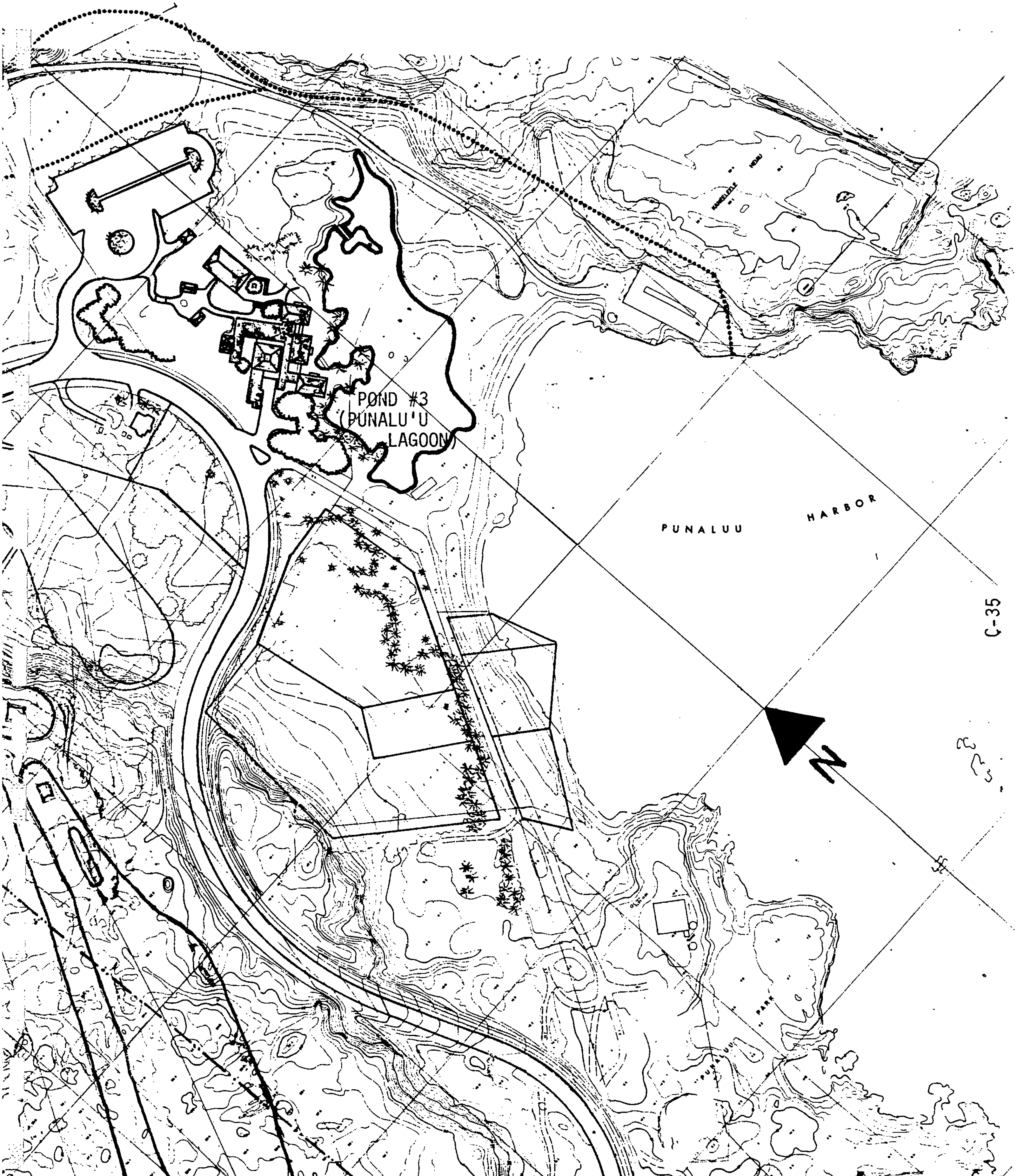
Taxa	Common Name	Status	Vegetation type(s)
LABIATAE			
Hyptis pectinata (L.) Poit.	Comb hyptis	X	KG,KN
Leonotis nepetaefolia (L.) Ait.	Lions-ear	X	KG
Plectranthus parviflorus Willd.	Spurflower	X	os
Salvia coccinea Juss. ex Murr.	Scarlet sage, lili-lehua	X	KG
LEGUMINOSAE			
Acacia confusa Merr.	Formosan koa	X	KG,KN
Acacia farnesiana (L.) Willd.	Klu	X	KG,KN
Caesalpinia major (Medic.) Dandy & Exell	Kakalaioa	I	KN
Canavalia cathartica Thouars	Mauna-loa	X	S
Cassia bicapsularis L.		X	KG,KN
Cassia leschenaultiana DC.	Partridge pea, lauki	X	KG,KN,os
Crotalaria incana L.	Fuzzy rattle-pod, kukae-hoki	X	KG,KN
Crotalaria pallida Aiton	Rattlepod	X	KG,os
Desmodium triflorum (L.) DC	Three-flowered beggarweed	X	KG,S
Desmodium uncinatum (Jacq.) DC.	Spanish clover	X	KN,os,W
Desmodium sp.		X	KG,KN
Indigofera suffruticosa Mill.	Indigo, 'iniko	X	KG,KN
Leucaena leucocephala (Lam.) de Wit	Koa-haole, ekoa	X	KG,KN,os
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	Sensitive plant, pua-hilahila	X	KG
Phaseolus lathyroides L.	Cow pea	X	KG,KN
Pithecellobium dulce (Roxb.) Benth.	'Opiuma	X	KG
Prosopis pallida (Humb. & Bonpl. ex Willd.) HBK.	Algaroba, kiawe	X	KG
Pueraria sp.		X	KG
Samanea saman (Jacq.) Merr.	Monkeypod, ohai	X	KG,KN

Taxa	Common Name	Status	Vegetation type(s)
Vigna marina (Burm.) Merr.	Nanea, pohilihili	I	S,W
LOGANIACEAE			
Buddleja asiatica Lour.	Asiatic butterfly bush, huelo-'ilio	X	KG
MALVACEAE			
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon, ma'o	X	KG,KN
Hibiscus tiliaceus L.	Hau	I	W
Malvastrum coromandelianum (L.) Garcke	False mallow, haunoi	X	KG
Sida fallax Walp.	'Ilima	I	KN,os,S
Sida rhombifolia L.	Cuba jute	X	KG,KN
Sida spinosa L.	Prickly sida	X	KG,KN
Thespesia populnea (L.) Soland. ex Correa	Milo	P	W
MELIACEAE			
Melia azedarach L.	Chinaberry, 'inia	X	KG
MENISPERMACEAE			
Cocculus ferrandianus Gaud.	Huehue, hue'ie	I	KN
MORACEAE			
Ficus sp.		X	KN
MYOPORACEAE			
Myoporum sandwicense Gray	Naio	E	os,S
MYRTACEAE			
Eucalyptus sp.			
Eugenia cuminii (L.) Druce	Java plum, palama	X	KG,KN
Psidium guajava L.	Guava, kuawa	X	KG
NYCTAGINACEAE			
Boerhavia diffusa L.	Alena	I	os
Mirabilis jalapa L.	Four o'clock, pua-ahiahi	X	os,W

Appendix C: Marine And Coastal Pond Baseline Study

SECTION 1: MARINE AND COASTAL POND BASELINE STUDY
PUNALU'U RESORT, KA'U, ISLAND OF HAWAII
OCTOBER 1984 SURVEYS

SECTION 2: MARINE AND COASTAL POND BASELINE STUDY
PUNALU'U RESORT, KA'U, ISLAND OF HAWAII
AUGUST 1986 SURVEYS



C-35

FIGURE 2. Location Map: Pond #3 (Punalu'u Lagoon)

William A. Brewer & Associates
Marine / Coastal / Terrestrial Consultants
for
Micronesia, Asia & the Greater Pacific

MARINE AND COASTAL POND BASELINE STUDY

PUNALU'U RESORT, KA'U, ISLAND OF HAWAII

OCTOBER 1984 SURVEYS

prepared for

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PREFACE TO 1984 AND 1986 BASELINE SURVEYS

An October 1984 survey of marine and coastal pond environments in the Punalu'u Harbor - Ninole Cove area was undertaken during the early project planning stages to gain an understanding of the natural resources of the region and to identify any potential environmental constraints associated with the proposed action.

A re-survey of the nearshore marine and coastal pond environments in the Punalu'u Harbor - Ninole Cove area was conducted in August 1986 to gain an increased understanding of the coastal resources of the region and to account for any changes in the natural resources of the coastal zone since the earlier study. Punalu'u Lagoon, a disturbed coastal pond located at the existing Punalu'u Resort restaurant complex, and two small transient coastal ponds, apparently created by recent storm wave action, were surveyed for the first time during the 1986 surveys. None of the coastal ponds at Punalu'u meet the currently accepted physical and biological criteria to be considered "anchialine" in character. Although possessing some of the physical and biological characteristics of true anchialine ponds, the Punalu'u ponds lacked the characteristic pond biota (caridean shrimps and encrusting algae) and the highly porous substratum necessary for a contemporary definition of anchialine. They are, therefore, for the purposes of this study, classified as coastal ponds.

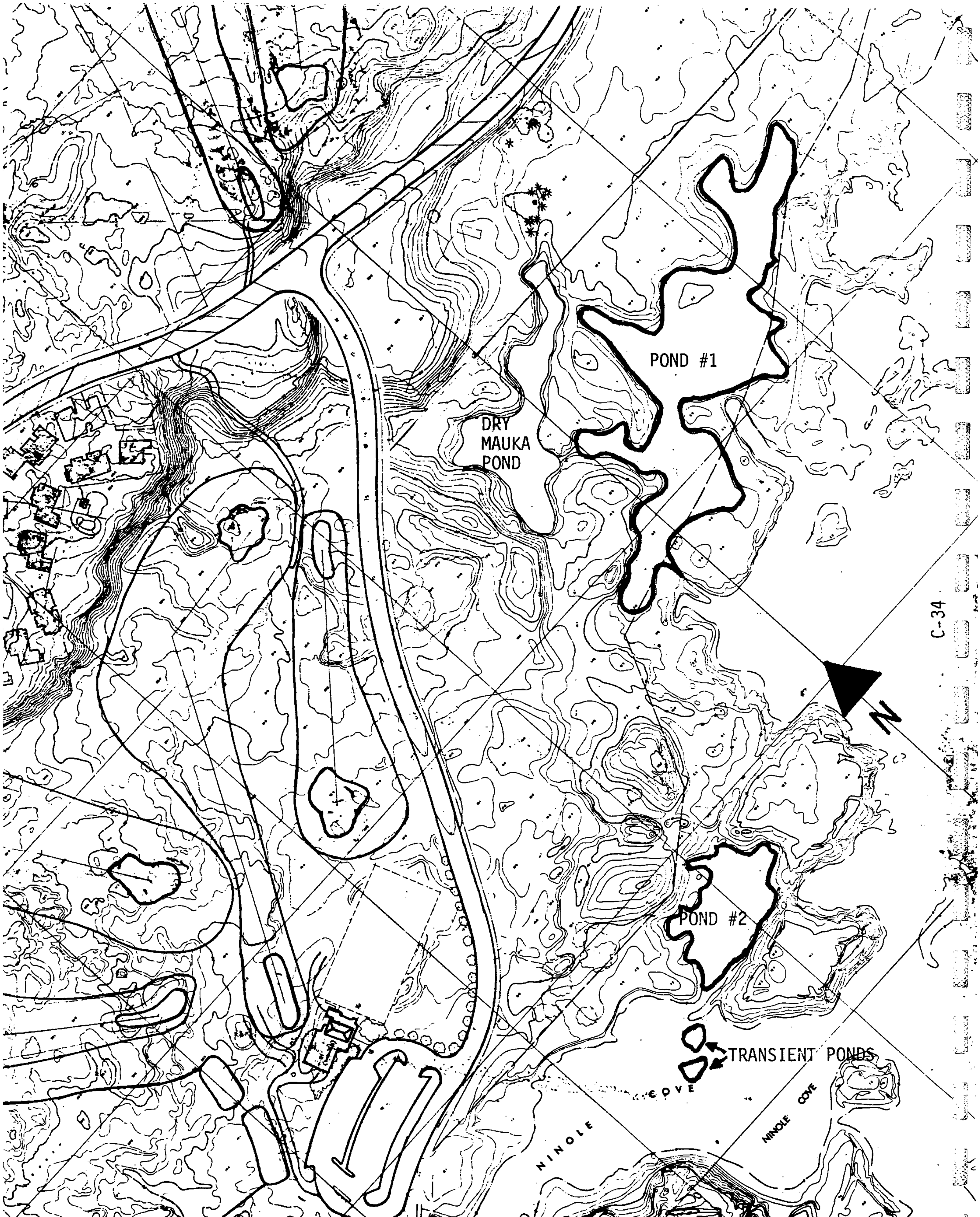

FIGURE 1. Location Map: Ponds #1,#2, and Transient Ponds

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TABLE 6

CHECKLIST OF FISHES, PUNALU'U HARBOR

<u>Family/Genus/Species</u>

ACANTHURIDAE (SURGEONFISHES)
Acanthurus dussumieri (palani)
Acanthurus hawaiiensis
Acanthurus leucopareius (maikaiko)
Acanthurus mata (puala)
Acanthurus nigroris (maiko)
Acanthurus olivaceus (na'ena'e)
Acanthurus triostegus (manini)
Naso lituratus (umaumalei')
Naso unicornis (kala)

CHAETODONTIDAE (BUTTERFLYFISHES)
Chaetodon auriga (kikakapu)
Chaetodon unimaculatus (lau-hau)

LABRIDAE (WRASSES)
Thalassoma fuscum ('awela)

MONOCANTHIDAE (FILEFISHES)
Pervagor spilosoma (o'ili-'uwi'uwi)

MULLIDAE (GOATFISHES)
Mulloides flavolineatus (weke)
Parupeneus porphyreus (kumu)

MURAENIDAE (MORAY EELS)
Gymnothorax undulatus (puhi-lau-milo)

OSTRACIONTIDAE (TRUNKFISHES)
Ostracion meleagris (moa)

POMACENTRIDAE (DAMSELFISHES)
Abudefduf abdominalis (mamo)
Chromis hanui
Plectroglyphidodon johnstonianus

1.0 INTRODUCTION

By letter dated October 26, 1984 from Phillips Brandt Reddick, the following scope of services were identified for the subject project:

- Underwater qualitative surveys encompassing corals, algae, fishes, and macroinvertebrates at representative sites at Ninole Cove and Punalu'u Harbor.
- Physical-chemical characterization of coastal waters at Ninole Cove and Punalu'u Harbor.
- Survey of coastal intertidal flora and fauna at representative locations at Ninole Cove and Punalu'u Harbor.
- Biological survey of coastal ponds, encompassing fish, macroinvertebrates, and algae.
- Physical-chemical characterization of coastal ponds encompassing dissolved oxygen, temperature and salinity.

The following sections address this scope of work.

2.0 METHODS

2.1. Physical-Chemical Measurements

Salinity and temperature measurements were made with a Yellow Springs Instrument Company (YSI) S-C-T meter equipped with a YSI model 3300 nickel-platinum conductivity/temperature probe. Dissolved oxygen measurements were obtained on a YSI Model 51B dissolved oxygen meter equipped with a membrane-covered polarographic sensor. The dissolved oxygen meter was calibrated according to factory guidelines in a water vapor-saturated chamber. Measurements were based on *in situ* sampling, except for offshore samples at Punalu'u Harbor which were collected by wading into the water and collecting the sample by hand in a wide-mouth one-half liter polyethylene container. Based on manufacturer-supplied specifications, worst-case possible instrument/probe errors are as follows: temperature, ±0.7 degrees Centigrade (C.): salinity, ±0.2 parts per thousand (ppt); dissolved oxygen, ±0.2 parts per million (ppm). However, considering the conditions encountered in the field (wide instrument meter oscillations associated with springwater flows in coastal ponds and in the ocean) these above specifications

have little relevance to the Punalu'u - Ninole region. With few exceptions, most readings were made by "averaging" meter oscillations at any given station.

2.2. Biological Surveys

2.2.1. Marine Environment

Marine surveys were conducted to qualitatively assess the major physiographic features, biological zonation patterns, and to develop a checklist of the represented algae, coral, macroinvertebrates and fish. Surveys were conducted with mask and snorkel which necessarily limited the surveys to waters less than 6-7 meters deep.

Corals, algae, fishes and major macroinvertebrates noted on the surveys were identified and listed without regard to their abundance in an area, though notes were taken to indicate general population densities, habitat features and the most numerous species characterizing a given zone or habitat. Where appropriate, counts or estimates of benthic invertebrate population densities were made with the assistance of a meter-stick which was used to lay out crude one-meter square quadrats.

The entire coastline encompassing Punalu'u Harbor and Ninole Cove is heavily influenced by cold intertidal and subtidal groundwater discharges and a major freshwater discharge from a large coastal pond (Figures 1 & 2). Cold, low-saline, water floats atop and mixes with the higher density nearshore ocean water, creating a schlieren effect which significantly restricted underwater visibility. This factor posed a handicap during the surveys and likely accounted for some species being omitted from the data record.

A total of five dives of approximately 30-45 minutes duration each were conducted in the general area encompassing Punalu'u Harbor to Ninole Cove. The prevailing wave action and occasional strong rip currents curtailed surveys in some areas and prevented a complete reconnaissance of all inshore areas. However, sufficient data were collected to ascertain the major physical and biological features of this exposed coastline.

Underwater data were recorded on Nalgene Poly Paper sheets. A Nikonos II underwater camera was utilized to document intertidal and subtidal physiographic features and representative marine and coastal pond flora and fauna.

2.2.2. Coastal Ponds

TABLE 5

CHECKLIST OF CORALS AND MACROINVERTEBRATES, PUNALU'U HARBOR

Phylum/Family/Genus/Species

COELENTERATA
- Poritidae
  - *Porites lobata*
- Pocilloporidae
  - *Pocillopora damicornis*
  - *Pocillopora ligulata*
  - *Pocillopora meandrina*

PORIFERA — Unident. encrusting sponges

ANNELIDA — Unident. tube worm

CRUSTACEA
- Grapsidae
  - *Grapsus tenuicrustatus*
- Xanthidae
  - *Carpilius maculatus*

MOLLUSCA
- Neritidae
  - *Nerita picea*
- Littorinidae
  - *Littorina pintado*
  - *Littorina scabra*
- Patellidae
  - *Siphonaria normalis*
- Vermetidae
  - *Serpulorbis variabilis*
  - *Dendropoma gregaria*
- Mytilidae
  - *Brachidontes cerebristriatus*
- Ostreidae
  - *Isognomon perna*
- Spirorbinae
  - *Janua knightjonesi*

ECHINODERMATA
- Asteroidea (sea stars)
  - *Linckia multiflora*

- Echinoidea (sea urchins)
  - *Echinometra mathaei*
  - *Echinometra oblonga*
  - *Heterocentrotus mammilatus*
  - *Tripneustes gratilla*
  - *Echinothrix diadema*
- Ophiuroidea (brittle stars)
  - *Ophiocoma erinaceus*
  - *Ophiocoma* sp.

TUNICATES
- Unident. encrusting (pink)
- Unident. encrusting (yellow)

Coastal pond #1, the largest pond at the study site, was surveyed during the course of two random searches of approximately 30 minutes duration each. These dives encompassed the perimeter of the pond and representative cross-sectional areas within the various small irregular coves and embayments within the pond. Pond #2, a smaller, largely eutrophic, landlocked water body, was surveyed by a single dive of approximately 20 minutes which was limited to an area of clear water encompassing approximately one-tenth of the makai, isthmus side, of the pond. Efforts to inventory other areas were prevented by a dense mass of filamentous algae that dominated the entire water column. Visibility was virtually zero in all but the makai side of the pond. Both ponds were also reconnoitered by walking the shoreline and closely inspecting areas with rooted emergent vegetation and overhanging grasses. A 6-inch diameter dip net was also utilized to sample pond margin areas with dense submerged vegetation.

3.0 RESULTS

3.1. COASTAL POND SURVEYS

Two coastal ponds were surveyed during the course of field investigations. Pond #1 (Figure 2) is the largest pond, reaching a length of nearly 250 meters in its longest surface dimension (roughly east-west) and is physically connected to the ocean via a 15-meter long, apparently natural, stream channel.

A third pond, now dry, is located immediately mauka of pond #1. It is separated from the latter pond by a narrow jeep road which parallels the shoreline. This pond is heavily vegetated by numerous wetland plants, suggesting that it periodically, perhaps seasonally, contains standing water. Older topographic maps indicate that these two ponds were once physically connected.

3.1.1. COASTAL POND #1

3.1.1.1. Water Quality

Water quality measurements in this large coastal pond suggest relatively uniform physical characteristics, though salinity data indicate a small but distinct gradient. Surface waters demonstrated a mean temperature of 21.2 degrees C.; bottom waters (1.0-1.5 meters) a mean of 21.6 degrees C. Salinities ranged from 1.2-1.9 ppt in surface waters; bottom waters were between 3.0-3.6 ppt. Dissolved oxygen levels were similar with all samples demonstrating values of between 67-79 percent of

saturation with respect to the prevailing temperature, salinity and barometric pressure (Table 1).

3.1.1.2. Biological Surveys

Pond #1 has a surface area of approximately 2.5 acres and a maximum depth of approximately 1.5 meters. It is fed by numerous springs of cool, low saline, water which provide exceptional underwater visibility. This pond is directly connected to the ocean through a small stream channel. The low tide discharge rate was approximately 20 cubic feet/second. The shoreline of the pond was lined with various wetland plants including the grass *Paspalum* sp. and the bulrush *Scirpus validus*. Duckweed and floating mats of *Azolla filiculoides* occur in small pockets along the more protected reaches of the pond margin.

The pond margin (shoreline) and areas of noticeable groundwater discharges harbored the majority of the pond biota. The floor of the pond is covered with silt and several centimeters of organic material which appears to be unfavorable to most fauna. Small mullet (*Mugil cephalus*) and juvenile aholehole (*Kuhlia sandvicensis*) were common throughout the pond, though the latter species was most numerous within stands of *Scirpus* where water circulation is high. The largest population of juvenile aholehole (several hundred) occurred within the ocean discharge channel. A relatively small population of mosquito fish (*Gambusia*) inhabited grassy shorelines in more protected portions of the pond. Large numbers of the endemic goby, oopu akupa (*Eleotris sandwicensis*), are found throughout the pond though occurring in highest densities in areas of groundwater discharges and along the pond margin. The highest population density of oopu (approximately 4-5/square meter) occurred in the discharge channel where water movement is high. Virtually all of the fish observed during the underwater surveys were juveniles. This observation was later partially explained by the presence of a gill net in a narrow embayment located off the main pond. Fishing is likely to the reason for the absence of large fish in the pond.

Macroinvertebrates were represented by the glass shrimp, *Palaemon debilis* (opae huna), and the snail *Melania*. *Palaemon* appears to be restricted to the bases of grass covered banks, thick stands of emergent vegetation, and rocky areas along the pond margin. This shrimp occurs in very large numbers (30-60/meter of appropriate shoreline) but is extremely difficult to accurately census because of its cryptic nature and nearly transparent exoskeleton. The gastropod *Melania* was also a common benthic species associated with the pond margin.

TABLE 3

PUNALU'U HARBOR WATER QUALITY

Date: 8/15/86 Time: 1320 hrs (High tide)

Station/Site #	Depth(M)	Temp.(C.)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (Boat ramp)	0.2	22.5	15.4	6.6
	1.3	27.6	27.7	8.2
	2.0	27.9	27.8	9.2
#2 (Channel)	0.2	23.4	21.1	5.6
	3.0	25.7	23.5	7.6
#3 (Beach)	0.5	19.7	6.6	8.6
	1.0	20.3	10.3	6.6

Date: 8/16/86 Time: 0800 (Low tide)

Station/Site #	Depth(M)	Temp.(C.)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (Boat ramp)	0.2	19.7	0.9	5.6
	1.0	20.4	1.9	5.7
#2 (Channel)	0.2	23.3	29.1	6.6
	2.0	27.3	29.9	9.1
#3 (Beach)	0.5	19.7	1.1	5.7
	1.0	21.1	4.4	6.8

TABLE 4

CHECKLIST OF MARINE ALGAE, PUNALU'U HARBOR

Division/Genus/Species

Chlorophyta (Green Algae)
- *Caulerpa racemosa*
- *Chaetomorpha antennina*
- *Enteromorpha* sp. ('ele'ele)
- Unident. green filamentous

Phaeophyta (Brown Algae)
- *Dictyota acutiloba* (alani)
- *Dictyota sandvicensis* (alani)
- *Ralfsia* sp.

Rhodophyta (Red Algae)
- *Ahnfeltia concinna* ('aki'aki)
- *Amansia glomerata*
- *Grateloupia* sp.
- *Hydrolithon breviclavium*
- *Hydrolithon reinboldii*
- *Jania* sp.
- *Laurencia* sp.
- *Lithophyllum kotschyanum*
- *Neogoniolithon frutescens*
- *Porolithon gardineri*
- *Pterocladia capillacea*
- *Sporolithon erythraeum*

Unknowns
- Unident. flat bladed, zero tide level (red or brown).
- Unident. *Gelidiopsis*-like wiry growth (red/brown), intertidal to subtidal rocks.
- Unident. *Asparagopsis*-like tufts (red/brown), subtidal rocks.

3.1.2. COASTAL POND #2

3.1.2.1. Water Quality

Water temperatures were similar to those of pond #1 though surface and bottom water salinities were lower (0.8-0.9 ppt in surface waters; 1.1 ppt in bottom waters (Table 1). This was surprising inasmuch as several meters of makai shoreline was subject to frequent wave splash during the survey period. Groundwater discharges significantly influence this pond. Surface water dissolved oxygen levels were higher than pond #1 (78-80 percent of saturation) and are probably the result of photosynthetic rates associated with the dense growths of filamentous green algae which dominate the water column throughout most of the pond. Except in areas dominated by groundwater discharges, the majority of the pond (perhaps 90 percent) demonstrates a noticeable turbidity (greenish-brown coloration) which was likely the result of a modest phytoplankton bloom. The phytoplankton population would also contribute to the dissolved oxygen values observed.

3.1.2.2. Biological Surveys

Pond #2, located immediately mauka of the beach at Ninole Cove, has been drastically modified by flashflooding since the survey, Wetlands and Wetland Vegetation of Hawaii (Elliot and Hall, 1977). Analysis of the wetland vegetation map provided in the above study (page 199) indicates that the existing pond and surrounding vegetation have little resemblance to that reported in the above study. This pond is approximately 50 meters in diameter and heavily silted. An estimated 80-90 percent of the pond is eutrophic, dominated by monotypic stands of filamentous green algae which occur throughout the water column. This algae creates large floating mats on the surface and thick anaerobic mats on the bottom. Biological diversity in the pond is low.

The goby, *Eleotris sandwicensis*, was the only fish recorded in the pond, though the density of the algal mass did not permit surveys to be conducted in other than the immediate makai area. This species was only seen in areas lacking algal mats and in areas influenced by groundwater discharges or occasional wave overtopping. The macroinvertebrate population was limited to the glass shrimp, *Palaemon debilis* (opae huna), which was restricted to emergent vegetation along the pond margin.

3.2. MARINE ENVIRONMENTAL SURVEYS

3.2.1. INTERTIDAL ZONE

The intertidal zone encompassing the shoreline from Punalu'u Harbor to Ninole Cove consists of: (1) biologically depauperate crescent-shaped black sand beaches and beach berms; and (2) wave-dominated exposed basaltic rocks, headlands and tidepools of low to moderate biological diversity. Storm wave action, intertidal and subtidal freshwater springs and a large point-source surface discharge of cool, low saline, water from a coastal pond appear responsible for the low to moderate diversity which characterizes most of the intertidal zone.

Sandy beaches and beach berms had no macroscopic flora or fauna present. Exposed rocky shorelines and embayments demonstrated intertidal zonation patterns not unlike other exposed coastlines in Hawaii, except for areas influenced by groundwater discharges. Exposed rocky shores directly influenced by wave action generally exhibited the most distinct or typical intertidal zonation patterns with characteristic splash zone, upper intertidal, and lower intertidal communities evident.

Typical splash zone "indicator" invertebrates included *Nerita picea*, *Littorina pintado*, and *Littorina scabra*.

The upper intertidal zone is distinguished by a dense band of the red seaweed *Ahnfeltia concinna*, except in small coves dominated by freshwater. The false opihi (*Siphonaria normalis*), the shingle urchin (*Colobocentrotus atratus*), and two species of grapsid crabs were the representative and dominant macrofaunal elements of this zone.

The lower intertidal zone was characterized by a variety of encrusting and fleshy red and green algae, with *Ulva fasciata* the most abundant species. The black foot limpet, *Cellana exarata* (opihi), is the representative species of this zone, occurring in very large numbers on many wave-exposed basaltic headlands. Other, more wave-protected, areas are noticeably devoid of opihi, possibly indicating frequent harvesting by local fishermen. Examination of the harvest of one opihi fisherman indicated well over one hundred adult opihi which were collected in less than one hour.

The rocky intertidal zone of wave-protected inshore coves, inlets, and embayments subject to groundwater or surface water discharges are devoid of most intertidal species, including the red alga *Ahnfeltia concinna*. This species appears to represent an excellent "indicator species" for such zones at Punalu'u inasmuch as the absence of this species generally indicated the absence of most, if not all other, intertidal

TABLE 1
COASTAL POND WATER QUALITY

COASTAL POND #1
Date: 8/15/86 Time: 1435 hrs

Station/Site #	Depth(M)	Temp.(C)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (East side)	0.1	21.5	1.9	5.8
	1.2	22.0	3.8	5.9
#2 (Center)	0.1	21.4	1.8	6.3
	1.0	21.6	3.9	6.4
#3 (West side)	0.1	21.6	2.0	5.8
	1.4	21.8	4.0	6.9
#4 (NW side in spring)	0.1	19.5	0.05	5.0
	1.4	19.5	0.1	5.0

COASTAL POND #2, NINOLE COVE
Date: 8/16/86 Time: 1100 hrs

Station/Site #	Depth(M)	Temp.(C)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (East side)	0.1	20.1	1.5	6.8
	1.4	21.0	6.6	8.4
#2 (N. side)	0.1	20.1	1.5	6.8
	1.0	21.3	6.4	8.4
#3 (West side)	0.1	20.1	6.8	6.8
	1.2	21.1	6.6	8.8
#4 (Isthmus)	0.1	22.4	5.6	9.0
	0.5	22.3	8.1	8.8
	1.0	22.3	6.6	6.9
	1.8	21.4	6.2	8.9
#5 (Mat)	1.5	21.3	6.6	0.4
(Mat)	1.3	21.2	6.4	4.4
(Mat)	1.6	21.2	6.6	1.8

COASTAL POND #3 - PUNALU'U LAGOON
Date: 8/16/86 Time: 0840 hrs

Station/Site #	Depth(M)	Temp.(C)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (Makai side)	0.3	24.4	1.2	4.4
#2 (Mauka side)	0.1	24.4	1.3	3.3
	0.7	24.3	1.5	3.3
#3 (West side)	0.2	24.4	1.2	6.9
	0.9	24.3	1.2	5.7

TRANSIENT PONDS AT NINOLE COVE
Date: 8/16/86 Time: 1000

Station/Site #	Depth(M)	Temp.(C)	Sal.(ppt)	Diss. Oxy.(ppm)
#1 (West pond)	0.3	21.4	1.5	6.2
#2 (East pond)	0.3	21.4	1.5	6.2

TABLE 2

CHECKLIST OF COASTAL POND BIOTA

Taxa/Genus/Species	Pond#: 1	2	3	Trans.
FISH				
Blennidae (Blennies)				
Entomacrodus marmoratus	X			
Cyprinidae (Carps)				
Cyprinus carpio			X	
Gobiidae (Gobies)				
Eleotris sandwicensis	X			X
Kuhliidae (Aholehole)				
Kuhlia sandvicensis	X	X		
Unident. kuhliid?		X		
Mugilidae (Mullet)				
Mugil cephalus	X			
Mullidae (Goatfish)				
Unident. juveniles	X			
Poeciliidae				
Poecilia sp.			X	
Gambusia sp.	X	X	X	X
CRUSTACEANS				
Palaemon debilis	X	X		X
Macrobrachium grandimanus	X	X		X
M. lar or *M. rosenbergii*			X	
GASTROPODS				
Assiminea sp. (*nitida?*)	X	X		
Melania sp. (*auriculoides?*)	X	X		
Theodoxus cariosa	X	X		
AMPHIBIANS				
Bufo sp. (tadpoles)			X	

species.

One unusual feature observed in a small, protected, rocky cove immediatly makai of pond #1 was a dense aggregation of the small mussel *Brachiodontes cerebristriatus*. This species has formed a near confluent monotypic carpet occupying approximately 10-15 square meters of rocky substratum. During low tide periods this population is bathed in low saline water from pond #1. This species was not observed elsewhere along the shoreline.

Nearly all tide pools in the area are dominated by cool, low saline, groundwaters which appear to limit opportunities for successful biological colonization and growth. However, one relatively high, isolated, tide pool was found to contain approximately thirty juvenile manini (*Acanthurus triostegus*) and several unidentified juvenile angelfish.

3.2.2. PUNALU'U HARBOR

3.2.2.1. Water Quality

The entire shoreline and nearshore waters encompassing the Punalu'u Harbor - Ninole Cove area is significantly influenced by intertidal and subtidal groundwater discharges and one major surface water discharge from a large, spring-fed coastal pond (pond #1). Collectively, these discharges account for the wide variation in the physical and chemical properties of the nearshore waters and the relatively low diversity of nearshore marine organisms observed in most areas.

Nearshore waters in Punalu'u Harbor demonstrated a distinct thermal and salinity gradient as a result of the abundance of groundwater discharges which flow into the ocean within the intertidal zone and from freshets eminating from subtidal pahoehoe flows. Cold groundwater floats atop the denser ocean waters and freely mix by wind and wave action. These discharges create a cold, low saline, surface water layer that ranges from approximately 0.3-1.0 meters deep. Surface water temperatures in the harbor were extremely variable and ranged from 19.2-21.1 degrees C. (Figure 1, Table 3). By contrast, bottom temperatures in the same locations ranged from 24.3-27.1 degrees C. The degree of thermal stratification is perhaps best exemplified in the salinity data. Surface waters ranged from 6.4-12.5 ppt; mid-water or bottom samples ranged from 18.1-22.0 ppt. Dissolved oxygen levels indicate that the deeper waters are more highly oxygenated despite its warmer temperature and greater density.

3.2.2.2. Biological Surveys

Punalu'u Harbor is fringed on its landward margin with approximately 200 meters of a crescent-shaped, steeply sloping, black sand beach. The immediate back beach area is periodically modified by bulldozer operations to maintain the coastal road free of sand deposits. The east and west sides of the bay are composed largely of lava flows, rocks, and headlands with numerous small vertical to near-vertical lava-rock bluffs. Portions of the east side of the harbor have been modified in the last 50 years for some type of wharf facility which no longer exists, except for concrete pads and occasional cement pilings. A large coastal pond occupies the inland portion of the bay's northern flank, its seaward margin located approximately 40 meters inland from the beach crest.

The floor of the bay is generally shallow and irregular and is characterized by undulating lava bedrock and massive deposits of basalt boulders, cobbles and wave-deposited limestone materials. Vertical relief is provided by large boulders and undulating pahoehoe flows which rise to within approximately one meter of the surface in several locations and account for numerous inshore wave breaks. Major inshore or offshore sand deposits are uncommon, though one area dominated by basaltic sands (and some coralline materials) was evident in a wave-protected depression in the approximate middle of the bay. Lava flows, boulders and rocks are often devoid of encrusting organisms, suggesting that the entire bay is subject to frequent and rather severe wave action and sand scouring. A 30-meter wide dredged channel occurs on the east side of the bay but could not be surveyed because of a strong rip current.

Only two species of coral were identified within the harbor. *Pocillopora meandrina* and *Porites lobata*, the dominant corals of most wave-exposed shallow coastlines in Hawaii, are of generally infrequent occurrence at Punalu'u and represented colonies are, with few exceptions, small and irregular in shape. Both species demonstrated several color variations. *Porites* growth forms ranged from small, scattered, and irregularly shaped vegetative growths, to a few massive coral heads covering as much as one square meter. However, vegetative growth forms deposited by storm-wave action were the most common type. Total coral coverage, by estimation, was less than 1 percent.

Twenty (20) species of marine algae were identified within the intertidal and subtidal zones of Punalu'u Harbor (Table 4). None of the species was particularly abundant, except for occasional large patches of *Ahnfeltia* and *Ulva fasciata*, which were conspicuous in the intertidal zone on the channel side of the harbor. The red algae *Pterocladia capillacea* was also

On the basis of the above described "aging" or senescence process, the Punalu'u ponds, with or without a direct surface connection to the sea, can be described as being in an advanced stage of senescence.

> "Conditions promoting rapid senescence are good exposure to light, shallowness, and weak connection with the water table so that sedimenting particles are not flushed away with tidal exchanges or groundwater flow". (Maciolek and Brock, 1974).

On the basis of the above conditions promoting rapid senescence, the Punalu'u ponds may also illustrate several stages in senescence. Rapidly flushed by abundant groundwater flows, pond #1 (albeit a coastal pond), may be interpreted as the "youngest" pond within the complex. Pond #2, being less well flushed and characteristically eutrophic, may be considered "intermediate" in age. The dry pond with abundant wetland vegetation, mauka of pond #1, may well be defined as a "well vegetated depression", per the above definition. Thus, given consideration of natural physical events which have modified pond #2, a sequential pond aging process can be witnessed within the existing Punalu'u - Ninole pond basin. This ecological succession process is not unique to Punalu'u, as many west Hawaii pond basins demonstrate a similar succession or aging pattern (Maciolek and Brock, 1974).

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common at the zero-tide level along the landward side of the boat channel. The presence of numerous species of "reef-building" coralline algae throughout the inshore reaches of the harbor (*Porolithon*, *Neogoniolithon*, *Lithophyllum*, and *Hydrolithon*) are evidence of the impact of occasional storm-wave action in the harbor. These species are normally associated with deepwater offshore reef crests, margins and slopes.

Twenty-four (24) species of fish were identified in Punalu'u Harbor, indicating a rather low diversity compared to other, more protected, coastlines in Hawaii (Table 5). The Hawaiian dascyllus, *Dascyllus albisella* ('alo'ilo'i), was the most abundant species and was always associated with scattered outcrops of *Pocillopora*. The Hawaiian sergeant, *Abudefduf abdominalis* (mamo), and the convict tang, *Acanthurus triostegus* (manini), were second and third, respectively, in abundance. The filefish, *Pervagor spilosoma*, was also common in some areas. The fish diversity within the harbor is very low and is undoubtedly the result of the low salinity of the harbor waters and the low coral density.

Echinoderms accounted for the majority of the macroinvertebrate life in the harbor with sea urchins accounting for the greatest number of species (Table 6). The boring urchins *Echinometra mathaei* and *Echinometra oblonga* dominated many boulders and cobbles and were particularly numerous at about the zero-tide level. The black urchin *Diadema paucispinum* (wana) was occasionally found in densities of up to 16/square meter in rocky areas. The more conspicuous urchins included the brilliant reddish-orange slate-pencil urchin, *Heterocentrotus mammilatus*, and the collector urchin, *Tripneustes gratilla*, both of which were found in rocky areas throughout the entire harbor.

3.2.3. NINOLE COVE

3.2.3.1. Water Quality

Water quality in the Ninole Cove area demonstrated a similar pattern as that of Punalu'u Harbor with surface water temperatures of 19.0-20.0 degrees C. and bottom temperatures of 25.9-26.0 degrees C. Salinity values ranged from 4.5-5.9 ppt in the surface water mass to 18.7-27.4 ppt in the benthic water mass (Table 3, stations 6 and 7). Dissolved oxygen levels ranged from 5.8-6.6 ppm.

3.2.3.2. Biological Surveys

Ninole Cove has been subjected to major physical changes in recent years as a result of a major flashflood event(s) which

completely filled in and destroyed more than 1.5 acres of the former embayment. An elevated beach berm and steeply sloping beach represent the existing landward boundary of the cove, a site aproximately 150 meters seaward of its former inland location.

The present Ninole Cove is surrounded by steep a'a bluffs on the west side and a low undulating pahoehoe on the east side. A somewhat crescent-shaped and rather steep black sand beach berm creates the present landward limit of the cove. Virtually all of the cove was dominated by a cool layer of groundwater which limits biological colonization in both intertidal and inshore subtidal zones. Black sand, brown (apparently terrigenous) sediments, and white to greyish-white coralline materials dominate the subtidal zone to a point approximately 45 meters seaward of the beach. The sandy inshore zone terminates in a narrow (15 meters wide) transition zone of scattered small boulders, rocks and cobbles. The physiography seaward of the transition zone is dominated by undulating pahoehoe flows which extend well past the seaward terminus of the cove. The pahoehoe occasionally extends to within a meter of the surface and is responsible for several inshore wave zones. The entire bay was one of exceptionally low biological diversity.

Small nodular growths of *Pocillopora meandrina* and fragments of wave-deposited *Porites lobata* comprised the coral community. Macroalgae were nearly absent, with only small cropped growths of *Chaetomorpha* and *Enteromorpha* observed in more protected areas. With the exception of small stands of *Ahnfeltia* on the seaward-most headlands, virtually all of the macroscopic plant life was represented by broken fragments of wave-deposited coralline-algae. Broken thalli of *Pterocladia* were seen in several locations, the result of wave-deposition from larger beds subsequently located outside and immediately east of the cove.

The fish fauna was composed of seven (7) species. Only twenty-eight (28) fish were counted during a thirty minute reconnaissance dive in the cove and eleven of these were observed in the immediate vicinity of a "cleaning station" of the cleaner wrass, *Labroides phthirophagus*. Macroinvertebrates were, similarly, low in both population size and diversity (Table 6). The carapaces of several lobsters were noted on the beach, though no live specimens were observed.

blue-green algae) and the highly porous substrates necessary for a contemporary definition of anchialine. The ponds in the Punalu'u - Ninole region should, therefore, be classified as coastal ponds.

The 1984 survey characterized pond #2 as being in an "advanced stage of senescence", as a result of the preponderance of thick algal growths that dominated the entire water column and contributed to its eutrophic character. However, the 1986 survey showed a significant reduction in filamentous algae over the earlier study, despite the prevailing anoxic conditions that still characterized the bottom algal mat or "ooze". Recent storm wave inundation may have flushed the pond and at least temporarily restored water quality. Except for the pond margin, overall habitat quality remains poor because of the continued presence of an anoxic benthic algal mat. The prevailing cool water temperatures suggest, however, that despite its landlocked character and profuse algal masses, the pond remains relatively well flushed by low saline groundwaters and, at high tide, by subterranean ocean water and occasional wave overtopping at the narrow isthmus which separates the pond from the ocean.

Punalu'u Lagoon (Pond #3) was not surveyed in 1984, but the 1986 survey indicated that it has been significantly modified by construction of an artificial shoreline and introductions of exotic aquatic biota (carp and topminnows) and domesticated ducks and geese. Water temperature data indicate that this pond was 2-3 degrees C. warmer than the other coastal ponds, suggesting that it is poorly flushed. A phytoplankton bloom was evident thoughout the mauka reaches of the pond and may be the result of nutrients contributed by domesticated waterfowl and enrichment from leaf litter contributed by the nearly circumferential trees.

Pond #1 is a "coastal" pond rather than an "anchialine" pond (after Maciolek and Brock, 1974; Brock, 1985) because of its direct surface water connection to the ocean between Punalu'u Harbor and Ninole Cove. Despite its "coastal" classification, it harbors a fauna often associated with anchialine ponds, but not does contain the red atyid or alpheid shrimp or cyanophytes often described from true anchialine ponds. This pond demonstrated great variability in represented species populations between the 1984 survey and the 1986 survey, a consideration which may reflect seasonality, a reduction in fishing pressure on certain species, and/or recent storm-wave events which may have improved the benthic habitat for bottom-dwelling, generally sedentary, fish such as *Eleotris* (oopu). Recent storm waves have also modified the emergent vegetation of the pond with several large stands of *Scripus* having been decimated. *Scirpus* was formerly

the principal habitat for juvenile aholenole.

Observations of seine-net fishing practices around the margin of the pond (observed in 1986) suggest that although the pond is subject to uncontrollable physical environmental influences as a result of its coastal setting, fishing practices probably exert a greater influence on the density, distribution and biomass of glass shrimp (*Palaemon*), prawns (*Macrobrachium grandimanus*), and to a lesser extent, oopu (at least over the short-term), than all the physical influences combined. Given the mesh size of the small seine nets utilized, a few persons working for several hours along the pond margin could easily harvest the majority of the crustacean biomass of the pond. Similarly, a single "bottom sweep" with a conventional small-mesh, lead-weighted monofilament seine net could effectively remove the majority the oopu population from the pond.

Conservative estimates place the number of anchialine (and coastal) ponds on Hawaii Island at between 600 and 650 (Brock, 1985). The majority (approximately 420) occur along the the coast from Kawaihae to Kailua-Kona on the west side of the island. From Kailua-Kona to Ka Lae (South Point) there are about 90 more anchialine ponds. Based on Brock's (1985) aerial photograph analysis, there are approximately 71 anchialine or coastal ponds occurring between Ka Lae and Kapoho (Ka Lae, 10; Naalehu, 2; Punalu'u, 2 (pond #3 was apparently obscured by the tree canopy); Pahala, 8 (4 questionable); Ka'u desert, 6 (4 questionable); Makaopuhi Crater, 1 (1 questionable); Kalapana, 10; Pahoa South, 2; Kapoho, 42 (29 in a cluster at Waiopae, 4 questionable). Historically, the ponds at Punalu'u may have been anchialine in terms of physical and biological characteristics, though today they can only be described as coastal ponds. Because anchialine waters are rare on ancient lavas, they are obviously temporary features on a geological time scale (Maciolek and Brock 1974). Natural and immediate obliterations occurs when flowing lavas override and fill existing pond depressions. According to Maciolek and Brock (1974),

> "gradual disappearance of ponds is a senescence phenomenon which results from the accumulation of organic and mineral deposits originating from aquatic production and wind-blown materials. As sediments fill a pond basin, emergent plants such as sedges, rushes, and grasses take root, succulents and vines encroach from the edges, and a damp, well-vegetated depression evolves".

4. DISCUSSION

The results of the marine baseline surveys indicate that, with the possible exception of the macroalgae, the Punalu'u - Ninole coastline is one of generally low biological diversity as contrasted with other, less exposed, coastlines on the island of Hawaii. The abundance of certain species of macroalgae at Punalu'u is likely the result of naturally elevated nutrient levels associated with groundwater discharges and frequent storm wave action which prevents one algae from dominating and maintains the area in a relatively early stage of ecological succession. The filamentous algae, *Enteromorpha*, is one example of an early "pioneer" species that is often displaced in time by other, larger species but is important in conditioning a substrate for the subsequent settlement and attachment of other species.

The low diversity and density of fishes probably reflects the low salinity of the inshore waters and the absence of suitable habitat. Corals were uncommon along the coastline and represented species were generally small, encrusting, vegetative growth forms offering little protective habitat required by most coral reef fishes. Although surveys conducted during other times of the year would likely add a number of additional fish (as well as invertebrates and algae) to the checklist, the prevailing wave-exposed nature of the coastline and the absence of significant coral development would not produce any significant increase in the unique inshore (harbor) fauna. There was no particularly unique, unusual or rare species of fish, invertebrate or algae observed in any part of the survey area.

Although the Ka'u region is well known for harboring one of Hawaii's largest populations of endangered and threatened sea turtles, none was seen during the survey period. *Pterocladia capillacea* was common along the east side of the inshore harbor channel and is known to be one of the preferred foods of the green sea turtle.

The coastal ponds in the Punalu'u - Ninole coastal basin harbor a fauna similar to estuaries and freshwater streams throughout Hawaii. The presence of a direct surface connection to the ocean in pond #1 precludes it from being classified as "anchialine" in character (Holthuis, 1973; Maciolek and Brock, 1974). Pond #2 is located immediately east of what was formerly Ninole Cove and has no direct connection to the ocean, though a 1977 map (Elliot and Hall, 1977) and aerial photographs (1968) indicate that the pond was once directly connected to Ninole Cove. Ninole Cove was physically altered during a major

flashflood event in the late 1970's which resulted in the filling of the entire cove with upland rock and sediment. Based on the water quality definition of anchialine offered by Holthuis (1973), the pond can be considered anchialine (ponds without surface connections to the sea, measurable salinity and tidal rhythms), but it does not meet the necessary biological criteria offered by Maciolek and Brock (1974) for an anchialine pond (mineral encrusting blue-green algae and the presence of the shrimps *Halocaridina rubra* and *Metabetaeus lohena*). Both ponds have, therefore, been classified as "coastal ponds" for the purposes of this study. Studies are presently underway in the South Kohala area of the big island which may shed additional information on the flora and fauna of both coastal and anchialine ponds in Hawaii. Based on topographic map surveys by Maciolek and Brock, 1974) there are an estimated 30 coastal or anchialine ponds in Ka'u District (including Punalu'u). Detailed study of aerial photographs of the region would undoubtedly uncover far more ponds.

4.0 CONCLUSIONS

The results of the 1984 survey and the 1986 re-survey of the Punalu'u - Ninole marine and coastal pond environments overwhelmingly indicate that natural physical processes and events, both long-term, in the case of groundwater discharges, and short-term, in the case of tsunamis, flashflooding and storm wave events, have and will continue to exert profound influences on the natural environment of the coastline. The effects of man's intervention in terms of past and present use characteristics is considerably less severe but, in localized areas, readily detectable and often easily observable.

The impact of recent storm waves on the intertidal and nearshore marine environment of Punalu'u Harbor was particularly evident in the 1986 surveys. Common nearshore and intertidal algae were, by estimation, reduced to a fraction of their 1984 standing crop (biomass). *Ulva fasciata*, one of the more abundant species in 1984, was not observed in 1986. Similarly, *Ahnfeltia concinna*, one of the characteristic high intertidal to splash-zone species of wave-exposed coastlines on the Big Island, was largely reduced to small encrusting holdfasts or was absent from areas that formerly harbored profuse stands. The apparent reduction in the standing crop of *Pterocladia capillacea* may in part be the result of heavy grazing by sea turtles. Sea turtles may be increasingly utilizing the Punalu'u *Pterocladia* beds because of storm wave decimation of other grazing areas resulting from the passage of Hurricane Estelle to the south of the island on or about July 24, 1986. Punalu'u Harbor would presumably confer some degree of storm wave protection over other, more exposed, coastlines in the Ka'u region. That storm wave damage occurred rather recently is suggested by the literature dealing with growth rates of intertidal and subtidal algae. *Eucheuma alvarazii*, *Ahnfeltia concinna*, and *Gracilaria salicornia* have demonstrated mean growth rates of 1.7, 3.42, and 5.05 percent/day, respectively, under ideal conditions (Doty, 1986). Had storm waves passed earlier than late July, 1986, re-growth would probably have been more apparent. Other evidence of recent storm wave damage is demonstrated by the preponderance of biologically barren subtidal rocks thoughout Punalu'u Bay, suggesting recent movement and sand scouring. Hundreds of deepwater sponges were found several hundred feet above the high tide line at Ninole Cove, indicating the severity of recent coastline wave attack.

Physical disturbance from storms is known to be the most significant factor determining the structure of Hawaiian coral reef communities (Dollar, 1981). The frequency and severity of

both short-term and long-term storm wave events are known to significantly influence coral reef structure and organization, both in time and space. Short-term moderate wave events generally shape the zonation patterns of Hawaiian reef environments and in the long-term promote ecological stability by maintaining well defined reef zones through differential mortality, fragmentation and transport (Dollar, 1977). By contrast, severe or long-term storm wave action often returns a reef area to an earlier successional stage and recovery from such intense events is generally slow. As such, many of the reef communities on the Island of Hawaii have been described as "physically dominated" environments with the represented reef communities reflecting the severity of disturbance. Such is the case at Punalu'u. Man is rarely able to compete with nature when it comes to the catastrophic changes which can be precipitated by short-term physical disturbances.

Natural groundwater discharges throughout the intertidal and subtidal zones of Punalu'u Harbor appear to play a significant role in determining the structure and composition of marine plant and animal communities by favoring certain species and excluding other species. *Ulva fasciata* is often an indicator of groundwater discharges and elevated nutrient levels and, in 1984, was common throughout the Punalu'u - Ninole coastline. It was absent in 1986 (or too small for valid taxonomic identification).

Coastal ponds at Punalu'u are under influences similar to the marine environment. The 1986 survey suggests that storm-wave flooding exerts a major influence on water quality and the structure of the biological community within the pond. This was perhaps most evident in Pond #2 at Ninole Cove. Topographic maps indicate that this pond was formerly an "open" pond that physically connected to the former shoreline at Ninole Cove. Flashflooding of Ninole Gulch in the late 1970's radically altered the physical environment of this pond and it is now entirely landlocked.

Based on the physical definition of "anchialine" ponds offered by Holthuis (1973) (lack of surface connection to the sea, measurable salinities, and a damped tidal fluctuation), pond #2 could be classified as an anchialine pond (at least following the flashflood event which rendered it landlocked). However, more recent definitions (Maciolek and Brock, 1974; Brock, 1985), based on additional research findings involving the biological community of anchialine ponds, indicate that while the Punalu'u ponds harbor some species often associated with anchialine ponds, they lack the characteristic pond biota (the hypogeal red caridean shrimps *Halocaridina rubra* and *Metabetaeus lohena*, and

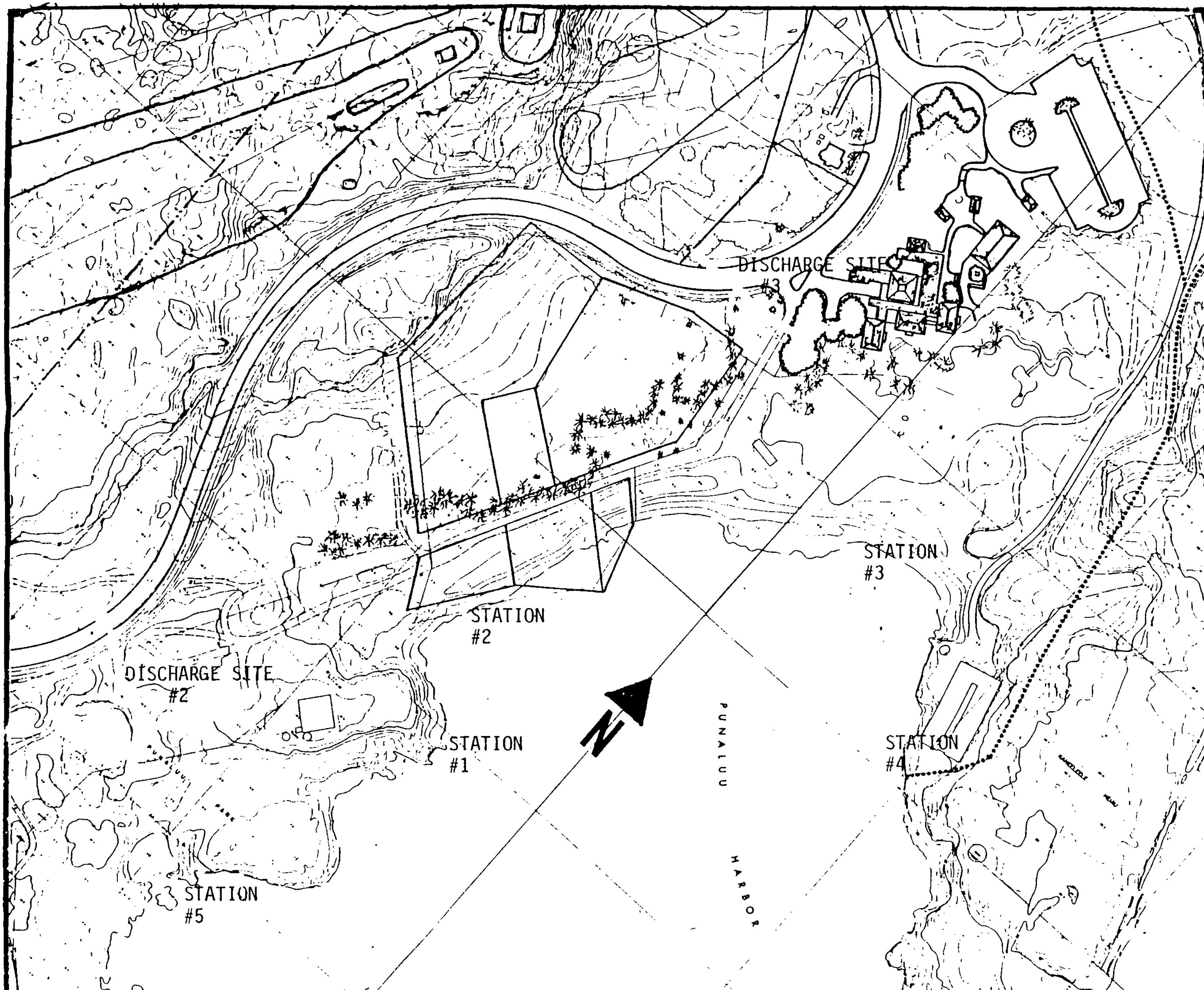

FIGURE 1. PUNALU'U HARBOR SAMPLING STATIONS

common at roughly the zero tide level in 1984, but were greatly reduced in size and standing crop in 1986, though the presence of sea turtles in the area may explain the reduction in the abundance of this species. *Ahnfeltia concinna* was also extremely common in the high intertidal zone in 1984, but was represented only by small, scattered, basal tufts or holdfasts in 1986. Aside from the diminution in *Pterocladia*, which may be explained by sea turtle grazing, the reduction in the standing crop of fleshy algae may be attributable to storm wave action associated with Hurricane Estelle on or about July 24, 1986.

Coralline algae, including *Porolithon*, *Neogoniolithon*, *Lithophyllum* and *Hydrolithon* were numerous throughout all rocky inshore reaches of the bay, as they were in the 1984 survey. These species, which are normally associated with deepwater offshore reef crests, margins and slopes, are yet another possible indication of the extent of storm-wave influence in Punalu'u Harbor.

Corals were represented by *Porites lobata*, *Pocillopora meandrina*, *P. damicornis* and one colony of *Pocillopora ligulata*. *Porites* colonies were generally irregular in shape and were represented by green and yellow-green color variants. Intact "coral heads" of *Porites* were only infrequently seen, the most common being vegetative growth forms deposited by wave action. *P. meandrina* and *P. damicornis* were second and third, respectively, behind *Porites* in abundance but neither species was particularly common. *P. ligulata*, a small, golden-brown coral resembling *P. meandrina* was observed on one occasion. This species is generally found in shallow, high wave-energy, offshore environments. Storm-wave deposition may explain its presence in relatively shallow (2.0 meters) inshore waters. Coral coverage in Punalu'u Harbor is estimated to be considerably less than 0.01 percent. Although quantitative measurements of coral coverage were not conducted in 1984, overall coverage appeared to be considerably less in 1986.

Twenty (20) species of fish were censused in 1986 versus 24 species recorded in 1984, indicating low diversity as contrasted with other, more protected, coastlines (Table 6). The most common species (in relative order of abundance) included the fantail filefish, *Pervagor spilosoma*, manini (*Acanthurus triostegus*), and various related acanthurids (surgeonfishes). In the 1984 survey the Hawaiian dascyllus, *Dascyllus albisella* ('alo'ilo'i) was the most abundant species and was always associated with scattered *Pocillopora* outcrops. *D. albisella* was was not recorded during the 1986 survey, a consideration that may reflect the apparent reduction in coral coverage noted in the 1986 surveys. Holocentrids (squirrelfishes), carangids (jacks),

and the zanclid, *Zanclus cornutus*, were not recorded during the 1986 survey. The acanthurids were, by far, the most diverse family of fishes observed, with 9 species recorded in 1986; six more than were censused in 1984.

The macroinvertebrate fauna was dominated by echinoderms of the family *Echinoidea*. The boring urchin *Echinometra mathaei* was the most abundant species, though *Echinometra oblonga* was noted in some areas. The orange-red slate-pencil urchin, *Heterocentrotus mammilatus*, was common in all subtidal areas, as was the collector urchin, *Tripneustes gratilla*. The black urchin, *Diadema paucispinum* (wana) was common in the bay in 1984 with densities of up to 16/square meter recorded. This species was not observed in 1986. Similarly, holothurians (sea cucumbers) were not observed in 1986, though they were frequently seen in the 1984 surveys.

Common macroinvertebrates of the intertidal zone included littorines (*Littorina pintado*) (pupu kolea); *Nerita picea* (pipipi); the false opihi, *Siphonaria normalis*; the mussel, *Brachidontes cerebristriatus*; vermetid snails (*Serpulorbis variabilis*, *Dendropoma gregaria*); the grapsid crab, *Grapsus tenuicrustatus*; and at least two unidentified encrusting colonial tunicates.

Balazs (1979) and Naughton (1986) have cited the importance of the Ka'u District of Hawaii for the endangered Hawaiian hawksbill turtle (*Eretmochelys imbricata*) and the threatened Hawaiian green sea turtle (*Chelonia mydas*). Their observations on the distribution and abundance of these turtles in the region appeared to be confirmed on August 16, 1986 when four large green sea turtles and two hawksbill turtles were observed foraging for algae in shallow water along the rocky east flank of Punalu'u Harbor during the afternoon high tide period. The turtles appeared totally unconcerned with the presence of humans, despite the relatively large number of people picnicking, surf-casting, swimming, and snorkeling in the bay (Admission Day weekend). Earlier the same day, two large green sea turtles were encountered resting in a relatively calm inshore gyre (in the approximate middle of the bay) at a depth of approximately 3 meters. There was no evidence that the turtles were disturbed by the presence of a diver in the water, inasmuch as they made no attempt to move out of the way of the diver or retreat to deeper waters.

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Water temperatures demonstrated a mean of 24.4 degrees C. with no discernible spring water discharges evident on the basis of temperature (Table 1). This was the warmest pond within the Punalu'u-Ninole area. Salinity values ranged from 1.2-1.5 ppt with the slightly higher levels reflecting bottom conditions. Dissolved oxygen values were variable and ranged from 3.3 to 6.9 ppm. The lower values were associated with eutrophic mauka areas with thick leaf/organic deposits and an overlying dense tree canopy. Except for the shallow makai reaches of the pond, most of the pond water had a dark green coloration indicating a microalgae bloom. The pond is littered with leaves, kukui nuts, palm fronds, bottles, cans and refuse.

3.1.3.2. Biological Surveys

The pond biota reflects the degree of manmade disturbance. The most conspicuous organisms are a dozen or more large (estimated 0.7-1.0 meters in length) common carp (*Cyprinus carpio*). Topminnows (*Poecilia*) sp., mosquito-fish (*Gambusia*), and toad (*Bufo*) tadpoles comprised the balance of the vertebrate population (Table 2).

Aside from small unidentified hydrophilid beetles and amphipods, the only macroinvertebrates observed were two very large (approximately 20 cm. from tail to rostrum) palaemonid prawns; either *Macrobrachium lar* or *M. rosenbergii*. Both are introduced species to Hawaii.

3.1.4. TRANSIENT PONDS AT NINOLE COVE

Two small ponds (10-50 square meters each as a function of the tidal period) lie approximately 20 meters apart and roughly 30 meters directly west and parallel to pond #2. Depths ranged from approximately 0.1-0.7 meter as a function of the tidal period. Both lie in a transition zone between the existing beach berm at Ninole Cove and the rocky, poorly vegetated, Ninole floodplain. These ponds were not present during the 1984 survey and may have been created by recent storm wave action. Localized vegetation damage suggests that waves recently overtopped the Ninole Cove beach berm and surged inland an estimated 100 meters. This wave action may have excavated these ponds inasmuch as they both lie in the floodplain of the Ninole backbeach area.

3.1.4.1. Water Quality

Temperature, salinity and dissolved oxygen levels were identical in both ponds: temperature, 21.4 degrees C.; salinity, 1.5 ppt; dissolved oxygen, 6.2 ppm. No thermal or density

gradient was detectable (Table 1).

3.1.4.2. Biological Surveys

The pond icthyofauna was limited to several small oopu (*Eleotris*) and *Gambusia* (Table 2). Six small prawns (*M. grandimanus*) were also observed. Both ponds had noticeable growths of filamentous yellowish-green algae present, possibly indicating that they were colonized from pond #2 during recent storm wave action.

3.2. PUNALU'U HARBOR SURVEY

3.2.1. Water Quality

As in the preceding survey, Punalu'u Harbor waters were extremely variable in all parameters tested and reflect the large volume of cold groundwater that discharges intertidally and subtidally throughout the bay. Temperatures ranged from 19.7-23.4 degrees C. in surface waters (top 1 meter) and 25.7-27.9 degrees C. in bottom waters (2-3 meters). Surface water salinity readings ranged from less than 1.0 ppt (immediately adjacent to the "swimming pool" spring abutting the boat launching ramp) to 15.4 ppt in the same area at high tide. Dissolved oxygen levels reflected the density/temperature gradients evident in the inshore reaches of the bay with lower readings in surface waters and higher readings in midwater/bottom stations. Surface water dissolved oxygen levels ranged from 5.6-8.6 ppm; midwater-bottom waters ranged from 7.6 - 9.2 ppm. The supersaturated condition of the deeper waters was not unusual considering the high wave action throughout the inshore and offshore reaches of the bay during the survey period.

3.2.2. Biological Surveys

The most significant change in the biota of Punalu'u Harbor was the great decrease in the standing crop of macroalgae. Although the algae checklist was essentially identical to the 1984 study, with 18 species recorded, there was a significant reduction in the biomass of the represented species. In the 1984 survey as many as eight to ten species could be readily identified within the underwater viewplain of the diver at any single rocky-intertidal station; in 1986, rarely were there more than two or three species recognizable and these were generally extremely small growths or tufts. *Ulva fasciata* (palahalaha) was relatively common in areas subject to groundwater discharges in 1984 but was not observed in 1986. Stands of the red alga *Pterocladia capillacea* were relatively

TABLE 1

WATER QUALITY DATA - COASTAL PONDS

August 27, 1984; 1340 - 1610 hrs.

Parameter:	Depth	Temp. (C.)	Salinity (ppt)	Diss. Oxygen (ppm)
POND NO. 1				
Site 1	surface (0.1 m)	21.6	1.9	5.5
	bottom (1.0 m)	21.7	3.0	6.7
Site 2	surface (0.1 m)	20.5	1.2	6.4
	bottom (1.3 m)	21.0	3.6	5.7
Site 3	surface (0.1 m)	21.5	1.6	6.3
	bottom (1.5 m)	22.0	3.1	6.2
Site 4	midwater (0.7 m)	21.5	1.4	6.4
POND NO. 2				
Site 1	surface (0.1 m)	21.5	0.9	7.2
	bottom (1.4 m)	22.3	1.1	6.4
SITE 2	Surface (0.1 m)	21.5	0.8	7.0
	bottom (1.2 m)	22.5	1.1	6.0

TABLE 2

CHECKLIST OF POND BIOTA

Group/Species	Pond No. 1	Pond No. 2
Fish		
Mugil cephalus (mullet)	X	
Kuhlia sandvicensis (aholehole)	X	
Gambusia sp.	X	
Eleotris sandwicensis (oopu akupa)	X	X
Crustaceans		
Palaemon debilis (opae huna)	X	X
Mollusks		
Melania sp.	X	

6.8 ppm and a bottom (above the benthic algal mat) mean of 8.6 ppm. The latter reading is likely the result of photosynthesis associated with the dense, mucous-like growths of yellowish-green to green filamentous algae that characterize most of the pond's benthic and midwater environment. Dissolved oxygen levels within the benthic algal mat ranged from 0.4-4.4 ppm. The lowest reading was recorded beneath approximately 0.4 meter of viscous decomposing algae. Disturbance to the mat produced hydrogen sulfide gas indicating essentially anaerobic conditions. Beneath the benthic algal "ooze" the bottom of the pond was composed of a relatively flat sand bottom with occasional rock outcrops. Pond depths ranged from approximately 0.5 meter around the margin to approximately 2.0 meters near the center.

A change in pond water quality was apparent between the 1984 survey and the 1986 survey. Most notably, water quality had improved over 1984 conditions. Although dense filamentous algal growths still characterize the pond, the growths were less well developed than in 1984 and the thick floating algal mats which dominated an estimated 80 percent of the pond environment during the same period were all but gone (or had sunk and contributed to the thick benthic mat). As a result, underwater visibility was significantly improved, though a yellow "pall" distinguished most of the central pond area. Recent storm wave inundation associated with Hurricane Estelle (or earlier storm-wave events) may have been responsible for this change.

3.1.2.2. Biological Surveys

The icthyofauna of pond #2 was limited to 50-70 aholehole which were concentrated around the isthmus (makai side) of the pond and occasional *Gambusia* which were infrequently observed around the pond margin. A third species, possibly a kuhliid (striped pigmented tail fin), was observed briefly on one occasion but was lost in the algae before identification was possible (Table 2). The benthic algal mat or organic "ooze" is apparently inhospitable to fish, as suggested by the low dissolved oxygen values. *Eleotris* was not observed, but was present during the 1984 survey.

The most conspicuous faunal elements of the pond were the mollusks *Assiminea*, *Melania* and *Theodoxus cariosa*. *Assiminea* is found everywhere algae is found and thus range from the bottom, to midwater, to surface algal growths. Efforts to quantitate their numbers were unsuccessful but they easily range from hundreds to thousands per square (or cubic) meter. *Assiminea* also occurs within emergent vegetation, submerged plants and plant roots, but never approaches the density associated with the filamentous algae which dominate most of the pond. They also graze on the surface layers of the benthic algal mat but are not generally found within the mat except in areas with only sparse mat development. The absence of large predatory fish (such as oopu) may explain their abundance in this pond. This tiny (3.5-4.5 mm.), soft-shelled snail may constitute an important food source for predatory fish.

Melania is found in moderate numbers (4-19/0.25 sq. meter) around the margin of the pond but, unlike *Assiminea*, appears to be largely restricted to rock outcrops, emergent vegetation, and areas with firm sediments. Large numbers of empty *Melania* shells occur within occasional pockets or depressions within the benthic algal mat, indicating that they may have succumb to anoxic conditions.

Theodoxus cariosa was common on a few larger rocks and boulders in the algal-free area on the makai (isthmus) side of the pond. Population densities on large rocks and boulders in the pond's "splash zone" averaged 6.7/0.25 sq. meter. They were not observed outside the isthmus/splash zone area.

The three mollusks observed during the 1986 survey were not recorded during the 1984 survey. This indicates that either significant recruitment has taken place since the 1984 survey or that the pea-soup like water quality which characterized this pond in 1984 prevented an accurate inventory of the represented species populations.

The glass shrimp (*Palaemon debilis*) and freshwater prawn (*Macrobrachium grandimanus*) constituted the remainder of the macroinvertebrate community. The largest populations of both species occurred in a shallow, narrow, 3-4 meter-long rock crevice within the pond's makai splash zone. Relatively few of either species were seen in the pond margin vegetation. Two children were observed seine-net fishing in this pond on August 16, 1986.

3.1.3. COASTAL POND #3 (PUNALU'U LAGOON POND)

The Punalu'u Lagoon pond occupies a surface area of approximately 1.5 acres and is located immediately makai of the restaurant complex and mauka of Punalu'u Harbor. The north and east sides of the pond have been significantly modified by creation of artificial islands and manmade rock shorelines and little natural vegetation exists. Approximately one dozen domesticated ducks and geese inhabit the pond. This pond was not inventoried during the 1984 baseline study (Figure 2).

3.1.3.1. Water Quality

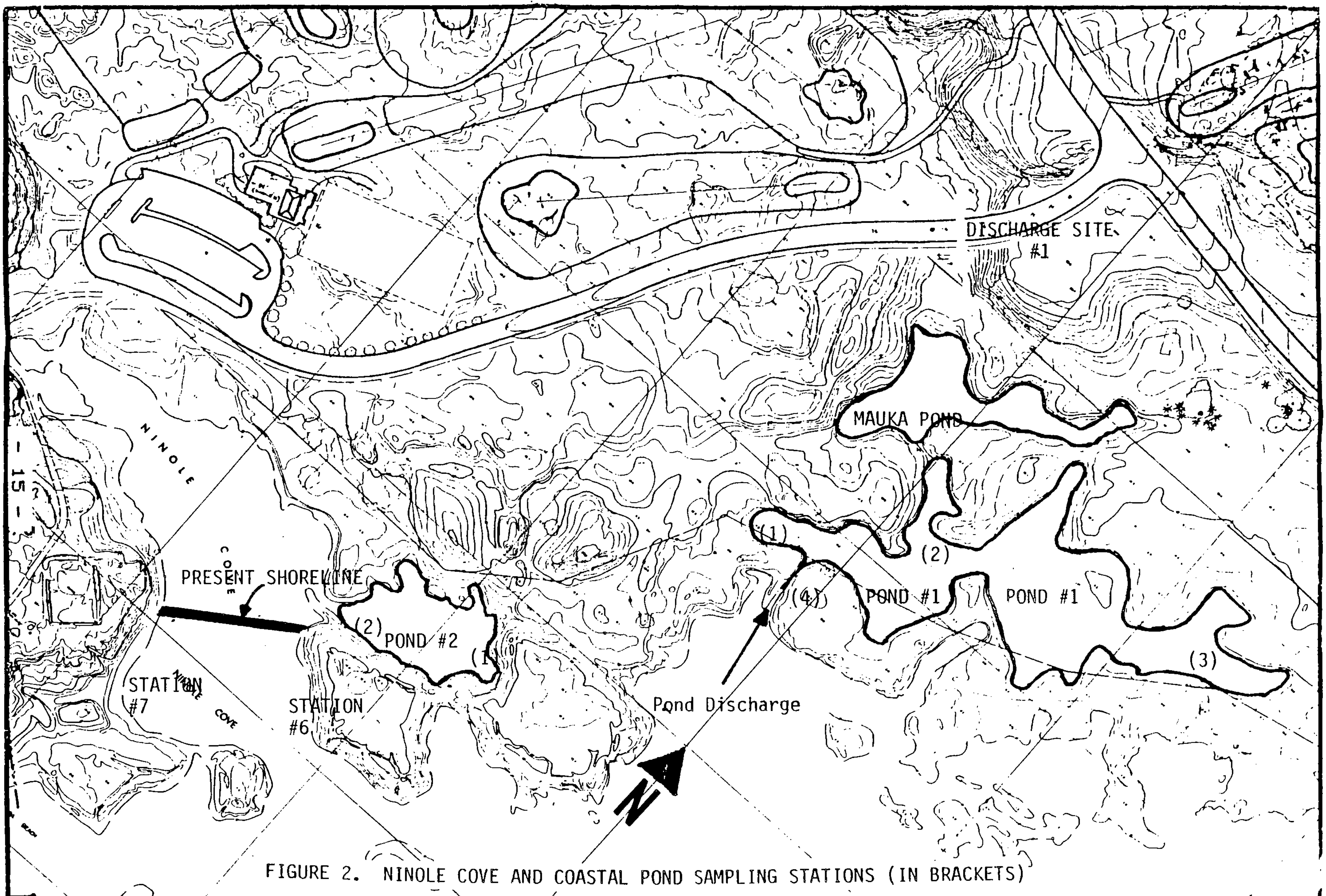

FIGURE 2. NINOLE COVE AND COASTAL POND SAMPLING STATIONS (IN BRACKETS)

(goatfish) which were seen in the discharge channel on one occasion (Table 2). *Entomacrodus* and goatfish were not recorded in the pond during the 1984 field survey. Both were observed in the drainage channel of the pond and probably move freely between the ocean and the pond. Both species are normally regarded as "reef" fish.

The most significant change in the fish biota between the 1984 and 1986 survey was the great increase in the number of *Eleotris* and their size distribution. In 1984, *Eleotris* was only rarely associated with the dense algal mat (which occurred throughout most of the pond bottom), occurring instead in highest densities in and around the ocean discharge channel and in areas subject to noticeable springwater flows. By contrast, the 1986 survey indicated that the population had increased perhaps 10-20 fold; they routinely inhabited areas with benthic algal mats; and adult specimens (length approximately 15-20 cm.) are now common. These changes may reflect a decrease in recent fishing pressure upon the species, or an improvement in pond water quality associated with the passage of Hurricane Estelle. Storm-wave flushing may have reduced or eliminated portions of the mat, thereby improving the habitat quality of the benthic environment for this species.

Crustaceans were represented by the glass shrimp (opae huna), *Palaemon debilis*, and the palaemonid prawn (opae oehaa), *Macrobrachium grandimanus*. Both species are largely restricted to sunken grass, roots, and emergent vegetation around the perimeter of the pond, though a few were noted in crevices between large shoreline rocks. Juvenile *Eleotris* frequent this same habitat, presumably for protection from adults of the same species and other predatory fishes. Glass shrimp ranged in number from 20-60 per meter of undisturbed shoreline. *Macrobrachium* is far less numerous with perhaps 3-6 observed per meter of undisturbed shoreline. Both species are especially difficult to census given their nearly transparent exoskeleton and cryptic behavior and actual numbers, especially in areas with deep undercut banks, could be considerably higher or lower.

Both *Palaemon* and *Macrobrachium* are eagerly sought after by fishermen who utilize a 2-3 foot wide, one-quarter inch mesh, wire seine net. The fishing technique involves wading around the perimeter of the pond with the net placed beneath roots and overhanging vegetation. The fisherman then shakes the submerged vegetation above the net, collecting the animals that attempt to escape to the bottom. On August 15, 1986, forty-five minutes of work for one young lady yielded hundreds of shrimp and prawns (and numerous small oopu) weighing perhaps two pounds from an estimated 100-150 meters of pond margin. Re-survey of the same

fishing area on the following day showed the entire pond margin devoid of shrimp and prawns.

The remainder of the macroinvertebrate population was dominated by mollusks. The neritid snail *Theodoxus cariosa* was found on large rocks in several areas near the center of the pond but rarely on rocks along the pond margin. The largest specimens were approximately 3-3.5 cm. in lateral dimension. According to Maciolek and Brock (1974) this species displays several morphological variations in coastal ponds. All of the larger specimens observed at Punalu'u exhibited extensive "wing-like" lateral development. This species was not recorded during the 1984 survey, perhaps as a result of the generally low faunal diversity associated with the central portions of the pond and the resulting focus of surveys along the pond margin. The snail *Melania* sp. was common along the pond margin and in deeper areas where thick benthic algal mats were not present. The snail *Assiminea* sp. was most commonly associated with emergent vegetation and submerged grasses along the pond margin. This tiny (3.0-4.5 mm.) snail was very common in some areas and rare in other, seemingly identical, areas. This species was not recorded in the 1984 survey and may have been overlooked because of its extremely small size. All three mollusks are commonly found in both open and closed coastal and anchialine ponds on the island of Hawaii. Of the 318 ponds inventoried by Maciolek and Brock (1974), *Theodoxus cariosa*, *Melania* and *Assiminea* occurred in 18, 62 and 24 percent, respectively, of the ponds surveyed.

3.1.2. COASTAL POND #2 (NINOLE COVE)

3.1.2.1. Water Quality

Water quality parameters were similar to those reported in the 1984 surveys. Pond surface waters had a mean temperature of 20.1 degrees C.; bottom waters, 21.1 degrees C. (Table 1). Slight variations were evident near spring discharges and immediately adjacent to the narrow basalt isthmus which separates the pond from the ocean. Slightly cooler temperatures characterized spring discharge areas and slightly warmer temperatures characterized the small area subject to intermittent wave overtopping and seawater inundation. However, these areas are small and localized and do not reflect typical pond conditions.

Salinity values indicated a density gradient with surface waters demonstrating a mean of 1.5 ppt; bottom waters a mean of 6.6 ppt.

Dissolved oxygen levels indicated a surface water mean of

TABLE 3

MARINE WATER QUALITY DATA - PUNALU'U HARBOR & NINOLE COVE

August 27, 1984: 1315 - 1510 hrs.

Parameter:	Depth (m)	Temp. (C.)	Salinity (ppt)	Diss. Oxygen (ppm)
Site 1	0.3	19.2	7.0	6.2
	1.5	26.4	19.5	6.7
Site 2	0.3	21.1	6.4	6.5
	1.0	24.6	18.1	6.8
Site 3	0.3	20.1	8.8	6.4
	1.0	27.1	21.7	6.6
Site 4	0.3	19.7	12.5	7.0
	1.5	24.3	22.0	6.6
Site 5	0.3	21.8	23.0	7.2
	1.5	25.7	25.5	7.2
Site 6	0.3	20.0	5.9	6.6
	2.0	26.0	18.7	6.4
Site 7	0.3	19.0	4.5	5.8
	2.0	25.9	27.4	6.4

TABLE 4

CHECKLIST OF MARINE ALGAE

Division/Genus/Species	Punalu'u Harbor	Ninole Cove
CHLOROPHYTA (GREEN ALGAE)		
Caulerpa racemosa	X	
Enteromorpha antennina ('ele'ele)	X	X
Ulva fasciata (palahalaha)	X	X
PHAEOPHYTA (BROWN ALGAE)		
Dictyota acutiloba (alani)	X	
Dictyota sandvicensis (alani)	X	
Ralfsia sp.	X	X
RHODOPHYTA (RED ALGAE)		
Ahnfeltia concinna ('aki'aki)	X	X
Amansia glomerata	X	
Grateloupia sp.	X	X
Hydrolithon breviclavium	X	X
Jania sp.	X	X
Laurencia sp. (encrusting pink)	X	
Lithophyllum kotschyanum	X	X
Neogoniolithon frutescens	X	
Porolithon gardineri	X	
Pterocladia capillacea	X	X
Sporolithon erythraeum	X	X
Unident. red encrusting	X	

have little relevance to the Punalu'u - Ninole region. With few exceptions, most physical-chemical readings were made by "averaging" meter oscillations at any given station.

2.2. Biological Surveys

2.2.1. Punalu'u Harbor

Marine biological surveys were focused on algae, corals, fish, and macroinvertebrates. All surveys were conducted with mask and snorkel, which necessarily limited the observations to depths of less than 6-7 meters. When appropriate, actual counts or estimates of the abundance or density of fish, corals, algae and macroinvertebrates were made. As in the previous survey, the discharge of voluminous quantities of low-saline groundwaters along the Punalu'u coastline greatly hampered underwater observations because of the schlieren effect created by mixing of waters of different densities. Because of heavy wave action, only the Punalu'u Harbor area was censused during the 1986 survey. Two dives of approximately 45 minutes each were made in a random manner in Punalu'u Harbor. Because of heavy wave action and very strong currents, survey efforts focused upon an area within 200 meters of the shoreline. Water depths within this inshore area ranged from less than one meter to approximately three meters. A powerful seaward-flowing current in Punalu'u Channel prevented examination of this deepwater environment. The same constraint was also imposed during the 1984 survey.

2.2.2. Coastal Ponds

Ponds #1 and #2 were surveyed by underwater mask and snorkel dives which encompassed the entire perimeter of each pond and representative cross-sectional areas through the center of the larger pond basin(s). Pond #1 (the largest pond) was censused via two dives of approximately 45 minutes duration each. Pond #2 was censused via two dives of approximately 30 minutes each. Pond #3 (Punalu'u Lagoon) was censused by walking/wading the perimeter of the pond. The prevailing shallow water, turbidity, and abundant litter (cans, broken bottles, etc.) did not lend itself to underwater surveys.

Underwater data were recorded on Nalgene Poly Paper sheets. A Nikonos II underwater camera was utilized to document both pond and marine environmental conditions encountered during the surveys.

3.0. RESULTS

3.1. COASTAL POND SURVEYS

3.1.1. COASTAL POND #1

3.1.1.1. Water Quality

Temperature, salinity and dissolved oxygen values were comparable to those recorded during the first survey of the pond in October 1984. Surface waters demonstrated a mean temperature of 21.5 degrees C.; bottom waters (1-1.5 meters) were between 0.3-0.5 degrees C. warmer (Table 1). Salinity values were likewise comparable to the earlier surveys with a mean surface water salinity of 1.9 ppt and a bottom salinity of 3.9 ppt during an afternoon high tide (+2.6 feet) period. Seawater would intermittently move up the discharge channel and into the pond during large wave sets; between wave sets there was a discharge of mixohaline water from the pond. Dissolved oxygen levels ranged from 5.8-6.9 ppm as a function of depth.

A sampling station located immediately adjacent to a large stand of *Scirpus* in the extreme northwest corner of pond #1 produced a water temperature of 19.5 degrees C. and a salinity of 0.05-0.1 ppt. This site represents the largest groundwater discharge in the pond. The presence of this site was earlier detected during an underwater survey. Dissolved oxygen levels were a uniform 5.0 ppm.

3.1.1.2. Biological Surveys

The most significant change in the site since the 1984 surveys was the strong evidence of storm-wave damage around portions of the pond perimeter. The former large submerged stand of *Scirpus*, immediately adjacent to the northwest side of the discharge channel, was flattened and appeared dead. Other stands in mauka locations also demonstrated varying degrees of disturbance. Damage to strand vegetation (*Scaevola*) was also apparent in some areas. This was probably the result of storm waves associated with the passage of Hurricane Estelle to the south of the island on or about July 24, 1986.

The ichthyofauna of the pond was composed of six (6) species and included juvenile mullet (*Mugil cephalus*) (4 counted); adult and juvenile *Eleotris sandwicensis* (oopu akupa); juvenile aholehole (*Kuhlia sandvicensis*); mosquito-fish (*Gambusia*); marbled blenny, *Entomacrodus marmoratus* (pao'o) (1 observed); and a school of six unidentified juvenile mullids

TABLE 5

CHECKLIST OF MARINE FISHES

Family/Genus/Species	Punalu'u Harbor	Ninole Cove
ACANTHURIDAE (SURGEONFISHES)		
Acanthurus dussumieri (palani)	X	
Acanthurus nigroris (maiko)	X	X
Acanthurus triostegus (manini)	X	X
BLENNIDAE (BLENNIES)		
Cirripectes variolosus	X	
Unident. blenny	X	
CARANGIDAE (JACKS)		
Melampygus sp.	X	
CHAETODONTIDAE (BUTTERFLYFISHES)		
Chaetodon auriga (kikakapu)	X	X
Chaetodon lunula (kikakapu	X	X
Chaetodon miliaris (lau-wiliwili)	X	
HOLOCENTRIDAE (SQUIRRELFISHES)		
Flammeo sammara ('ala'ihi)	X	
LABRIDAE (WRASSES)		
Coris gaimard (1 juvenile)	X	
Labroides phthirophagus	X	X
Stethojulis blateata ('omaka)	X	
Thalassoma fuscum ('awela)	X	
MONOCANTHIDAE (FILEFISHES)		
Pervagor spilosoma	X	
MURAENIDAE (MORAY EELS)		
Gymnothorax undulatus (puhi-lau-milo)	X	
OSTRACIONTIDAE (TRUNKFISH)		
Ostracion meleagris (moa)	X	
POMACENTRIDAE (DAMSELFISHES)		
Abudefduf abdominalis (mamo)	X	X
Dascyllus albisella ('alo-'ilo'i)	X	
Plectroglyphidodon johnstonianus	X	

SCARIDAE (PARROTFISHES)		
Scarus sordidus (uhu)	X	
Unident. juvenile scarids	X	
TETRAODONTIDAE (PUFFERS)		
Canthigaster jactator	X	
ZANCLIDAE (MOORISH IDOL)		
Zanclus cornutus (kihikihi)	X	X

L I S T O F F I G U R E S

MARINE AND COASTAL POND BASELINE STUDY

PUNALU'U RESORT, KA'U, ISLAND OF HAWAII

RE-SURVEY OF AUGUST 1986

1.0 INTRODUCTION

A re-survey of the nearshore marine and coastal pond environments in the Punalu'u - Ninole region was conducted in August 1986 to gain an increased understanding of the coastal resources within an area designated for potential resort expansion and to account for any changes in the natural resources of the coastal zone since the October 1984 survey. Punalu'u Lagoon, a disturbed coastal pond located at the existing Punalu'u Resort restaurant complex, mauka of Punalu'u Harbor, was surveyed for the first time. Also examined for the first time were two small "transient" ponds located in the Ninole Gulch floodplain/backbeach area. These ponds were apparently created by storm-wave action sometime following the October 1984 survey (possibly by Hurricane Estelle's passage, south of the island, on or about July 24, 1986).

2.0 METHODS

2.1. Physical-Chemical Measurements

Salinity and temperature measurements were made with a Yellow Springs Instrument Company (YSI) S-C-T meter equipped with a YSI Model 3300 nickel-platinum conductivity/temperature probe. Dissolved oxygen measurements were obtained utilizing a YSI model 51B dissolved oxygen meter equipped with a membrane-covered polarographic sensor. The dissolved oxygen meter was calibrated according to factory guidelines in a water vapor-saturated chamber. All measurements were based on *in situ* sampling. Based on manufacturer-supplied specifications, worst-case possible instrument/probe errors are as follows: temperature, ±0.7 degrees Centigrade (C.); salinity, ±0.2 parts per thousand (ppt); dissolved oxygen, ±0.2 parts per million (ppm). However, considering the conditions encountered in the field (wide instrument meter oscillations associated with springwater flows in coastal ponds and in the ocean) these above specifications

TABLE 6

CHECKLIST OF INVERTEBRATES

Phylum/Family/Genus/Species	Punalu'u Harbor	Ninole Cove
COELENTERATA		
PORITIDAE		
Porites lobata	X	X
POCILLOPORIDAE		
Pocillopora meandrina	X	X
ANNELIDA		
Unident. tube worm 1	X	
Unident. tube worm 2	X	
Unident. tube worm 3	X	
CRUSTACEA		
GRAPSIDAE		
Grapsus grapsus	X	X
Grapsus tenuicrustatus	X	X
XANTHIDAE		
Carpilius maculatus	X	
MOLLUSCA		
NERITIDAE		
Nerita picea (pipipi)	X	X
LITTORINIDAE		
Littorina pintado	X	X
Littorina scabra	X	X
PATELLIDAE		
Cellana exarata (opihi)	X	
Siphonaria normalis	X	X
VERMETIDAE		
Serpulorbis variabilis	X	
ECHINODERMATA		
ASTEROIDEA (SEA STARS)		
Linckia multiflora	X	
ECHINOIDEA (SEA URCHINS)		
Diadema paucispinum	X	
Echinometra mathaei	X	X
Echinometra oblonga	X	
Heterocentrotus mammilatus	X	
Colobocentrotus atratus	X	X
Tripneustes gratilla	X	X
Echinothrix diadema	X	X
OPHIUROIDEA (BRITTLE STARS)		
Ophiocoma sp.	X	
HOLOTHUROIDEA (SEA CUCUMBERS)		
Holothuria atra	X	
Actinopyga mauritiana	X	

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Marine / Coastal / Terrestrial Consultants
for
Micronesia, Asia & the Greater Pacific

MARINE AND COASTAL POND BASELINE STUDY

PUNALU'U RESORT, KA'U, ISLAND OF HAWAII

AUGUST 1986 SURVEYS

prepared for

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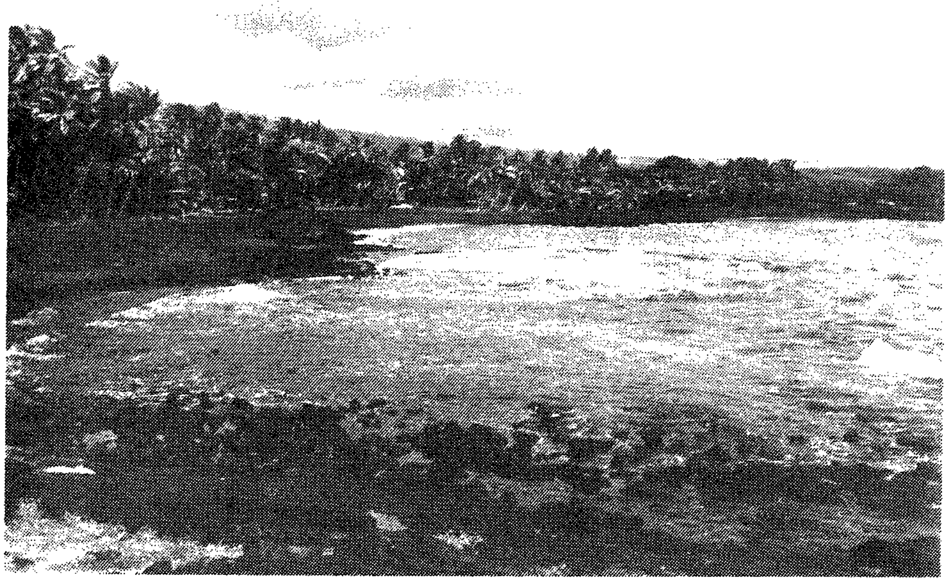
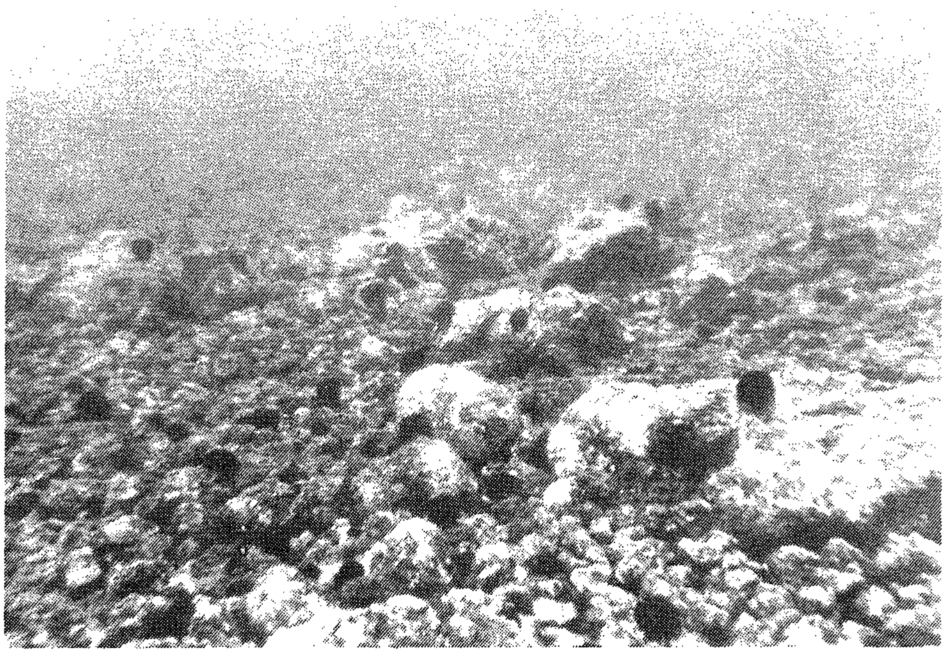
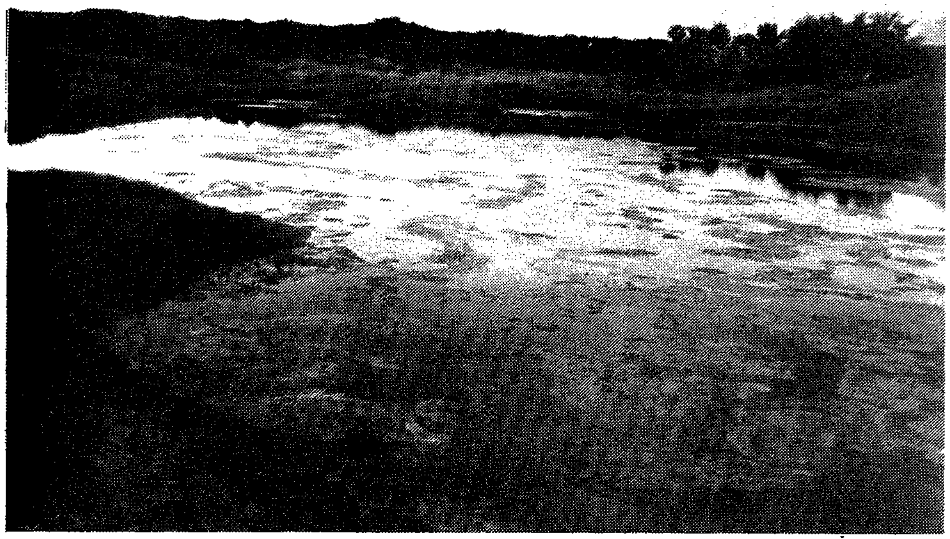


1. PUNALU'U HARBOR SHORELINE

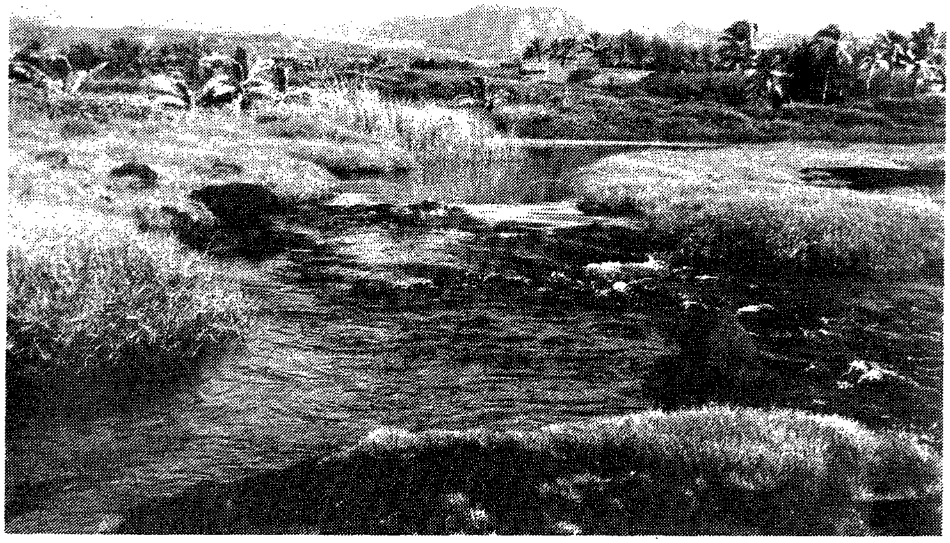


2. ROCKY SUBSTRATUM OF PUNALU'U HARBOR

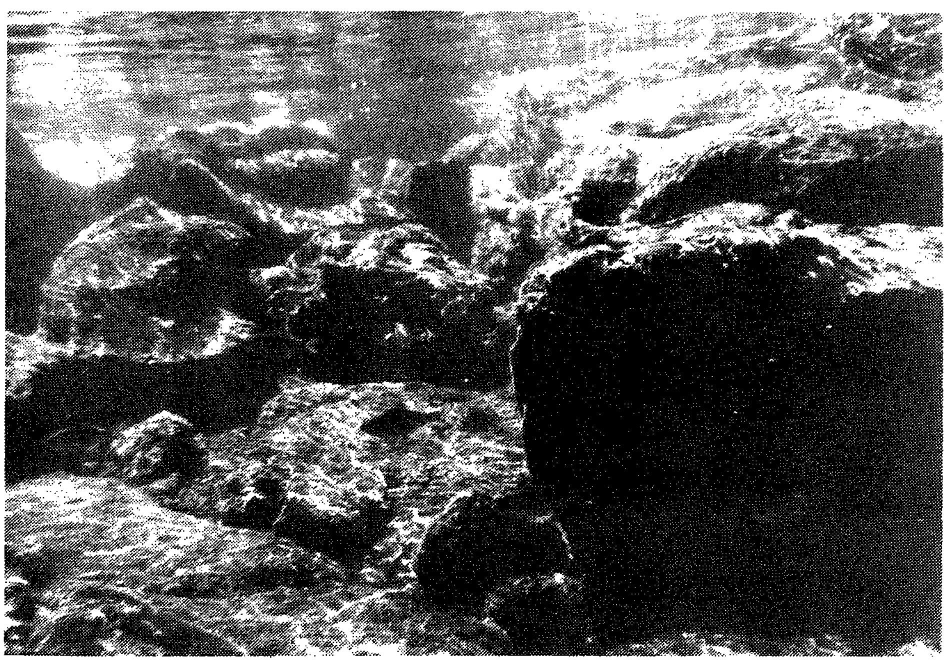


7. COASTAL POND NO. 2 IN AN ADVANCED STAGE OF SENESCENCE

8. BEACH BERM AT NINOLE COVE



5. **STREAM CHANNEL DISCHARGE, POND NO. 1**



6. **JUVENILE AHOLEHOLE IN DISCHARGE STREAM, POND NO. 1**

3. COASTAL POND NO. 1

4. "SIRPUS" VEGETATION IN POND NO. 1

Appendix D: Coastal Uses At Punalu'u Resort Project As Perceived By Present Users

PERSONNEL

Akala Products, Inc.
Paul Bartram
1145 21st Avenue
Honolulu, Hawai'i 96816

John Clark
Hawaiian Shoreline Consultants
P. O. Box 661
Kailua, Hawaii 96734

Eugene P. Dashiell
Planning Services
715 Kapaia Street
Honolulu, Hawai'i 96825

COASTAL USES AT PUNALU'U, HAWAI'I

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Many shoreline activities are not only recreational, but cultural; parents pass on information and heritage to children.

5. Ponds- Restore Ninole Pond for swimming, fishing; no white sand; smaller pond near Ninole has green growth that comes from sewage pollution; more growth, more pollution.
6. Ninole Cove- Develop camping sites there; leave shoreline access road from Punaluu Beach Park to Ninole open; no importation of white sand to cove area.
7. General- The resort expansion is threatening the local lifestyle.

Interview Number: 9

Punaluu Interview #13 and #14 (combined comments- both basically the same)

Type of User- Turtle Researchers.

Residency- Oahu.

Most Heavily Used Environments- Sand beach and sand coves in the rocky shoreline.

Remarks:

The profusion of ground water mixing with the ocean water in a protected bay has stimulated the growth of two types of algae, red and green, that are important turtle foraging foods. Punaluu has one of the largest concentrations of green turtles in the eight major islands. Hawksbills nest here and at other sites nearby that contain suitable amounts of black sand.

Turtles are sensitive to human activity and lights at night on the beach and may feel threatened. Hatchlings may be distracted by night lights and head inland where they are prey to animals or victims or cars instead of finding their way into the ocean. If further development means more activity and more lighting on the shoreline, it may create problems for the turtles.

Interview Number: 13

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COASTAL USES AT PUNALU'U, HAWAI'I

INTRODUCTION

This report characterizes existing use patterns along the coast of Punalu'u, Hawai'i within the boundaries of the Punalu'u Resort development. The information was gathered primarily by interviewing representatives of major user groups.

User groups depend on specific micro-environments which tend to define the nature and boundaries of user activities. The user groups and the micro-environments are described. The effects of the proposed plans are discussed in terms of the impacts on user groups and micro-environments. Measures on mitigation are described based on the proposed plans or existing information.

Punaluu Interview #8.

Type of User- Hiker, amateur archaeologist.

Residency- Longtime Ka'u resident.

Most Heavily Used Environments- Trails on lava flows; rocky shoreline.

Remarks:

1. Heiau- Protect important cultural, historical sites.
2. Boat Ramp- In poor repair; access road sections may have different owners, Brewer and Bishop Estate.
3. Black Sand Beach- Poor swimming.
4. Rocky Shoreline and Beach Park- Used heavily by local residents; fish populations smaller than in former times; few <u>opihi</u> left; most <u>opihi</u> gathering done either southwest or northeast of Punaluu and Ninole.
5. Ponds- Restore Ninole Pond.
6. Ninole Cove- None.
7. General- Completely in favor of all resort expansion, no negative comments.

Interview Number: 8

Punaluu Interview #9, #10, #11 and #12 (combined interview with four people)

Type of User- Fishermen, picnickers, hikers, surfers, bodyboarders.

Residency- Lifetime Ka'u residents (all four).

Most Heavily Used Environments- Beach park, rocky shoreline, trails.

Remarks:

1. Heiau- Protect important cultural, historical sites.
2. Boat Ramp- Poor repair; important pole fishing site, especially for families.
3. Black Sand Beach- Important turtle nesting site; sewage pollution may endanger turtle foraging areas, turtles, and other near shore marine life; may pollute swimming, surfing, bodyboarding sites.
4. Rocky Shoreline and Beach Park- Most important shoreline recreation site in Ka'u; everyone comes for all occasions; keep development back of existing roads; keep development off central bluff; maintain <u>makai</u> road on central bluff for tsunami evacuation and access to graveyard; beach used by special interest groups.

   Nearshore waters important for gathering activities- <u>limu, wana, opihi</u> and for pole fishing and throw-netting; want easy access to these areas, not long walks. especially camping sites.

Interview Number: 9

Table 1

SEVEN KEY LOCATIONS OF COASTAL USES IN THE PROJECT AREA

ENVIRONMENT	USES
1. Kane'ele'ele Heiau	Religious, Historic
2. Boat Launching Ramp, Wharf	Small Boat Launching, Fishing, Camping, Pole Fishing
3. Punalu'u Black Sand Beach	Fishing, Camping, Sunbathing, Swimming,
4. Rocky Shoreline, Including Punalu'u Beach Park	Camping Opihi, Wana and Limu Picking, Pole Fishing, Throw Netting, Diving, Hiking, Researching, Surfing, Bodyboarding
5. Coastal Ponds	Swimming by Children, Researching, Throw-netting
6. Ninole Cove (prior to infilling and after restoration)	Swimming, Fishing, Hiking
7. Ka'ie'ie Heiau (Outside project boundaries)	Religious, Historic

HISTORY OF COASTAL USES

Traditional Fishing Village

Ka'u District's shoreline is primarily comprised of a dry and arid cliff line. However, in the area between Honuapo and Punalu'u (about 4.5 miles) there are many fresh water springs along the shoreline and just beneath the ocean's surface. Early Hawai'ians dived down and filled empty gourd bottles with fresh water from these undersea springs. Punalu'u means "spring (water) dived (for)."

Punalu'u includes an embayment which formed a natural harbor along the rough and rocky coast. The combination of the fresh water and the embayment probably contributed to the development of a native Hawai'ian fishing village. Villagers netted akule and opelu and caught ehu, kalikali, opakapaka, and ulaula with handlines. Fishing canoes, net drying racks, and nets were observed on the black sand beach well into the twentieth century.

Sugar Cane Period

In the 1860's, sugar cane was planted commercially in Pahala. By the 1880's, Ka'u had four plantations (Kelly, Marion) with mills, half a dozen without mills, and perhaps 20 individual sugar growers raising cane on various sized acreages. The village at Punalu'u grew to become the port town of the district of Ka'u. Interisland steamers were regular visitors. They anchored offshore. Goods and passengers were freighted in and out by lighters. Eventually, the town boasted several stores, a hotel, a jail, a warehouse, a wharf, a stagecoach line, and telephone service.

Post-Sugar

Punalu'u was eventually abandoned as a commercial harbor when automobiles appeared and good roads were built to link all of the Big Island to the deep-water port at Hilo. By the 1940's, large trucks moving on improved roads hauled raw sugar in bulk to Hilo. The buildings at the landing were torn down and the wreckage removed.

With these changes, Punalu'u's population dwindled. The tsunami of 1946 was especially destructive and contributed to more people moving away. Eventually, only a handful of the former residents remained. The area remained unchanged until the Punalu'u Resort began in the early 1970's.

Punaluu Interview #6.

Type of User- Fishermen (boat and shoreline), picnickers.

Residency- Lifetime Ka'u resident.

Most Heavily Used Areas- Boat ramp, beach park, rocky shoreline.

Remarks:

1. Heiau- Culturally significant; protect.
2. Boat Ramp- Needs improvement.
3. Black Sand Beach- Take little children to northeast end to swim; older children surf and bodyboard off southwest end at high tide; important for turtles.
4. Rocky Shoreline- Very important, popular throw-net site in Ka'u; easily accessible (drivable), can bring entire family, good also for limu, wana, spear fishing; important site containing historical birth stones.
5. Ponds- Restore Ninole Pond.
6. Ninole Cove- None.
7. General- None.

Interview Number: 6

Punaluu Interview #7.

Type of User- Swimmers, picnickers, hikers.

Residency- Early years in Ka'u; now in Kona.

Most Heavily Used Environments- Beach, beach park, former pond, trails.

Remarks:

1. Heiau- None.
2. Boat Ramp- None.
3. Black Sand Beach- Important for turtles; they come in for limu, which grows well because of large amount of ground water mixing with salt water.
4. Rocky Shoreline and Beach Park- Important for consumptive gathering and fishing.
5. Ponds- Restore Ninole Park; was favorite swimming and fishing site.
6. Ninole Cove- None.
7. General- None.

Interview Number: 7

COASTAL USES

METHODS

The survey of existing uses of the shoreline at Punalu'u and Ninole was conducted through a series of interviews with Ka'u residents and others who visit the area. The interviews were conducted either in person, on site or by telephone. The principal interviewer, Mr. John Clark, talked with persons whom he knew to be knowledgeable of the Punalu'u area. Persons were selected on their familiarity with Punalu'u and specific user activities in the area. A second group of people were selected from a list of persons who had provided testimony about the proposed development or who were involved with user groups or interest groups affecting the Punalu'u area.

During the Period 8 to 12 August 1986, the project area was inspected and some interviews conducted. This was not a survey to measure "beach use" during that period. Beach users were not counted, but rather persons performing different categories of use were interviewed.

Some of the information is the same or similar to that recorded in the hearing transcript of the public hearing held at Ka'u High School on January 29, 1986. This is because some of the same individuals who spoke at the hearing were interviewed and because many of the concerns are common to almost everyone who was surveyed.

The summary of interviews (See Appendix) includes information from users representative of the following groups: opihi-pickers, throw-net fishermen, pole fishermen, small-boat fishermen, beach goers, researchers, Punalu'u residents and business persons. The summary is broken down by the seven key locations in the vicinity of the project:

1. Kane'ele'ele Heiau (outside and adjacent to the project boundary)
2. Punalu'u Boat Ramp
3. Punalu'u Beach
4. Rocky Shoreline, Including Punalu'u Beach Park
5. Coastal Ponds and Nearshore Springs
6. Ninole Cove
7. Ka'ie'ie Heiau (outside and adjacent to the project boundary)

COASTAL USE ACTIVITY AREAS

1. Kane'ele'ele Heiau (adjacent to Punalu'u boat ramp and outside but adjacent to the Punalu'u Resort project boundary).

Kane'ele'ele Heiau is located atop the northeastern point of Punalu'u Bay outside and adjacent to the project boundary. It is a massive and extensive complex that is visited primarily by amateur archaeologists, hikers and tourists. A stepping-stone trail runs from the northern end of the heiau complex to Kanenelu. Several mauka-makai trails intersect it. The stepping-stone trail is used by hikers, fishermen, researchers and opihi pickers (commercial and non-commercial) all of whom park at the boat ramp before walking to Kanenelu and Kamehame beyond. In recent times the heiau has been visited, on occasion, by contemporary Hawaiians to conduct religious ceremonies. Pole fishermen fish at various points along the seaward edge of the complex. Turtle researchers visit the area, particularly nearby Keone'ele'ele.

These are the major concerns expressed by users:

- Continue to maintain public access to the heiau;
- Preserve the heiau;
- Protect green sea turtle habitats.

2. Boat Ramp and Wharf.

The Punalu'u Boat Ramp is located in the northeastern corner of Punalu'u Bay, adjacent to the old landing and wharf. There are no public ramps in the southern portion of the island of Hawai'i and Punalu'u (privately owned by C. Brewer) along with Ka'ulana (owned as Hawai'ian Homes Lands) are the only two locations available for launching. Both sites are extremely hazardous to launch from because of unimproved ramps, shallow bottoms offshore, unprotected wave conditions and lack of improved and marked channels. But, for the high volumes of tuna catches, commercial fishermen prefer Ka'ulana because it is nearer to the fishing grounds off South Point.

The access road to the Punalu'u ramp leaves the public beach road and crosses private property until it reaches the shoreline. The road is narrow and unpaved. The ramp is single-laned, short, and in only fair repair. The unpaved parking area adjoining the ramp is small and often congested with automobiles and trailers, leaving little room to manuever a trailered boat for launching. The limited space and the ramp's design also makes retrieving a boat a risky operation. As soon as the trailer clears the water, the driver must take a hard left or he will run out of exit space.

Punaluu Interview #5.

Type of User- Fishermen, picnickers, vendors.

Residency- Lifetime resident of Ka'u.

Most Heavily Used Environments- Beach park, rocky shoreline, beach, boat ramp.

Remarks:

1. Heiau- Important historical, cultural sites; sacrificial stone at Kaneeleele.
2. Boat Ramp- Needs improvement, important ramp for Ka'u; only one easily accessible, the only other ramp is Kaulana at South Point (far drive, remote).
3. Black Sand Beach- Too rocky for many swimmers; important turtle nesting site. With re-opening of restaurant and improved lighting in beach park parking lot, hawksbills seem to be staying away resulting in many green sea turtles feeding near beach.

   Children surf and bodyboard off south end of beach next to point.
4. Rocky Shoreline and Beach Park- Important for <u>limu</u>, throw-net, spear fishing; site of historically famous birth stones.
5. Ponds- Black sand beach covered former pond named Kauila; present beach road passes over site; Ninole Pond destroyed by soil erosion from flash flooding in <u>mauka</u> areas; ground denuded by resort

development; restore Ninole Pond; do not bring in white sand.

6. Ninole Cove- Maintain as park.
7. General- Can live with proposed resort expansion, but if had choice, prefer no development on central bluff.

The Punalu'u ramp is one of several alternate sites considered and rejected by the (U.S. Army Corps of Engineers as a small-craft harbor site in the south end of the island of Hawai'i Kaulana Bay Navigation Improvements, South Point, Island of Hawai'i, Final Detailed Project Report and Environmental Statement, September 1981). The site was rejected by the Corps for the following reasons:

> The Punalu'u area has been developed by Brewer in recent years as a tourist destination point. Based on existing and future development in the area, availability of land for potential sites for a harbor and shoreside facilities are limited. Several sites within the Punalu'u area may be eligible for listing on the Hawai'i and National Register of Historic Places (access road to ramp and old sugar dock). Punalu'u is also known to be an important feeding habitat for the threatened green sea turtle. Because of problems associated with the acquisition of private shoreline land for navigational improvements, provisions for public vehicular access, archaeological considerations and encroachment into threatened species habitat, this site was consequently eliminated in favor of a more desirable location (Page EIS-8).

The Corps has recommended the site at Ka'ulana, South Point, for development as a protected launch ramp for small craft to meet the needs of the growing commercial fishing business in that area. The plan provides for a one-lane launch ramp with a breakwater for offshore protection from wave attack. There would be parking facilities.

Both the Corps and the State of Hawai'i have authorized funds for construction. Construction has been delayed pending the outcome of litigation brought by native Hawai'ians against the State and Federal governments over planning matters and development priorities for lands managed by the Hawai'ian Homes Commission. In recent months, protestors have blocked the access road to this unimproved and unofficial boat launching site, probably because of feelings related to the litigation.

In general, the public appears to favor development of Ka'ulana and it seems likely that if the litigation is resolved, the construction of a harbor there may proceed and thereby provide an alternative to the Punalu'u ramp. Recent discussions with Corps of Engineers' representatives yielded no prediction, however, for a development timetable of Ka'ulana (Pelowski, John, Chief, Planning Branch, Personal Communication, August 28, 1986).

The boat ramp/wharf site at Puanlu'u is one of the most popular pole fishing sites in Ka'u. Local fishermen camp in the area and fish during the day and during the night for papio, ulua, moano, oio, and other species of fish. Because this site is in the lee of the point, it is usually free of waves surging over the rocks. Families bring their children here to fish.

These are the major concerns expressed by users:

- A boat launch facility in Ka'u District is an economic necessity because of the significance of fish in local diets, culture and in the economy.

- The old wharf provides some convenient pole fishing sites with access to deeper and calmer water than the rocky shoreline. These sites should be protected and perhaps improved.

3. Punalu'u Black Sand Beach.

Punalu'u Beach is a black cinder sand (volcanic glass) beach [with a single aa lava flow as a source (MacDonald & Abbott, 1970)] that borders Punalu'u Bay. It is a small, arcuate pocket beach about 800 feet long and 70 feet wide and lies between lava flows at both ends. There is little seasonal change to the beach during the year. However, tropical storms, hurricanes, and tsunamis have considerably reduced the sand volume of the beach during the past 200 years.

Lava bedrock and lava boulders are exposed at the water's edge along most of the beach, creating poor swimming conditions. The only good, rock-free swimming site is situated immediately inshore of the boat ramp in the northeastern corner of the bay. For this reason, swimmers and sunbathers concentrate in this area. This site is also the most protected corner of the bay, so families with little children also tend to congregate here.

Immediately offshore and adjacent to this site is the boat ramp. This area of the beach is really the only place in the entire Punalu'u-Ninole shoreline where ocean swimming is feasible. To reach the open ocean after launching, boats proceed through the deep channel along the northeastern point of the bay. This is the only channel in and out of Punalu'u Bay. As such, it is the major drain for most of the bay waters, and a very powerful rip current runs through it continuously. This is a very dangerous area for all swimmers, but especially for persons unfamiliar with local waters.

Punalu'u Beach is a regular stop for the circle-island tour buses and vans. Many independent travelers in rental cars also stop. During the day numerous tourists were observed walking along the beach, visiting the curio shops, taking pictures and picnicking. The entire beach and backshore appears crowded with people and

Punaluu Interview #3.

Type of User- Former water safety supervisor.

Residency- Hilo (number of years unknown).

Most Heavily Used Environment- Beach.

Remarks: None (there are, however, water safety concerns at the beach).

3. Black Sand Beach- Very heavy rip tide running out through boat channel; popular swimming site inshore of channel and therefore needs manned lifeguard tower on part-time basis (weekends and holidays) when possible. (Difficult to find qualified persons who will work there part-time resulting in almost continuous tower vacancy.)

Interview Number: 3

Punaluu Interview #4.

Type of User- Boat fishermen, Coast Guard reservists.

Residency- Lifetime Hilo residents.

Most Heavily Used Environment- Boat ramp, offshore waters.

Remarks: None except on boat ramp and safety concerns.

2. Boat Ramp- Overall poor condition; Coast Guard reserves use occasionally for training missions; potential launching/landing site for rescue operations; would like improved facilities at ramp site.
Fast rip tide out boat channel; strong longshore current towards Ninole.

Interview Number: 4

vehicles. The County of Hawai'i Department of Parks and Recreation does not maintain visitor counts at parks and firm counts of visitations are unavailable.

Signs are posted on the beach warning visitors not to remove the black sand. Many people take souvenir samples anyway. The black sand at Punalu'u is a finite resource. It was created by a lava flow or flows which entered the sea nearby.

The entire Ka'u shoreline, including the beaches and nearshore waters of Punalu'u are documented nesting and feeding areas for the green turtles (U.S. Army Corps of Engineers, September 1981 and Balazs, George H., September 1979).

These are the major concerns expressed by users:

- There are hazardous swimming conditions at Punalu'u, inexperienced swimmers can easily get into trouble;
- This is the only ocean swimming site in the area;
- There are high levels of visitation and crowding which reflect the limited beach and backshore area;
- There is a potential loss of sand to souvenir takers;
- There may be adverse effects on green sea turtles.

4. Rocky Shoreline Including Punalu'u Beach Park.

Punalu'u Beach Park is situated on the southwestern point of Punalu'u Bay. The park includes parking, showers, restrooms, picnic pavilions, drinking water, electricity, and camping sites.

According to discussions with Park users, Punalu'u Beach Park is a significant recreational site in the district of Ka'u. The park serves the local community as a community center on the shoreline. The park is very heavily used on weekends and holidays. It is popular for camping but there are only about 20 campsites. Whittington Beach Park, about 5 miles south of Punalu'u has about 10 campsites. These are heavily used, but there are no actual visitor counts (Personal communication, County of Hawai'i, Department of Parks and Recreation, August 29, 1986). Despite a lack of data on park usage, there is verification of the acute need for shoreline recreational facilities in Ka'u.

According to the State Comprehensive Outdoor Recreation Plan, one of the short-term options for Ka'u District is to "increase shoreline recreation opportunities by improving existing facilities and programs" (SCORP, Department of Planning and Economic Development, September 1980, p. 218).

Many of the Punalu'u residents interviewed said that they visit Punalu'u Beach Park after work to simply get away and relax for awhile. Parties are held here for special occasions, anniversaries and birthdays. The pavilions help meet these uses. It should be noted that this type of recreational or social use is common throughout the Big Island parks where, during plantation days and before the advent of tourism to any extent, area residents were the prime users. In fact, the parks were built to meet the interests at that time. For example, pavilions permit large groups of people to socialize.

The beach park, in conjunction with the adjacent beach, the nearby boat ramp, and the adjoining rocky shoreline, is a primary site for a wide variety of local ocean recreation activities. Most of the Ka'u District's shoreline is comprised of low to high sea cliffs with very few protected embayments. Punalu'u Bay is one of the few areas where the sea cliffs are very low or almost non-existent. The bay is recessed into the shoreline and protected by a series of small rock islets offshore. These conditions offer good opportunities for spear fishing, pole fishing, squiding and thrownetting. According to users, Punalu'u is probably the most popular site for throw-netting in Ka'u.

Thrownet fishermen commonly catch <u>nenue</u>, <u>manini</u>, mullet, and other nearshore species. <u>Akule</u> are sometimes caught by "surround-netting" in the bay. <u>Limu</u> is gathered along the shoreline. These species are harvested: <u>pahee</u>, <u>akiaki</u>, <u>lipoa</u>, <u>kohu</u>, <u>ele'ele</u>, and "Portagee ogo". Also gathered, to a lesser extent, are <u>wana</u> and <u>opihi</u>. <u>Wana</u> are not popular with many people and most of the important <u>opihi</u> harvesting is done in less accessible areas, either to the Puna or Kona side of Punalu'u. In summary, the users indicated that Punalu'u Beach Park and Punalu'u Bay (as well as adjacent shoreline within the boundaries of the Punalu'u Resort development) support consumptive activities that provide a combination of food and recreation for Ka'u residents.

Adjacent to the beach park at the southwestern point of Punalu'u Bay is a shallow <u>papa</u> (reef flat). At mid to high tide, waves breaking on this papa, provide a surfing and bodysurfing site for local residents, primarily children and young adults. Its small short-lived waves are easy to get to and suitable for surfers and bodysurfers of novice to intermediate ability. It is the only site in Ka'u that surfers can drive to and the only one suitable for little children. In addition to the ordinary usage of the park and the surrounding shoreline, special uses occur in the area. For example, Ka'u High School Hawaiiana classes walk through the area. The students are allowed to fish, and to cook and eat their catches at a picnic in the beach park. Their instructor is a <u>kapuna</u> who discusses the old ways and the old legends of Punalu'u and Ka'u. Hawaiiana classes are brought in from outside the district from as far away as Mountain View Elementary School. Senior citizens are bused in from Hilo to

Punaluu Interview #1.

Type of User: Fisherman (shoreline and boat).

Residency : Lifetime resident of Ka'u.

Most Heavily Used Environments: Boat ramp, rocky shoreline, nearshore waters, offshore waters.

Remarks:

1. Heiau- None.
2. Boat Ramp- Already crowded, inadequate for present users.
3. Black Sand Beach- Save for turtles.
4. Rocky Shoreline and Beach Park- Very important for throw-net fishermen; only low-lying shore easily accessible; nearshore waters important for limu; where people of Ka'u get together.
5. Ponds- Restore Ninole Pond.
6. Ninole Cove- Wants shoreline access road from Punaluu Beach Park to Ninole to remain open.
7. General Comments- Against any development below present golf course and existing roads; against development on central bluff; maintain makai road up bluff for residents for graveyard and tsunami evacuation.

Interview Number: 1

Punaluu Interview #2.

Type of User- Swimmer, picnicker, beachcomber.

Residency- Spent most of life in Ka'u; retired Hilo residents.

Most Heavily Used Environment- Beach park, beach, rocky shoreline.

Remarks:

1. Heiau- Maintain integrity.
2. Boat Ramp- None.
3. Black Sand Beach- History of erosion; historically, may swim there.
4. Rocky Shoreline and Beach Park- None.
5. Ponds- Restore Ninole Pond (former swimming site).
6. Ninole Cove- None.
7. General- Primarily use golf course and beach park.

Interview Number: 2

spend the day and picnic. Elderly patients from Ka'u Hospital and Kona Hospital are occasionally brought in.

The 50-foot bluff on the shoreline presently houses only one structure, a chapel that is administered by the trustees of Kauahaau Church in Waiohinu. Several miles inland of Punalu'u are a number of flattopped hills. According to informants, these hills are unique landscapes and are part of the overall attractiveness of the area. They are also part of the culture and legend of Ka'u.

These are the major concerns expressed by users:

- Preserve and improve the park so it can continue to serve the recreational and social needs of the community;
- Protect the environmental quality of the shoreline habitats to help maintain marine resources for consumption and recreation;
- Preserve the camping areas from intrusion from higher density uses to maintain a peaceful and quiet camping experience.

5. Coastal Ponds and Nearshore Springs.

A large volume of fresh groundwater flows seaward along the Punalu'u Coast emerging in coastal ponds and nearshore springs. The larger ponds are used, to some extent, for throw-netting. Hand-held nets are employed to harvest small shellfish which inhabit the perimeters of the ponds. Children occasionally swim in the larger ponds.

These are the major concerns expressed by users:

- There is a potential loss of access to the ponds;
- The ponds or the groundwater could be polluted by sewage effluent or urban runoff.

6. Ninole Cove.

In the mid-1970's, Ninole Cove was once a sheltered embayment and fishpond. Today only a small portion of the original pond remains. The majority of the pond was destroyed by flash flooding in mauka areas that carried tons of soil and boulders into the pond and filled it. In addition to serving as a fishpond, Ninole Cove was once a popular swimming area as well as a focal point for social gatherings.

These are the major concerns expressed by users:

- Restoration of the Cove would provide additional safe swimming for children and older persons;
- Restoration of the fishpond could provide fishing opportunities similar to those now offered by the coastal ponds;
- Restoration should include measures to prevent future siltation of the cove.

7. Ka'ie'ie Heiau (Out of the project boundary and adjacent to Ninole Cove).

Ka'ie'ie Heiau is located atop the lava point immediately southwest of Ninole Cove. The structure is visited primarily by amateur archaeologists, hikers and occasionally by tourists. A portion of the old government road runs across the lava flow from this area and ends at Kawa. Sections of the road are still paved with <u>ili ili</u>. Hawaiiana classes and organized hiking groups walk to Kawa and back during cultural and historical excursions. Pole fishermen fish at various points along the seaward edge of the site.

The major concern expressed by users was:

- Additional foot traffic through this site could damage it.

<u>POTENTIAL IMPACTS OF PROPOSED ACTIONS</u>

The plans could have two types of impacts on coastal uses. First are impacts which occur during construction and tend to have short-term effects. These are discussed in general terms only. The second type of impacts are those which could have long-term effects.

SHORT-TERM IMPACTS DURING CONSTRUCTION

There are four types of impacts on coastal uses which may occur during construction.

1. Runoff from the construction site which may contain silt and which may fill in coastal ponds, dirty nearshore waters and cause siltation on beaches.

2. Dust from the construction site which may blow into user areas, cover vegetation, settle in coastal ponds and on beaches.

3. Noise from equipment and men working which may disturb the

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APPENDIX

SUMMARY OF INTERVIEWS WITH COASTAL USERS

tranquility of a normally peaceful area.

4. Interruptions to shoreline access.

Mitigation: County, State and Federal regulations regulate runoff, dust and noise from construction sites. If stringently enforced, these regulations should provide adequate protection of user areas.

LONG-TERM IMPACTS SUMMARY DISCUSSION

There are potentially two main impacts of the proposed plans. These are summarized and then discussed in detail.

<u>Summary of the Impacts of the Increase in Users</u>

The increase in users will include the following populations:

- New guests or residents of Punalu'u.
- Tour groups and other day visitors who stop for lunch at Punalu'u.
- Residents of Ka'u, the county and even the state, who will be attracted to the improved public facilities.

These groups will significantly increase the population of existing coastal users at Punalu'u. The increase in users will significantly alter the character of the coastal environment and its users along the Punalu'u coast. The project area along the coastline will appear more "man-made" and less "natural" in the eyes of users. The visitation experience will be less solitary because of the increased numbers of people who will visit the area.

Higher density use may increase the possibility for conflict between existing and new users. Greater numbers of users will increase competition for limited resources, including marine life of consumptive value.

<u>Summary of the Impacts of the Changes in Access</u>

Three changes in access are planned.

- The dirt road on the backshore of the Black Sand Beach would be closed. This would provide a less congested, more pleasant and larger beach without disrupting access to Punalu'u Beach Park or to the launch ramp.
- The approach to the rocky shoreline would be altered by construction of the fairway for the 8th golf hole. Rocky shoreline users may still walk the length of the shoreline and there will be improved parking lots at Punalu'u Beach Park and Ninole Cove.
- There will be improved access and additional parking stalls for Ninole Cove users.
- Public access to the small coastal ponds would be eliminated (because of concerns for preservation of fish and wildlife resources).

SPECIFIC CONCERNS ABOUT PLAN COMPONENTS

The following discussion addresses the proposed plans in terms of specific impacts at the 5 key locations of coastal use in the project area. Table 2 displays a grouping of project actions as they are expected to affect the coastal uses within the project boundaries and at the two <u>Heiau</u> which adjoin the Punalu'u Resort boundaries.

IMPACTS OF THE INCREASE IN COASTAL USERS

Several of the proposed development plans (See Table 3) have significant impacts because they would introduce more coastal users. The following discussion addresses the plans in Table 3.

COASTAL RESOURCES WHICH ARE AFFECTED

Boat Launching Ramp

It is likely that some new residents of the Punalu'u Village center would own small sports boats and launch them at the existing ramp. This would increase use at the ramp and the potential for friction or conflict between existing and new users would increase. This is especially significant in view of the importance and traditional role of fishing in the local community.

This problem is made worse because of the difficulty of using the existing ramp, its general disrepair and wave exposure.

Mitigation: The Punalu'u ramp is not a publically owned facility as are most of the boat launching or berthing facilities in the State. For the Ka'u District, Ka'ulana would be an excellent launch ramp facility if it should be built. The likelihood of its implementation is good given the fact that both the state and federal governments have authorized the project and the funds to construct it. If the Ka'ulana facility is not constructed, however, the severe need in Ka'u for a ramp will focus attention on Punalu'u as a place for improved launching facilities.

density conditions. Visitors are more likely to picnic and residents are more likely to camp. Separation of the two user-areas may reduce the potential for conflict.

Mitigation: Separation could be accomplished using plants and perhaps decorative barriers as screens between the two areas. Some camping areas adjacent to the pavilions could be reserved for large groups, perhaps in conjunction with the use of the pavilions.

Restoration of Ninole Cove as an Ocean Recreation Area (State, County and Federal Permits, as Required, Will be Obtained Prior to Initiating the Restoration), Which Has Been Filled Due to Flooding and Storm Waves

Users agree that the cove should be restored. They are concerned that the natural condition of the area should be retained by placing only black sand and iliili at the site. The famous Iliili Hanau o Koloa, the so called birth pebbles, which are located between the present beach park and Ninole, should not be mined for any restoration or beach creation.

IMPACTS OF THE CHANGES IN ACCESS

Prohibition of Human Access to the Coastal Ponds

There are several coastal ponds along the shoreline. The ponds are used by swimmers (particularly small children), fishermen and researchers. Prohibition of human access is intended as a mitigation measure to preserve the ponds as natural resources from the effects of resort development and concomitant increases in human use.

Mitigation: Consideration should be given to restoring a portion of Ninole Cove as a fishpond to offset the loss of access to the coastal ponds for subsistence fishing.

There are significant beneficial impacts to the natural environment of the ponds by prohibiting human use. The adverse impacts to users of the ponds are proposed to be mitigated as follows.

Mitigation: The improvements to Punalu'u Beach Park, the restoration of Ninole Cove and development of the water play areas will all provide improved swimming and water sport areas. The restoration of Ninole Cove could also provide improved nearshore fishing.

Relocation and Construction of Approximately 6,800 Lineal Feet of Punalu'u Road and Ninole Cove Place (Private Roadways Within the Resort)

The dirt road which runs laterally across the Black Sand Beach, paralelling the ocean, will be closed. This action will not significantly alter access to Punalu'u Beach Park or to the boat launch ramp, but it will halt access by vehicles between the Beach Park and the launch ramp via the Black Sand Beach backshore. Removal of the dirt road will increase the total beach area and make the beach and park more pleasant for most users. This would be a beneficial impact to the natural environment and to most beach-goers, campers and park users. It may be an adverse impact to persons accustomed to driving from the park to the boat ramp via the beach.

Mitigation: There will be improved access and parking for the park and launch ramp users via new or other paved roads and parking lots. Road relocation is a mitigation measure in itself, which will improve the beach over the long-term by reducing the disturbance to the backshore which occurs due to vehicular traffic. Beach-goers will find the beach more pleasant in the absence of vehicles.

Golf Course Modifications and Relocations of Four Golf Holes

The relocation of the 8th golf hole will alter access to the rocky shoreline because the existing road will be relocated and the fairway will form a barrier between Punalu'u Resort and the shoreline. This is not a significant adverse impact however, because the existing public access path along the shoreline (a 10-foot-wide lateral access easement) will not be affected.

Mitigation: No mitigation is required. Parking will be improved at both ends of the shoreline access path -- Punalu'u Beach Park and Ninole Cove. The existing shoreline path will remain.

Table 2

GROUPING OF PROPOSED ACTIONS BY IMPACTS

	ENVIRONMENT						
PROPOSED ACTIONS	KANE'ELE'ELE HEIAU	BOAT RAMP	BLACK SAND BEACH	ROCKY SHORE	COASTAL PONDS	NINOLE COVE	KA'IE'IE HEIAU
[These actions cause more people to use existing coastal resources.]							
1. 500 TO 650 HOTEL ROOMS	M	M	M	M	M	M	M
2. VILLAGE CENTER	M	M	M	M	M	M	M
3. WATER PLAY AREA	M	M	M	M	M	M	M
4. 1,360 TO 1,925 RES. UNITS	M	M	M	M	M	M	M
5. LAGOON CLUB	M	M	M	M	M	M	M
6. 8 TENNIS COURTS	M	M	M	M	M	M	M
7. PUNALU'U BEACH PARK IMPROVEMENT	M	M	M	M	M	M	M
8. NINOLE COVE RESTORATION	M	M	M	M	M	M	M
[These actions affect access to existing coastal resources.]							
9. ROAD RELO-CATIONS	N	N	A	A	A	A	A
10. GOLF COURSE MODS.	N	N	N	A	A	N	N

Notes: M = Impacts of more people; A = Access impacts; N = No effect. See text for detailed discussion.

TABLE 3

PLANS WHICH INTRODUCE MORE COASTAL USERS

- Developing 500 to 650 Hotel Rooms (Ninole Cove and Black Sands Restaurant Site).
- Creating Punalu'u Village (a Low Rise, Mixed-use Complex Including 330 to 500 Multi-family Residential Units and 65,000 Square Feet of Commercial Use Located on the Central Bluff).
- Creating a Water Play Area Within the Village Center That Will Include a Series of Pools, Waterfalls and Sand Areas Flanked by a Landscaped Courtyard.
- Providing for the Development of 1,360 to 1,925 Additional Multi- and Single Family Residential Units.
- Developing a Recreation and Entertainment Center (Lagoon Club).
- Adding Eight Tennis Courts and Other Resort Support Facilities and Amenities.

Source: Phillips Brandt Reddick and Associates

Punalu'u Black Sand Beach

Punalu'u Beach is heavily used by Ka'u and other Big Island residents and tourists. The increased number of users will add to the density of use on the beach. This would occur primarily during the daytime and would take the form of beach walking, sunbathing and swimming.

Mitigation: Closing the dirt road over the beach backshore will provide additional sandy beach area.

The channel which extends seaward from the northeast end of Punalu'u Black Sand Beach past the boat ramp to deep water is a dangerous area to swim and there are already problems with the mix of swimmers and boats being launched at the ramp.

Mitigation: The channel should be marked and perhaps roped off from swimmers. Signs should be posted to warn swimmers about the dangerous current in the channel. The restoration of Ninole Cove and the proposed water play area are intended to provide safe places for swimming and water sports.

The serenity and natural features of the area attracts many special interest groups such as senior citizens and handicapped persons to Punalu'u. They may feel uncomfortable or conspicuous in the presence of large numbers of tourists or non-local residents. If golf holes are in close proximity to campers at Punalu'u Beach Park, conflicts between campers and golfers may occur.

Mitigation: Provide for improved camping facilities as a first priority.

Provide separate picnicking facilities for large tour groups, especially those which may stop over for lunch on circle-island tours. These groups have a significant and disruptive impact on a small picnic area.

Use landscaping to screen camping facilities from the golf course to avoid stray golf balls and also to separate campers, golfers or picnickers.

There is the possibility of nighttime noise and a loss of solitude for campers, fishermen and researchers. If there is an increase in nighttime noise and light, there will be further degradation of the beach as a turtle nesting area which will decrease its value for use by researchers. Increased human activity at night, more noise and more lights will discourage nesting activity even more than at present.

Mitigation: Provide shielded lights to protect campgrounds or turtle habitat from night lights. Restrict oceanside hotel noise after certain hours.

Rocky Shoreline Including Punalu'u Beach Park.

The proposed Ninole Cove Hotel could be a significant intrusion into the existing serene rocky shoreline area. It would also affect Ninole Cove, especially after restoration.

Mitigation: Set back from the lateral shoreline easement trail facilities which might be located where loud noises originate and buffer the hotel with extensive landscaping between it and the lateral shoreline easement.

Prevent nighttime noise and light from affecting the beach path and coastal users such as fishermen or turtle researchers through the use of shades on all lights and noise curfews.

The shoreline trail system is one pedestrian route to Ninole Cove from Punalu'u Resort and from other places. This area will be more intensely used and may require increased maintenance and safety features. There would be increased foot traffic along the rocky shoreline. These uses would occur during daytime and in the evening. These "new" uses could disturb the existing uses of <u>opihi</u>, <u>wana</u>, and <u>limu</u> picking; fishing, hiking and researching. The existing uses would have less solitude.

Mitigation: Provide for maintenance of the shoreline trail and include signs or other features which warn newcomers of possible hazards. No mitigation of the loss of solitude seems possible.

Ninole Cove

If the cove is cleaned and restored, it would attract swimmers (as it once did). There is the possibility of conflict between visitors and residents if crowded conditions evolve.

Mitigation: The water play area is designed to attract Punalu'u Resort guests and other visitors. It would serve as a major alternative water sport area to Ninole Cove and the Black Sand Beach.

Include a swimming area in the Ninole Cove restoration project.

THE EFFECT OF PUBLIC PARK IMPROVEMENTS

<u>Expanding the Existing Punalu'u Beach Park, Providing a New Access Road and Constructing Additional Parking and Recreation Facilities</u>

These improvements may make the Park more attractive to current and future residents. User-days would increase as a result. Increased use by both groups may lead to conflicts under high

Appendix E: Drainage And Flood Study

DRAINAGE AND FLOOD STUDY

FOR

PUNALU'U RESORT

KA'U, ISLAND OF HAWAII

Prepared For:

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NOVEMBER 1987

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TABLE OF CONTENTS

SECTION 1
LOCAL SURFACE DRAINAGE STUDY

1.1 Existing Conditions

The project area is predominantly characterized by large open spaces and minimal paved areas. Ninole Stream an ephemeral stream, flows through the western part of the project. (Ephemeral streams flow only during and immediately after periods of heavy rainfall.) Storm runoff from the area mauka of the State Highway and west of Punaluu Road drain to Ninole Stream. Surface runoff from Punaluu Road is diverted into catch basins and into a reinforced concrete drain line which runs under the road and discharges to the ocean by a natural drainageway between Ninole Cove and Punaluu Beach Park. Two other drainage culverts located within Punaluu Beach County Park and near the Punaluu Black Sand Restaurant area discharge runoff from the nearby golf course areas to the ocean.

1.2 Drainage Study

The proposed resort improvements will alter the natural drainage patterns within the project area. Some of the natural drainage channels will be redirected or blocked and other new channels will be created. For example, the proposed roadways will fill in several natural drainage channels. Means must be provided to either maintain the natural course of the channel or provide an alternate drainage route. In addition, the proposed improvements will alter the natural character of the ground, thereby changing the quantity of surface runoff. The purpose of this drainage study is to predict the changes in surface runoff quantities and drainage patterns and to describe the improvements required.

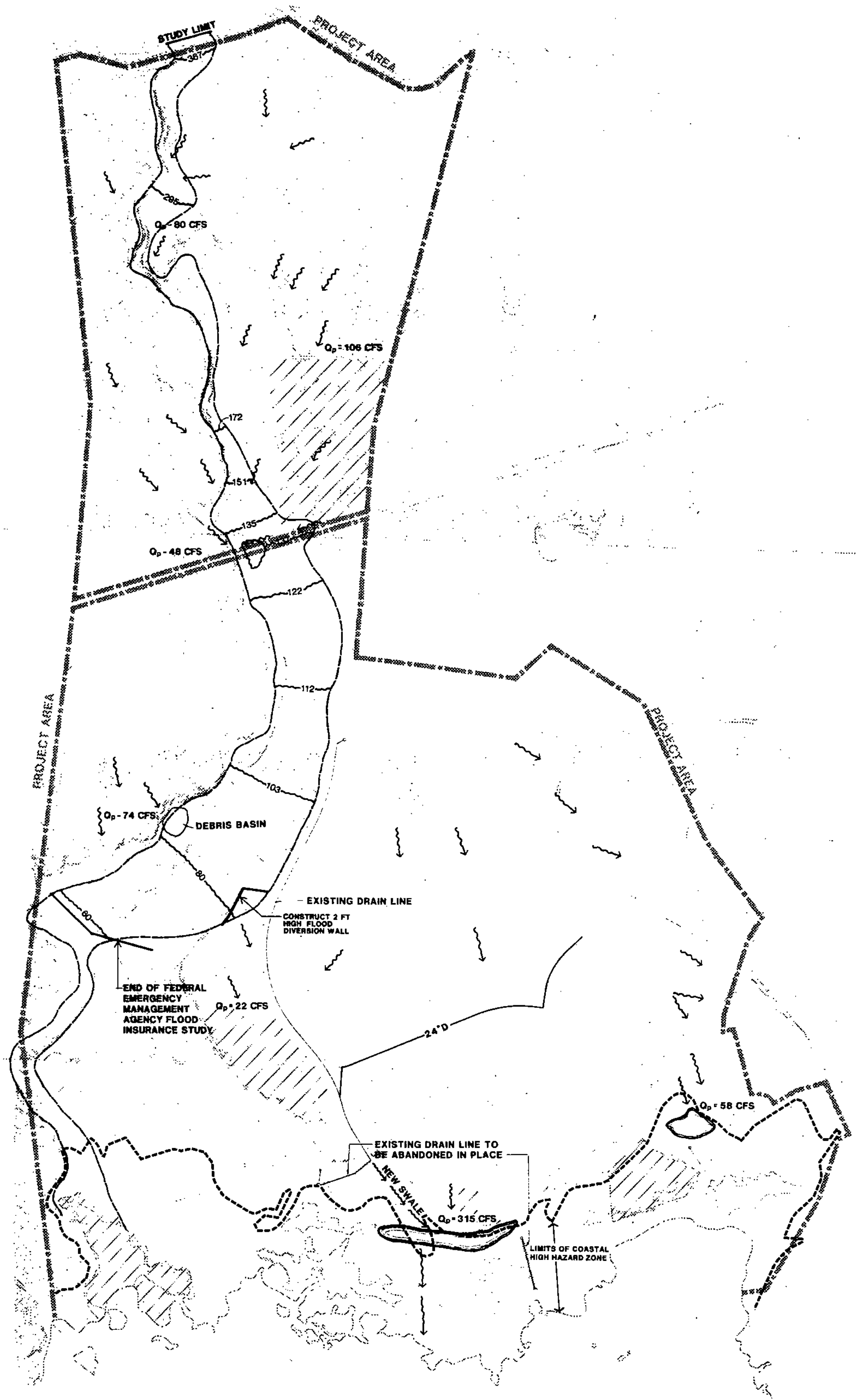
1.3 Local Drainage Conceptual Plan

A drainage study was conducted on specific areas within the resort area to determine the development's impact. These areas include the new Kalana II and III areas, Ninole Bluffs, Colony II, Central and Village Center. Existing areas such as Kalana I, Colony I and Golf Holes 9 through 18 will

remain unchanged with future development and hence were excluded from the study. The criteria and guidelines in the Drainage Standards of the County of Hawaii were used for this study.

The Rational Method, $Q = CIA$, was used to determine the discharges for the areas under existing conditions and with the proposed developments. Table 1.1 summarizes the existing and future discharges. Runoff from the Kalana and Ninole Bluffs areas will drain into Ninole Stream. Ninole Stream, on occasion, is known to overflow and flood the highway during severe storms. Development of the Kalana area (mauka of the highway) is expected to increase the stormwater runoff, and may contribute to the existing flood problems. Therefore, to prevent any more flood problems, the additional stormwater runoff generated by the Kalana area development will be stored in a catchment basin. Because of differing discharge points, Ninole Bluffs were evaluated using a 10-year storm event while the other areas were evaluated using a 50-year storm event. (According to County drainage standards, drainage systems which discharge directly into a pond or catchment basin must be designed for a 50-year storm. Systems which discharge directly into the ocean or streambed may be designed for a 10-year storm.) With the implementation of the planned developments, runoff to Ninole Stream is anticipated to increase from 92 cfs to 306 cfs, a 3 percent increase in the 10-year Ninole Stream peak storm flow (Ninole Stream 10-year storm flow = 6,900 cubic feet per second, see Section 2). Runoff from the lower areas toward the ocean is anticipated to increase from 100 cfs to 384 cfs.

The drainage plan for the resort will utilize as much as possible the scheme of swales and diversion ditches in open areas. Roadway culverts and catch basins will be constructed where necessary to provide for adequate drainage of paved areas. Storm runoff collected by these means will be ultimately discharged into the ocean.



LEGEND:

- ~~72~~ WATER SURFACE ELEVATIONS
- 100-YEAR FLOOD LIMIT
- COASTAL HIGH HAZARD
- → CFS 50-YEAR DRAINAGE FLOWS

SCALE IN FEET 200 0 200 600

FLOOD STUDY AND TSUNAMI INUNDATION MAP

Punalu'u Resort

KA'U, ISLAND OF HAWAII

APRIL 1988

pbr

TABLE 1.1

DRAINAGE DISCHARGE FOR PROPOSED DEVELOPMENT AREAS[1]

Discharge To	Drainage Area	Approx. Acreage	Discharge (cfs)[2] Existing	With Develop.	Increase
Ninole Stream[3]	Kalana I and II	79.3	97	306	209
	Ninole Bluffs	20	21	74	53
	SUBTOTAL	99.3	118	380	262
Ocean[4]	Colony II	4.9	6	22	16
	Village Center	21.7	26	93	67
	Central	86.2	68	269	201
	SUBTOTAL	112.8	100	384	284
TOTAL		212.1	218	764	546

(1) Does not include areas such as Colony I, Kalana I and Golf Holes 9 through 18 where drainage conditions will not change.
(2) Determined from "Storm Drainage Standards," Department of Public Works, County of Hawaii.
(3) Based on a 10-year storm event.
(4) Based on a 50-year storm event.

Surface water runoff can contain low concentrations of oil and grease washed off the roads during storms. In order to minimize the impact of these low concentrations on the water quality of the shoreline, catchment facilities will be constructed as part of the drainage system to remove the oil and grease before the runoff is discharged into the ocean.

The catchment facilities serving the Colony II, Village Center, and Central Area will be constructed at the downstream end of the drain line systems. They will be designed as large, irregularly-shaped depressions or basins on the edge of the golf course. Basin sizes will be designed and constructed to contain the runoff of a 50-year storm event. The basins will have an average depth of three feet. The catchment facility for the Kalana area will be constructed at two sites on the upstream side of the Hawaii Belt Highway, one on each side of Ninole Stream. The design of the two catchment basins is identical to one another. The basins will be circular, having a diameter of 300 feet and an averge depth of 5 feet. The basins will be grassed and integrated into the golf course grading plan. These basins will be dry during most of the year. However, during large storm events, stormwater runoff will flow through the drainage system and into the basins. Debris and oil will accumulate there and be removed by the golf course maintenance personnel.

A number of catchment schemes for the Colony II, Village Center and Central Area was examined to determine the most cost efficient alternative. The selected scheme is a two-basin scheme. Basin 1, located near Golf Hole 8, will receive runoff from Colony II, Village Center, and the majority of the Central area. Basin 2, located near Golf Hole 7, will serve the balance of the Central area.

Runoff collected in the basins will dissipate primarily by natural percolation into the porous lava subsurface. For storms larger than the 50-year storm event, part of the stormwater will flow out of the basin, into swales, and downslope toward the ocean.

In the case of Basin 2, excess runoff will flow through an existing culvert and into Punaluu Lagoon. For the worst case situation where all of the 50-year storm runoff discharges into the lagoon, a maximum ten-inch rise in water level will occur within the lagoon, assuming no losses by percolation.

The two other existing culverts will not be integrated into the future drainage system. The culvert in Punaluu Beach County Park will be abandoned in place. The culvert near Ninole Cove will also be abandoned in place to prevent runoff from ultimately entering into an existing coastal pond.

SECTION 2
NINOLE STREAM FLOOD STUDY

2.1 Purpose of Study

Portions of Ninole Stream experienced flooding in 1979, 1981 and 1982. As a result, Ninole Cove has been filled in with sedimentation primarily due to the 1981 storm. The Hawaii County Floodway Boundary and Floodway Maps designate a floodway through a portion of the resort. FIRM maps further designate the floodway with zones A3, A5, B and C. Zones A3 and A5 are special flood hazard areas inundated by the 100-year flood with average flood depths of 1.5 feet and 2.5 feet, respectively. Zone B is defined as an area between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. Zone C is defined as areas of minimal flooding. However, this study did not evaluate the entire reach of the stream through the project site. Continuation of the flood study through the project site is necessary to establish the stream flood limits. The flood boundaries will be used to define the limits of the proposed resort improvements and determine where flood prevention improvements are required. The local drainage plan of the resort will also be coordinated with the floodway boundaries.

The purpose of this flood study was to predict the limits of flooding within the resort in order to determine if any further flood mitigating measures are required. Hydrologic and hydraulic analyses of Ninole Stream were prepared by the Federal Emergency Management Agency (FEMA) in 1982. (Reference: "Flood Insurance Study, Hawaii County, Hawaii," Federal Emergency Management Agency, February 1, 1982). However, the study was limited to only the lower 2,300 feet of the stream from Ninole Cove to the maintenance area.

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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

100 YEAR FLOOD = 10,800

SUMMARY PRINTOUT

	SECNO	ELMIN	CWSEL	CRIWS	QLOB	QCH	QROB	VCH	SSTA	ENDST	STCHL	STCHR	10K*S
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	600.000	330.00	344.71	348.45	72.12	10726.61	1.27	27.05	78.65	239.42	192.00	238.00	483.81
	550.000	294.00	300.61	305.14	9.38	10789.11	1.50	37.17	62.49	150.98	68.00	150.00	2457.53
	500.000	285.00	295.30	295.67	4880.88	5487.56	431.56	16.06	20.32	304.10	235.00	275.00	143.12
	450.000	236.00	246.79	252.56	.00	10800.00	.00	37.72	119.85	169.24	116.00	184.00	1425.47
	400.000	162.00	172.46	175.38	320.73	10472.69	6.57	24.22	103.00	189.47	130.00	188.00	397.90
	370.000	145.00	151.28	153.97	4018.50	6773.46	8.04	29.17	197.90	362.57	310.00	360.00	812.14
	340.000	127.00	134.90	136.93	2421.27	8323.12	55.61	27.07	442.42	761.43	710.00	758.00	450.85
	335.000	124.00	132.43	133.93	3283.75	7499.33	16.92	24.35	108.58	582.93	530.00	580.00	399.43
*	325.000	120.00	136.97	136.97	3705.39	7094.61	.00	11.12	225.60	681.45	630.00	682.00	409.25
*	315.000	120.00	136.97	136.97	3705.39	7094.61	.00	11.12	225.60	681.45	630.00	682.00	409.25
	305.000	119.00	127.74	129.30	3853.75	6946.25	.00	22.97	206.97	567.41	500.00	572.00	442.55
	250.000	118.00	122.15	123.47	8929.13	1870.86	.00	13.89	202.56	632.92	580.00	646.00	338.45
*	200.000	109.00	118.80	118.80	6387.80	4412.20	.00	11.68	98.41	492.07	438.00	494.00	80.83
	170.000	105.00	111.69	112.90	6092.87	4692.54	14.59	19.01	272.45	576.73	525.00	572.00	295.53
*	150.000	102.00	109.01	109.01	1150.53	9551.45	98.03	8.24	102.36	796.04	430.00	780.00	101.03
	130.000	97.00	103.02	104.00	.00	10715.50	84.50	10.32	579.29	1021.34	550.00	1010.00	238.95

SECNO	ELMIN	CWSEL	CRIWS	QLOB	QCH	QROB	VCH	SSTA	ENDST	STCHL	STCHR	10K*S
120.000	81.00	94.75	95.02	.00	10705.86	94.14	11.06	730.15	1346.17	680.00	1340.00	290.25
100.000	72.00	79.91	81.46	344.59	8660.12	1795.28	20.88	1108.73	1289.56	1125.00	1185.00	242.66
95.000	56.00	58.98	60.00	.00	7795.37	3004.63	17.58	1312.55	1622.36	1310.00	1465.00	541.78

This study determined the peak storm discharges for Ninole Stream at Ninole Cove for the following flood recurrence intervals:

10 year	6,900 cfs
50 year	9,200 cfs
100 year	10,800 cfs
500 year	14,800 cfs

2.2 Study Methodology

2.2.1 Study Techniques

There are several acceptable techniques for computing flood flows and flood elevations. To be consistent with flood limits determined for the lower reach of Ninole Stream, the FEMA analytical procedures were used for this study in lieu of other acceptable techniques. (Note: In general, the FEMA procedures are more conservative than the other techniques and result in higher flood elevations and limits.) The FEMA analytical techniques and definitions are described below.

A. 100-Year Flood

A flood event of a magnitude expected to be equalled or exceeded once (on the average) during any 100-year period, commonly termed a 100-year flood, has a 1 percent chance of being equalled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods, rare floods could occur at short intervals or even with the same year. The 100-year flood was chosen for analysis because of its significance for flood plain management and for flood insurance premium rates.

B. Hydrologic Analysis

Hydrologic analysis was carried out to establish the peak discharge-frequency relationship for the selected flood recurrence interval of 100 years. The multiple regression technique was used to develop the relationship between pertinent

characteristics for the gaging station flood-frequency curves and basin and climatological characteristics. The station flood-frequency curves were determined using the procedures outlined in the Water Resources Council Bulletin No. 17, "Guidelines for Determining Flood Flow Frequency," Washington D.C., March 1976. A generalized skew coefficient of -0.05 was used. Discharge was correlated to various basin and climatological characteristics using a regression equation of the form:

$$Q_{100} = 34.3 \times (DA)^{0.77} \times (P24\text{-}2)^{2.26}$$

Where, DA = drainage area (sq. mi.)
P24-2 = 2-year 24-hour precipitation

Regression constants were computed by the method of least squares. Statistical tests were made to eliminate those basin and climatological characteristics that had little or no significance. The most significant characteristics for the Kau area were found to be drainage area (DA) and the 2-year 24-hour precipitation (P24-2). The resulting 100-year discharge from the regression equation for the Ninole Stream drainage area of 21.47 square miles was 10,800 cubic feet per second (cfs). All hydrologic information and results were obtained directly from the following reference: "Flood Insurance Study," Hawaii County, Hawaii, Federal Emergency Management Agency, Community Number - 155166, February 1, 1982.

C. Hydraulic Analysis

Hydraulic analysis was performed to provide estimates of flood elevations along the stream. The Army Corps of Engineers (COE) HEC2 step-backwater computer program was used in calculating water-surface elevations for the selected recurrence interval of 100 years.

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 IBM-PC-XT VERSION
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C
T1      WINOLE STREAM
T2      NATURAL PROFILE - SUPERCRITICAL
T3      100 YEAR FLOOD = 10,800 (CFS WINOLE COVE CONFLUENCE)

J1 ICHECK    INQ     NINV     IDIR     STRT    METRIC   HVINS     Q       WSEL      FQ

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J3 VARIABLE CODES FOR SUMMARY PRINTOUT

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J5 LPRNT   NUMSEC            ********REQUESTED SECTION NUMBERS********

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PROFILE FOR STREAM 100 YEAR FLOOD = 10,800

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PLOTTED POINTS (BY PRIORITY)-+-ENERGY,W-WATER SURFACE,I-INVERT,C-CRITICAL W.S.,L-LEFT BANK,R-RIGHT BANK,M-LOWER END STA

ELEVATION       0.     40.     80.    120.    160.    200.    240.    280.    320.    360.
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           2000.  .       .       .     - .       .       . I WC E.       .       .   M   .       .
           2400.  .       .       .       .       .    I LW. E    .       .       .  M    .       .
 [illegible] 2800.  .       .       .       .       .I WCE  .       .       .       . M     .       .
   370.00  3200.  .       .       .       .    ILW EM     .       .       .       .       .       .
   340.00  3600.  .       .       .       . ILW E   M     .       .       .       .       .       .
   335.00  4000.  .       .       .       .I W E  .       .       .       .       .       .       .
   325.00  4400.  .       .       .       I  WELRM.       .       .       .       .       .       .
   315.00  4800.  .       .       .       I  WELRM.       .       .       .       .       .       .
   305.00  5200.  .       .       .       I WE   M.       .       .       .       .       .       .
   250.00  5600.  .       .       .       IWER M  .       .       .       .       .       .       .
   200.00  6000.  .       .       .    I LE M     .       .       .       .       .       .       .
   170.00  6400.  .       .       .   ILWEM       .       .       .       .       .       .       .
   150.00  6800.  .       .       .   IE M.       .       .       .       .       .       .       .
   130.00  7200.  .       .       .  IRE  .       .       .       .       .       .       .       .
   120.00  7600.  .       .       I REM   .       .       .       .       .       .       .       .
   100.00  8000.  .       .    ILWE M     .       .       .       .       .       .       .       .
    95.00  8400.  .       .  IWE  . M     .       .       .       .       .       .       .       .
```

Parameters for the HEC2 program, such as channel roughness coefficients and cross-section geometry, were obtained from photographs of similar streams and from topographic maps. Manning's n values used for the channel varied between 0.40 and 0.45. Manning's n values for overbank areas reflected flow obstructions (such as overgrowth, trees, and buildings) and ranged from 0.035 to 0.120. The Hawaii Belt Road bridge configuration was established from record drawings. The flow regime for the entire reach was assumed supercritical. The starting water surface elevation was therefore assumed to be at critical depth. The HEC2 data file used in the RMTC study segment (upstream of the COE study segment) and the corresponding HEC2 program results are attached at the end of this section.

D. Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gains from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Areas of hazardous velocities are also considered as part of the floodway. Minimum standards of the Federal Emergency Management Agency (FEMA) limit such increases in flood heights to 1.0 foot, provided hazard velocities are not produced. The floodway in these studies were computed on the basis of equal conveyance reduction from each

side of the flood plain. The floodway fringe is the area between the floodway and the extents of the flood. The floodway fringe includes the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot.

2.2.2 FEMA Flood Limits

The FEMA study referenced earlier predicted the limits of the 100-year flood along Ninole Stream from Ninole Cove to approximately 2,300 feet upstream. The significance of the 100-year flood is that it is used as the national base flood for purposes of flood plain management. The study used standard hydrologic and hydraulic methods in order to satisfy Federal Management Emergency Agency (FEMA) Flood Insurance Study (FIS) requirements. Backwater computations for flood water elevations and floodway widths were done using the Corps of Engineers HEC2 computer program. The calculations attached to the end of this section provide additional information on the engineering study methods used. The same methods were used to extend the flood study limits along the stream reach from the limit of the earlier FEMA study, through the project site, to 3,300 feet above the Hawaii Belt Highway. The 100-year peak discharge of 10,800 cfs as determined by the FEMA study was also used in this study. This peak represents flow from the entire Ninole Stream drainage area of 21.47 square miles. Generally, 100-year flood limit includes boundaries for floodway and floodway fringe areas. Briefly, the floodway is that portion of the flood area that conveys flow. There are strict provisions imposed by the Flood Insurance Agency (FIA) regarding development within the floodway. The floodway fringe encompasses the area between the floodway boundary and the flood extents. The floodway fringe usually contains areas of ponding and shallow flooding. The 100-year floodway boundary is, in this case, taken to be the same as the 100-year floodway fringe boundary.

The predicted limits of the 100-year flood is shown in the body of the EIS. The study results indicate moderate flooding will occur in the lower reaches of the stream, inundating the driving range and a portion of the golf course. The clubhouse should not be affected except for a section of

HEC-2 DATA
Sht 3 of 3

X1	120	22	680.0	1340.0	340.0	350.0	340.0	0	0	0
X3	10									
GR	100	0	94	15	94	40	94	145	92	400
GR	94	600	92	635	96	680	93	800	94	910
GR	95	1110	96	1175	95	1200	96	1245	94	1260
GR	90	1280	82	1295	81	1305	82	1320	84	1330
GR	90	1340	100	1353						
NC	0.060	0.120	0.040							
X1	100	23	1125.0	1185.0	540.0	650.0	600.0	0	0	0
X3	10									
GR	90	0	91	100	92	190	92	370	92	440
GR	90	510	90	570	91	730	90	830	88	910
GR	86	1050	84	1090	86	1100	81	1108	78	1110
GR	76	1125	74	1135	72	1145	72	1165	74	1185
GR	78	1280	80	1290	90	1310				
NC	0.060	0.060	0.040							
X1	095	43	1310.0	1465.0	0	0	0	0	0	0
X3	10									
GR	90	0	86	- 30	84	75	82	90	80	132
GR	80	170	82	265	84	400	87	460	82	525
GR	80	555	78	640	76	680	74	695	74	730
GR	76	745	76	775	72	800	74	840	72	900
GR	70	975	69	1000	68	1030	66	1115	64	1145
GR	62	1155	60	1160	58	1164	56	1175	55	1190
GR	56	1200	56	1230	56	1290	60	1310	56	1320
GR	56	1465	58	1475	60	1490	56	1515	56	1560
GR	58	1615	60	1630	90	1810				
EJ										

ER

the parking lot near the stream bank. The proposed Colony II development is within the floodway fringe. Upstream of the maintenance area, the floodway widens along the eastern overbank with floodway fringe limits extending well into the golf course. The Ninole Bluffs development located on the other overbank will not be affected. The bridge at Hawaii Belt Highway serves as a flow obstruction resulting in inundation of a 300-foot segment along the highway at its low point about 250 feet northwest of the bridge. The lowest parcels (zoned for single-family) just upstream of the highway may also experience some flooding due to this obstruction. However, only a fraction of the lot area will be affected. Maximum flood depths of 6 inches are estimated. Upstream of this area, the floodway is generally confined to the channel with the floodway fringe reaching limited overbank areas. Regions of inundation would involve only golf course areas.

There are two approaches in dealing with flood hazards. The most economical is by imposing flood plain management guidelines. For example, having restricted development within the floodway will reduce the chances of flood related injury and damage. The second way is by utilizing flood protection structures. The most common methods of minimizing stream flooding by this approach include channel widening and lining, retaining structures (earthen or masonry berms or walls), and retention ponds. For Ninole Stream, crushed rock masonry berms 6 to 8 feet high along raised banks would be sufficient to contain the 100-year flood for most of the reach. A more detailed study analysis would be needed for design and costs. Placement of such a berm may be necessary in the reach between the Hawaii Belt Highway and the maintenance shop area to insure flooding does not occur over the golf course. Flooding of the Hawaii Belt Highway may be difficult and costly to prevent and may require raising of the roadway and/or bridge widening.

2.3 Completed Flood Improvement Projects

Several channel improvements were recently completed to mitigate flooding. Berms were installed between the maintenance area and Aspen Institute to contain the flood. Finally, a portion of the stream mauka of the highway was widened and deepened to mitigate flooding of the lower lots.

Considerable work was done on Ninole Stream in 1972 when the golf course was built. The streambed was widened and deepened at many locations from the highway to Ninole Cove. A debris basin was constructed upstream of the maintenance building to capture large boulders, trees, and sediment. These large objects have a potential for inflicting major damage as they are swept along with the flood.

A berm of armor stone was constructed along the eastern bank from the Ninole Cove outlet to just below the 10th green. Near the maintenance building, large armor stone berms were installed on both banks of the stream. Earth berms were erected on the eastern bank from the 10th green along the golf fairways below the highway. After the storms of 1981 and 1982, the streambed was widened and deepened from the highway to the 14th green. The east bank near the 14th green was reinforced with large boulders set in concrete. A temporary berm was erected to divert sheet flow off of the Colony II parcel.

Many measures have been taken with the result that floods have been generally restricted to the golf course and as the analysis shows existing and planned development are not expected to be subject to flooding.

HEC-2 DATA
Sht 1 of 3

```
ED  NO    YES
C
C    20
C   650        UPPER LIMIT OF SUBDIVISION
C   600
C   550
C   500
C   450
C   400
C   370
C   340
C   335        ABOUT 1 WIDTH UPSTR. OF STATE HWY BR.
C   325        UPSTR. EDGE OF STATE HWY. BR.- NORMAN BR. XSEC
C   315        DWNSTR. EDGE OF STATE HWY BR.- NORMAL BR. XSEC
C   305        ABOUT 4 WIDTHS DWNSTR. OF STATE HWY BR.
C   250
C   200
C   170
C   150
C   130
C   120
C   100
C   095        AT END OF PREVIOUS FIS STUDY
T1      MINDLE STREAM
T2      NATURAL PROFILE - SUPERCRITICAL
T3      100 YEAR FLOOD = 10,800 (CFS MINDLE COVE CONFLUENCE)
J1   -10      2      0      1     -1      0      0      0  367.0      0
J2    -1      0     40      0    400      0     -1
J3    38     42      1      2     13     14     15     26     53     54
J3    21     22      5
J5    -1    -10
NC  .060   .060   .045   0.60   0.80
QT     1  10800
X1   650     10  338.0  422.0  310.0  310.0  350.0      0      0      0
GR   370      0    368    150    366    196    364    268    362    338
GR   360    360    356    382    360    390    368    422    370    430
X1   600     16  192.0  238.0  300.0  300.0  300.0      0      0      0
GR   350      0    348     12    346     36    344    102    344    114
GR   346    144    346    184    344    192    332    214    330    220
GR   330    224    340    234    344    238    346    242    348    254
GR   350    284
X1   550     15   68.0  150.0  200.0  220.0  260.0      0      0      0
GR   310      0    308     18    306     28    304     40    302     50
GR   300     68    298    104    296    116    294    134    294    144
GR   300    150    310    166    314    174    318    190    320    208
X1   500     11  235.0  275.0  390.0  600.0  550.0      0      0      0
GR   298      0    294     30    292    100    292    170    290    210
GR   290    235    286    245    285    250    286    265    290    275
GR   300    330
NC 0.035  0.060  0.045
X1   450     14  116.0  184.0 1110.0 1120.0 1130.0      0      0      0
GR   270      0    268     36    268     58    266     72    260     96
GR   250    116    240    128    236    140    240    150    252    184
GR   254    234    252    250    250    252    248    280
X1   400     19  130.0  188.0  340.0  300.0  335.0      0      0      0
GR   180      0    180     20    180     34    178     62    174     86
GR   170    130    168    138    162    148    162    166    170    188
GR   180    194    190    218    196    232    196    272    194    290
GR   192    304    192    354    192    390    190    412
NC 0.035  0.060  0.040
```

HEC-2 DATA
Sht 2 of 3

```
X1   370     10  310.0  360.0  260.0  330.0  290.0      0      0      0
GR   164      0    156     45    154    130    150    230    148    310
GR   146    318    145    330    146    342    150    360    170    400
X1   340     16  710.0  758.0   70.0   70.0   70.0      0      0      0
GR   160      0    158     10    154     25    150     95    140    120
GR   138    130    136    240    134    610    134    675    132    700
GR   130    710    127    735    130    758    140    765    146    775
GR   160    818
X1   335     14  530.0  580.0   43.0   43.0   43.0      0      0      0
GR   140      0    138     36    136     50    134     68    132    120
GR   131    432    132    512    130    530    124    550    124    562
GR   130    580    140    592    150    606    160    636
NC  .070   .070   .080
X1   325     30  630.0  682.0   25.0   25.0   25.0      0      0      0
BT    10  630.0  142.0  139.0  646.0  143.0  140.0  646.1  143.0  140.0
BT 646.9  143.0  140.0  647.0  143.0  140.0  664.0  145.0  142.0  664.1
BT 145.0  142.0  664.9  145.0  142.0  665.0  145.0  142.0  682.0  146.0
BT 143.0
GR   150      0    140    165    136    245    134    310    136    520
GR   138    560    140    600    142    630    139    630    125    632
GR   123    637    122    645    126    646    140  646.1    140  646.9
GR   126    647    120    648    120    663    126    664    142  664.1
GR   142  664.9    126    665    125    673    132    678    132    681
GR   143    682    146    682    147    690    150    745    160    895
X1   315      0                45.0   45.0   45.0      0      0      0
X2                                              1
NC  .035   .060   .040
X1   305     20  500.0  572.0  170.0  140.0  135.0      0      0      0
GR   150      0    148     60    142     90    140    100    132    130
GR   130    150    128    205    126    220    126    370    128    435
GR   128    490    129    500    128    510    124    518    120    535
GR   119    545    120    550    128    568    130    572    150    695
X1   250     19  580.0  646.0  400.0  410.0  410.0      0      0      0
GR   150      0    146     70    143     80    140    150    140    150
GR   138    160    130    190    120    206    118    210    118    224
GR   120    360    122    394    124    492    125    548    124    580
GR   118    606    118    626    130    646    140    676
X1   200     16  438.0  494.0  250.0  210.0  220.0      0      0      0
GR   126      0    123     28    123     45    123     90    118    100
GR   116    170    116    264    116    416    116    434    116    438
GR   110    454    109    466    110    478    120    494    130    516
GR   140    542
X1   170     17  525.0  572.0  270.0  230.0  235.0      0      0      0
GR   120      0    114     10    114     50    113    150    113    200
GR   113    220    111    300    108    525    108    528    106    535
GR   105    545    106    560    108    568    110    572    120    600
GR   122    618    128    635
X1   150     18  430.0  780.0  345.0  300.0  330.0      0      0      0
X3    10
GR   116      0    112     45    110     90    108    115    108    350
GR   109    430    106    490    104    640    106    680    108    730
GR   108    738    108    745    102    750    104    775    106    780
GR   108    792    110    800    120    820
X1   130     24  550.0 1010.0  290.0  280.0  300.0      0      0      0
X3    10
GR   102      0    100     30     98    205     97    250     98    310
GR    98    335     97    350     98    370     98    400    104    550
GR    99    700     99    750    100    800    102    845    103    890
GR   102    920    100    972     98    980     97    990     98   1000
GR   100   1010    104   1025    110   1045    120   1075
```

Appendix F: Current And Circulation Investigations—Punalu'u Harbor And Ninole Cove

CURRENT AND CIRCULATION INVESTIGATIONS
PUNALU'U HARBOR AND NINOLE COVE
ISLAND OF HAWAII

Prepared for
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Pahala, Hawaii

Prepared by
Sea Engineering, Inc.
Waimanalo, Hawaii

September 1986

I. STUDY AREA LOCATION AND GENERAL DESCRIPTION

Punalu'u Harbor and Ninole Cove are located on the southeast coast of the island of Hawaii, as shown on Figure 1. The shoreline along this coast is very irregular, with steep rocky volcanic terraces dropping abruptly into the sea. Punalu'u Harbor is bounded by low rocky terraces on both sides, and numerous lava rock shoals and boulders, many of which bare at low tide, form an irregular natural breakwater along the south side of the cove. The harbor bottom is composed of rocks, cobbles and boulders, with thin patches of medium to coarse volcanic sand. A relatively stable beach composed of volcanic sand forms the interior shoreline of the harbor. This approximately 800 foot long arcuate pocket beach has been reported to experience little change during the year (Ref. 1). The physical characteristics of Punalu'u Harbor and beach are illustrated on Figure 2. Water depths on the southwest side of the harbor are 2 to 5 feet, with a deeper channel extending along the northeast side of the harbor.

The Ninole Cove area is approximately 3,000 feet southwest of Punalu'u Harbor. This narrow rocky cove extended inland over 500 feet, however it was completely filled with earth, sand, rocks and boulders during a flash flood of Ninole Stream in 1980.

The shoreline in the study area is noted for its considerable fresh water outflow all along the shore. Fresh water can be seen seeping from the shore in Punalu'u Harbor and Ninole Cove, and the cold water is readily felt by swimmers in the nearshore area.

During the field investigations the currents in the study area were discussed with local residents, fishermen and boaters, and the measured nearshore and offshore currents and circulation patterns were in close agreement with what "local knowledge" said they would be. The measured offshore coastal currents, with an apparent net transport to the south, is also in agreement with previous studies and existing information.

The analysis of nearshore sediment samples shows that the material is sand sized or larger, with no evidence of silts or mud in the nearshore zone. This is consistent with the fact that the study area is a reasonably high wave energy environment which makes it difficult for fine material to settle, and nearshore currents are sufficient to move the suspended fines offshore where they are rapidly dispersed by the coastal currents. Thus it is probable that any turbidity generated by work in the nearshore zone or on the shoreline in either Punalu'u Harbor or Ninole Cove would be rapidly flushed seaward and dispersed over a wide area.

VI. REFERENCES

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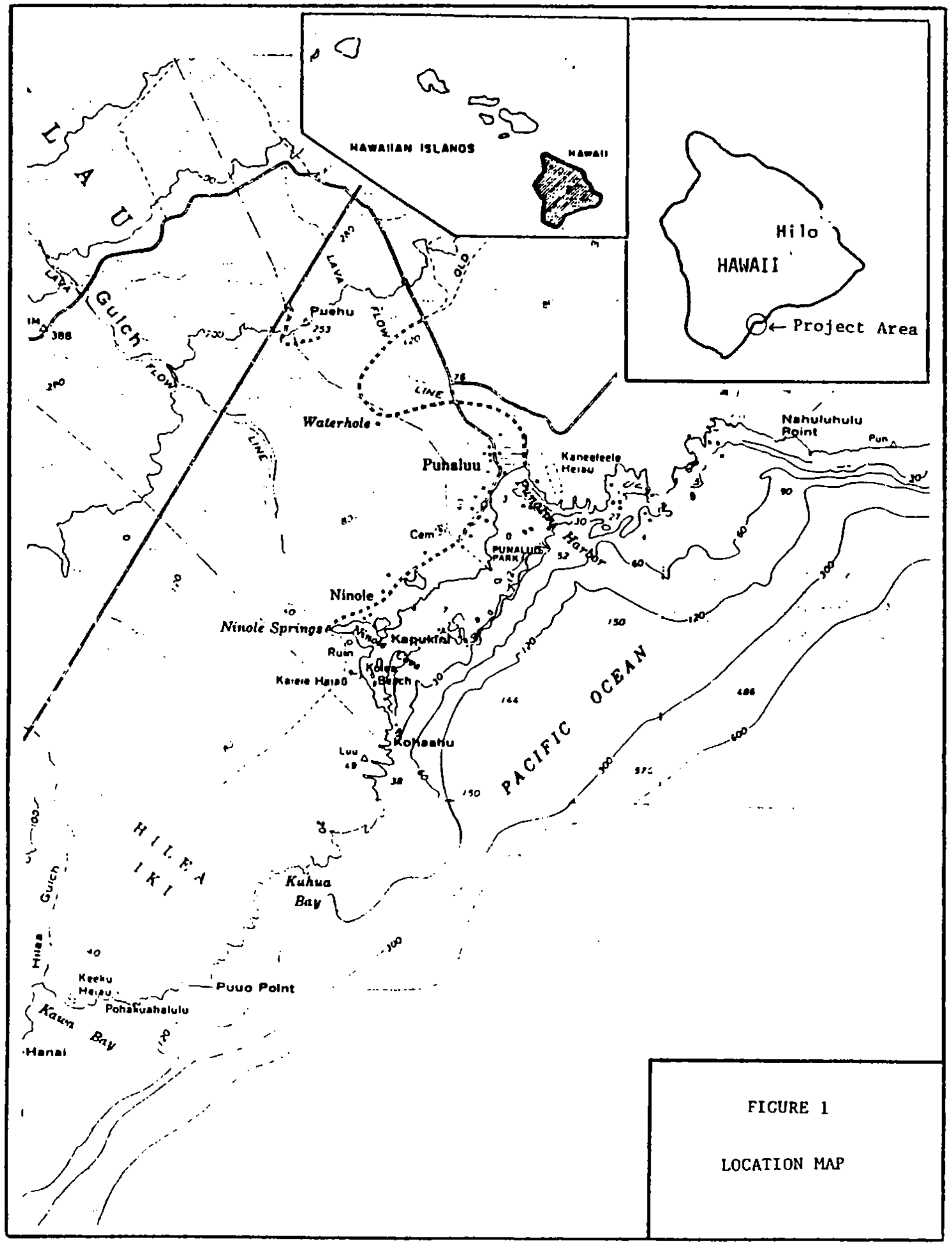

FIGURE 1

LOCATION MAP

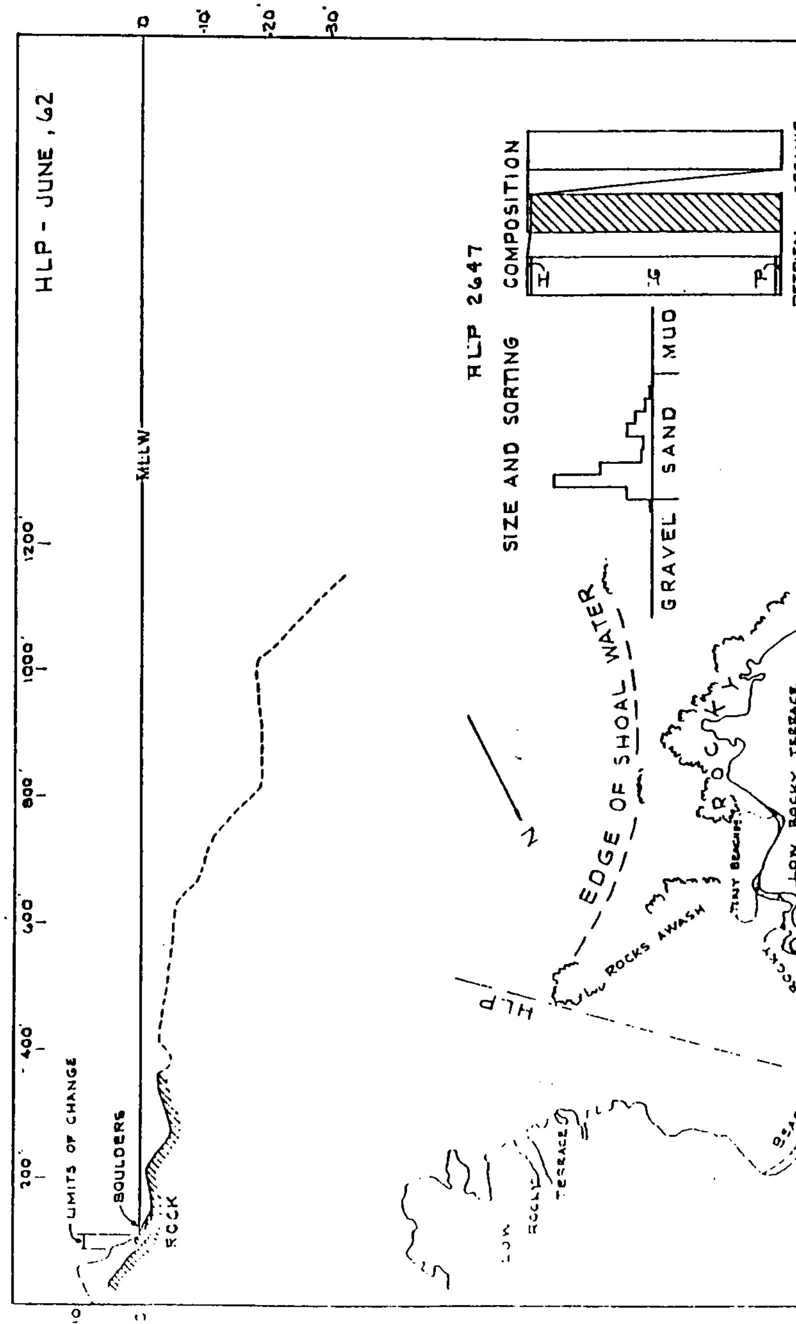

FIGURE 2
GENERAL STUDY AREA
PHYSIOGRAPHY
(from Ref. 1)

very far outside of the small embayment which forms Punalu'u Harbor.

The nearshore currents and circulation system in the vicinity of Ninole Cove is also wave-driven. The orientation of the shoreline and direct exposure to the prevailing incident wave approach, and the small islands and shoal areas offshore, most of which are awash at high tide, results in considerable surf along the shore the majority of the time. During the field investigations, current drogues and dye patches moved along the shore and out a rip current through the surf beside the larger of the offshore islands. After moving through the nearshore breakers the drogues moved rapidly seaward, and curved south as they became entrained by the southward flowing flood tide coastal currents. There was considerable wave action in the vicinity of Ninole Cove during the three days of field investigations, in spite of the fact that the tradewinds were light to moderate, thus it seems likely that there is generally sufficient wave action to result in good circulation and flushing of the nearshore waters in this area.

The offshore coastal currents were found to vary in both speed and direction with the tide. During the flood tide there was strong surface flow to the southwest at 10 to 15 cm/sec (0.25 knots), and a weaker 5 cm/sec (0.1 knots) subsurface flow also to the southwest. The surface flow is presumably partially wind-driven by the prevailing tradewinds from the northeast. The ebb tide flow was weaker, generally setting to the southeast through southwest on the surface with speeds of 5 to 15 cm/sec (0.1 to 0.25 knots). The ebb tide subsurface flow was easterly, also at speeds of 5 to 15 cm/sec. The ebb tide currents were particularly weak seaward of Ninole Cove, and an onshore (west) set to the currents was measured. During both flood and ebb tide the current flow in Punalu'u Harbor was seaward out the channel on the northeast side at speeds up to 45 cm/sec (0.9 knots) where it merged with the coastal current. A generalized circulation pattern for the study area is shown on Figure 15.

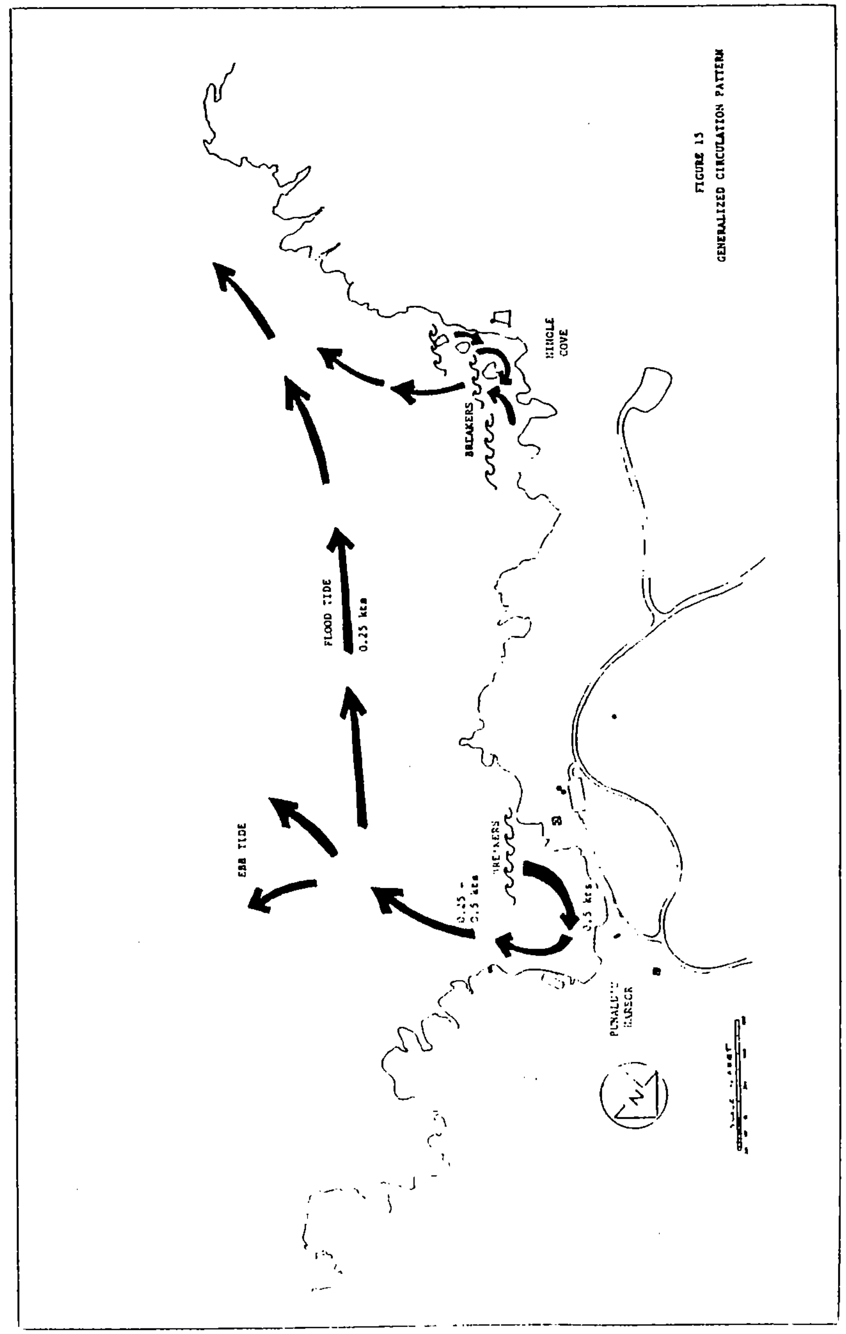

FIGURE 15
GENERALIZED CIRCULATION PATTERN

II. GENERAL OCEANOGRAPHIC PARAMETERS INFLUENCING CURRENTS AND CIRCULATION IN THE PROJECT AREA

WIND

The climate in Hawaii is characterized by two distinct seasons, primarily defined by the annual variation in persistence of the northeast tradewinds. During the summer months of about May through September, the tradewinds predominate, blowing out of the northeast 80 to 90 percent of the time with speeds generally from 10 to 25 mph. The winter season, from about November through March, is characterized by a weakening of the tradewind persistence and the occurrence of southerly or westerly winds as a result of localized low pressure and frontal system. The months of October and April are generally considered transitional periods between seasons. The mean monthly frequency of tradewind occurrence in Hawaiian waters is shown below (from Ref. 2).

MONTH	PERCENT (%)
January	42
February	55
March	61
April	74
May	86
June	91
July	95
August	94
September	83
October	71
November	64
December	57
ANNUAL	65

"Wind speeds off East Hawaii are relatively lighter than over the open ocean for about 15 miles seaward from the northern slopes of Mauna Kea to south of Hilo. The minimum wind speed is centered in Hilo Harbor. The probable cause of this lessening of speeds near

the east coast is that the trades flowing in perpendicular to the coast, is slowed with the massive mountains, Mauna Kea and Mauna Loa, acting as physical barriers to the perpendicular wind flow at the coast." (Ref. 2) Typical moderate tradewind patterns off east and south Hawaii are shown on Figure 3.

Winds in the immediate study area are also influenced by land/sea breezes generated by the temperature differential between land and sea. The diurnal heating and cooling of the land causes an onshore wind during the day and an offshore wind at night. "All along the eastern shores of the Big Island, the sea breeze reinforces the trade wind flow up the slopes of the dominating mountains: Kohala Mountains, Mauna Kea and Mauna Loa. This uplift of the air produces afternoon cloudiness and showers. At night, the land breeze opposes the trades over land or offshore." (Ref. 2) The land/sea breezes are not strong, however, and their circulation does not extend very far inland or over the ocean.

WAVES

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, Kona storm waves and North Pacific swell. These wave types and their general approach directions are shown on Figure 4. Waves are considered to be in deepwater, and thus unaffected by the bottom, when the water depth is equal or greater than one-half the wave length.

Tradewind waves may be present in Hawaiian water throughout most of the year, but are most frequent between April and September, the summer season, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typically, the deepwater tradewind waves have periods of 6 to 8 seconds and heights of 4 to 10 feet.

South swell is generated by southern hemisphere storms and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest,

Depth (ft)	Salinity (°/oo) STA. 1	STA. 2	STA. 3
1	33.2	33.6	34.5
5	33.4	33.8	34.5
10		34.1	34.5
20		34.5	35.0
30		34.5	35.0

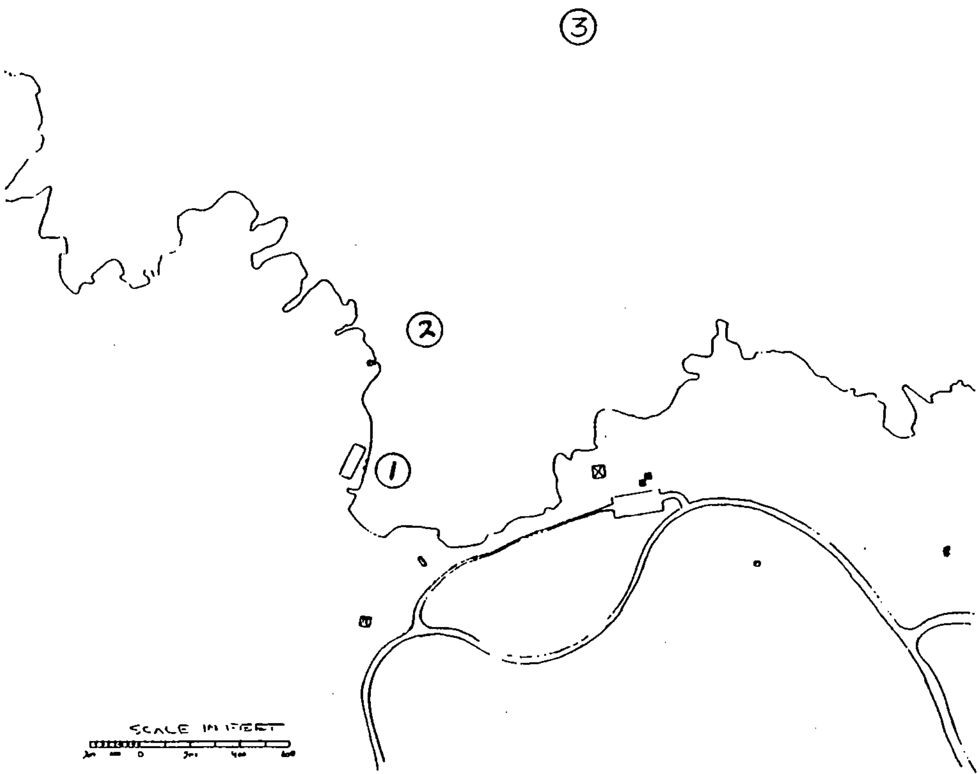

FIGURE 14

SALINITY STRATIFICATION
IN THE VICINITY OF PUNALU'U HARBOR
Sept. 2, 1986 - FLOOD SLACK TIDE

V. DISCUSSION AND CONCLUSIONS

The nearshore current and circulation pattern in Punalu'u Harbor is primarily wave-driven. Waves breaking on the shallow shoal area on the southwest side of the harbor result in a mass transport of water shoreward over the shoal which is relieved by a clockwise flow along the beach and out the deeper channel on the northeast side of the harbor. This circulation pattern is the result of several factors. First, the prevailing waves from the east and south approach so as to make a breaker angle favorable to the clockwise flow. Secondly, the waves break at a greater distance offshore at the southwest side of the harbor, producing a wave setup induced water surface elevation differential which is also favorable to a clockwise circulation pattern. Thirdly, the deeper water on the northeast side of the harbor provides an easier path for the return flow seaward than does the shoal area on the southwest side. The study area is directly exposed to the prevailing tradewind generated waves and south swell, as well as to some portion of northerly and southwesterly waves, thus the wave induced circulation system within the harbor is likely the typically prevailing condition. No variation in the current speed or circulation pattern within the harbor as a function of tide was observed during the field investigations, in spite of the fact that the tide range (about 2+ feet) was relatively large by Hawaii standards. Because there is generally always some wave action in the study area the circulation within the harbor should generally be good, with the current speed varying as a function of the incident breaker heights. The current speed along the beach is typically about 15 cm/sec (0.25 knots), increasing to 30 cm/sec or greater (0.5 knots) as it flows out the channel. The current setting out the channel moves rapidly seaward and is entrained by the offshore coastal currents. This circulation system within the harbor results in good flushing and a rapid turnover of the nearshore harbor waters. The salinity measurements also support the hypothesis of rapid mixing of the nearshore waters with the coastal water. The lowered surface salinity caused by fresh water inflow along the shore could not be traced

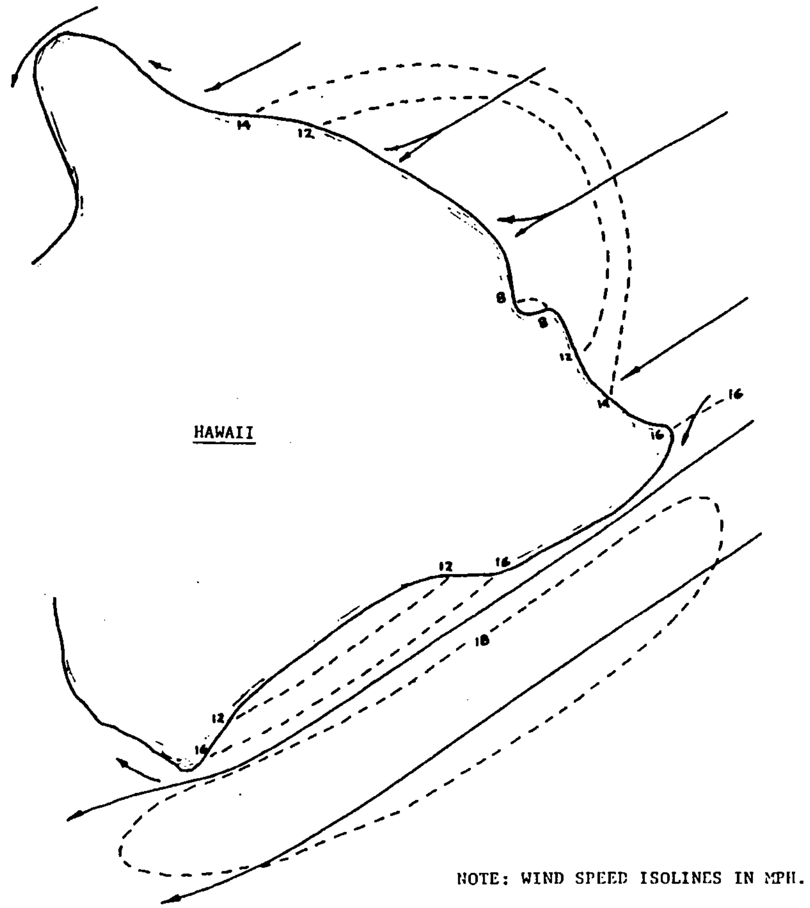

FIGURE 3

MODERATE TRADE WIND PATTERNS OFF
EAST AND SOUTH HAWAII (from Ref. 2)

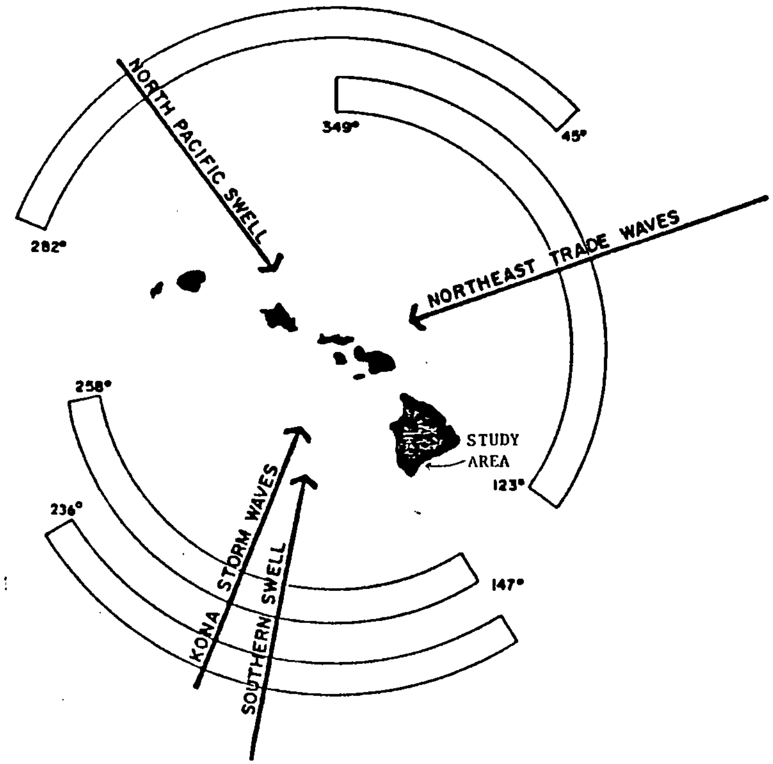

FIGURE 4

GENERALIZED WAVE TYPES

(Adapted From The Atlas of Hawaii)

TABLE 2

SAND GRAIN SIZE ANALYSIS

Sample Location	Grain Size Classification	Median Grain Size (mm)	Sorting
Punalu'u Hbr Offshore	medium to coarse sand	1.7	very well sorted
Punalu'u Hbr Nearshore	fine to very find sand	0.11	moderately well sorted
Punalu'u Hbr Swash Zone	fine to medium sand	0.4	very poorly sorted
Ninole Cove Swash Zone	medium sand	0.9	poorly sorted
Ninole Cove Backshore Fines	medium to coarse sand	0.75	very poorly sorted

SALINITY STRATIFICATION

There is considerable fresh water inflow into the nearshore waters of the study area, and this fresh water surface layer makes an excellent tracer to estimate the transport, mixing and dilution of nearshore water with the offshore coastal waters. Salinity was measured in the field using a Beckman RS5-3 Portable Salinometer. Salinities as low as about 27‰ were measured in the harbor waters near shore. On September 2, 1986, during the approximate flood slack tide, salinity profiles were taken at three locations: 1 - inside the harbor in the channel on the northeast side, 2 - just outside the harbor entrance, and 3 - offshore. These profile stations and the salinity profiles are shown on Figure 14.

with periods of 12 to 20 seconds and deepwater heights of 1 to 6 feet.

Kona waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and heights up to 10+ feet. These waves approach from the south to west, with the largest waves usually from the southwest. Deepwater wave heights during a severe Kona storm in January 1980 were about 17 feet with a period of 9 seconds.

North Pacific swell is produced by severe winter storms in the Aleutian area of the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year but is largest and most frequent during the winter months of October through March. North or northeast swell is sometimes generated by winter storms northeast of the islands. North Pacific swell typically has periods of 12 to 20 seconds and heights of 5 to 15 feet.

These general deepwater wave types follow different paths to reach the study area. Waves from the north and west diffract and refract around the islands, with only a portion of their deepwater energy generally reaching the study area. Tradewind waves and south swell, on the other hand, approach the study area directly. Based on Marine Advisors (Ref. 3) data for the ocean sector from the Northeast (57°) clockwise to the southwest (236°), typical (statistical) deepwater wave characteristics offshore of the study area are estimated as follows:

	Frequency of Occurrence (%)	Wave Height (feet)	Wave Period (sec)	Wave Direction (°TN)
Tradewind Waves	68	5	9	90
North Pacific Swell	22	8	12	90
Kona Storm Waves	8	4	6	180
South Swell	53	3	13	190

In addition to the primary wave types, infrequent tropical storms and hurricanes may generate large waves which affect the east coast of Hawaii.

Deepwater waves moving toward the project site are primarily altered by refraction as they pass over changing bottom contours, shoaling as they move from deep to shallow water, and ultimately by breaking. Deepwater waves with given characteristics will propagate toward shore until the water depth becomes shallow enough to initiate breaking. The maximum breaker height in shallow water is a function of (1) the water depth; (2) the bottom slope; and (3) the incident wave height and period (steepness). The large waves will break some distance offshore, then reform and continue shoreward as smaller, shorter period waves until they also break.

TIDE

Tides in the vicinity of the Hawaiian Islands are generally semi-diurnal with a pronounced diurnal inequality (i.e. two high and two low tides each 24-hour period, with markedly different elevations). Tides at Honuapo Bay, 5 miles southwest of the study area, are reported as follows (Ref. 4):

Mean Higher High Water	2.5 feet
Mean High Water	2.0
Mean Tide Level	1.1
Mean Low Water	0.3
Mean Lower Low Water	0.0

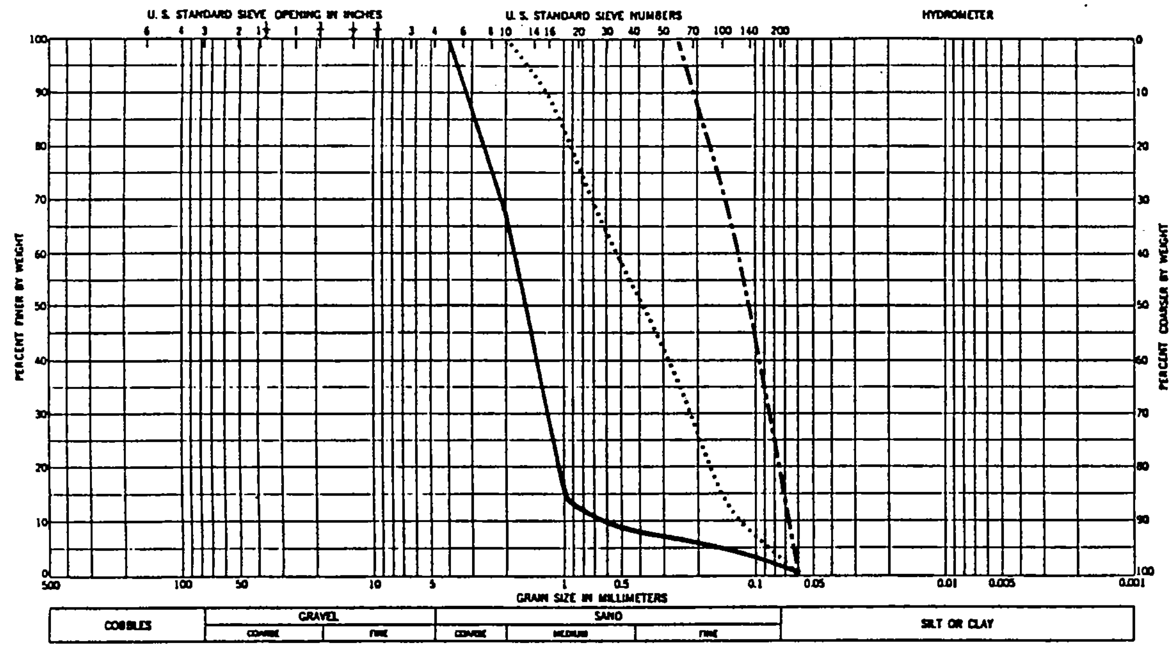

FIGURE 12

PUNALU'U HARBOR SAND SAMPLES

OFFSHORE

NEARSHORE

SWASH ZONE

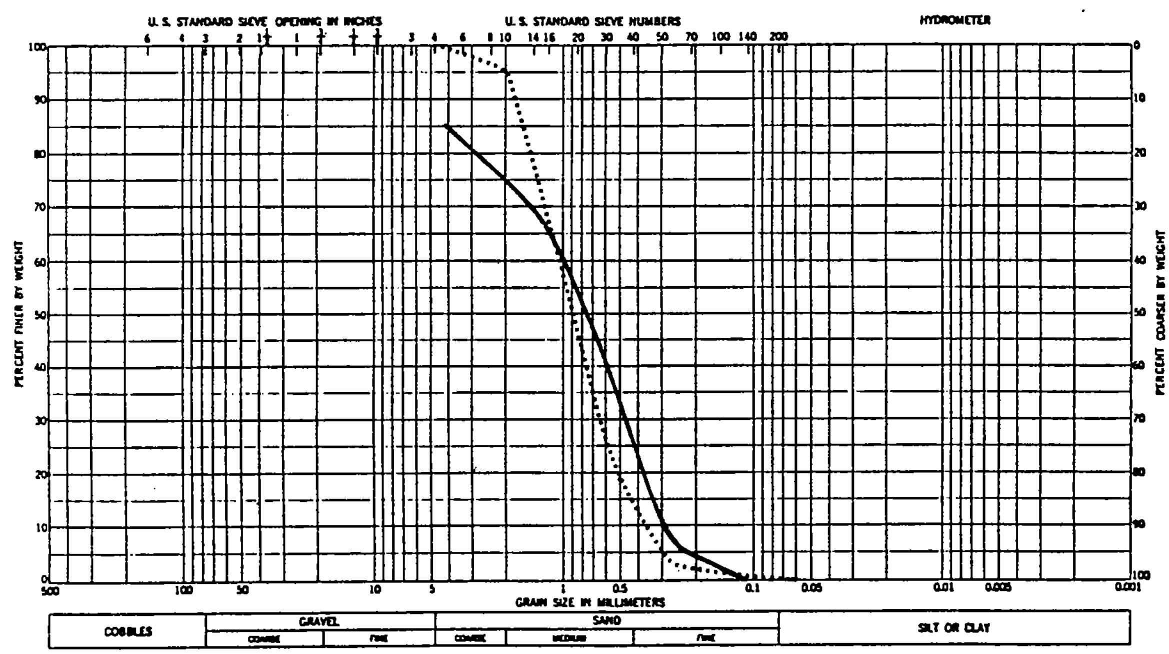

FIGURE 13

NINOLE COVE SAND SAMPLES

SWASH ZONE

BACKSHORE FINES

III. SUMMARY OF EXISTING INFORMATION ON CURRENTS ALONG THE SOUTHEAST COAST OF HAWAII

Coastal currents in Hawaii are the resultant of several components: (1) the oceanic "permanent flow" sweeping past the islands; (2) tidal currents generated by the passage of astronomical tide waves past the islands; (3) wind-induced surface currents; and (4) mass transport associated with the movement of wind waves. Along the shoreline the nearshore currents are also the result of wave action against the shore. Each of the components is variable in direction and strength with time, and the components are greatly influenced by the nearshore topography, thus there can be a great deal of variability in the coastal current speeds and directions on a daily basis as well as seasonally and annually.

The oceanic flow around the Hawaiian Islands sets toward the west, with an average velocity of less than about 0.5 knots and a range of less than 0.1 knots to more than 1 knot (Ref. 5). The tide waves move through the islands from north-northeast to south-southwest. In the open ocean the tidal currents set approximately southwest at high tide (i.e. the flood tide current sets in the direction of propagation of the tide wave), and reverse direction during the ebb tide. Nearshore tidal currents are greatly affected by the shape of the islands and the nearshore topography. The local wind-driven surface currents generally follow the prevailing wind direction, and are often in different directions than the currents below the surface.

Waves are a major factor influencing the nearshore, shallow water currents. The mass transport of water by breaking waves and the action of waves breaking at an angle to the shore generates longshore currents which are largely responsible for sediment transport (beach erosion) and rip currents which facilitate the exchange of nearshore water and coastal waters. The current speed and direction inside of the breaker zone is largely dependant on the breaker height and angle to the shoreline.

The general offshore current patterns around the Hawaiian Islands are shown on Figure 5. Based on reportings in the U.S. Coast Pilot (Ref. 7), the net transport is generally to the southwest along the southeast coast of the island of Hawaii, from Cape Kumukahi to Ka Lae (South Point). A strong flood tide current to the southwest likely results from a combination of the oceanic flow around the island, the flood tide current and the prevailing tradewind drift. A weaker northeasterly current occurs during the ebb tide.

Two current measurements near the study area are reported by Wyrtki et al (Ref. 8). Off Apua Point, 22 miles northeast of the study area, the net transport was to the southwest at about 5 cm/sec (0.1 knots) at the 15 m depth in a water depth of 100 m, based on 16 days of measurement. A greater net transport was measured off Ka Lae, 20 miles southwest of the study area. The net transport was west-southwest at 19 cm/sec (0.4 knots) at the 15 m depth in a water depth of 80 m, based on data for 38 days. These measurements were made in August and September, 1968.

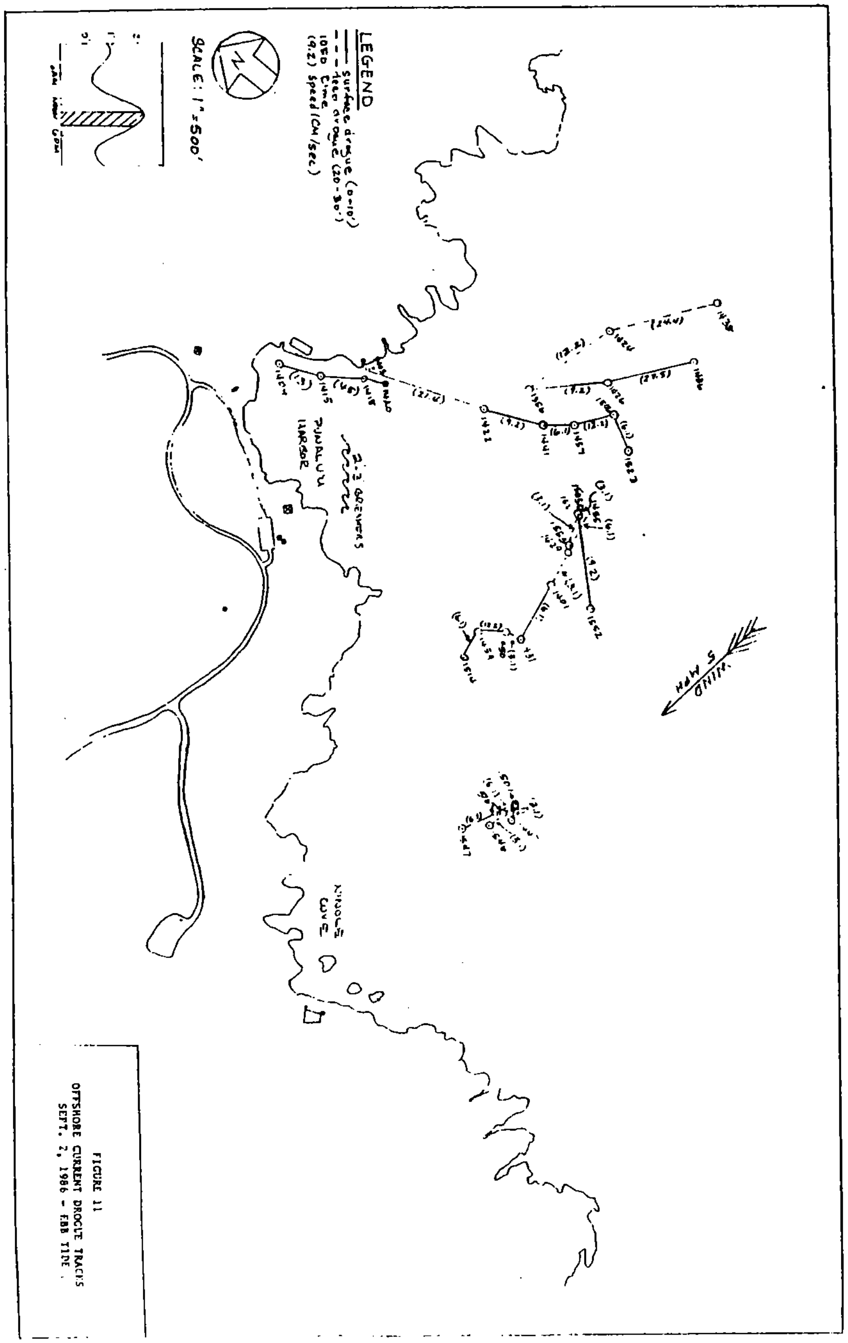

FIGURE 11
OFFSHORE CURRENT DROGUE TRACKS
SEPT. 2, 1986 - EBB TIDE.

SAND SIZE ANALYSIS

Sand samples were obtained from three locations in Punalu'u Harbor and two locations in the vicinity of Ninole Cove and analyzed for their grain size distribution. In Punalu'u Harbor the samples were taken from a sand pocket approximately 100 feet seaward of the beach, from a band of finer sediment along the shore just below the low water line, and from the swash zone on the beach. The grain size distribution for these three samples is shown on Figure 12. In the Ninole Cove area one sand sample was taken from the swash zone on the beach, and a sample was taken from a deposit of fine material in the backshore area filled by the flood-borne debris. The grain size distribution for these two samples is shown on Figure 13.

A summary of the grain size analysis for the sand samples is provided on Table 2. The grain size classification is based on the Unified Soil Classification system (corresponds to U.S. Standard Sieve sizes). The median grain size defines the typical grain size in millimeters that divides the sample so that half the sample, by weight, has particles coarser than the median size. The sorting, or standard deviation, is a measure of the degree to which the sample spreads out around the typical particle size. A size distribution is described qualitatively as well sorted if all particles have sizes that are close to the typical size, and poorly sorted if the particle sizes are distributed evenly over a wide range of sizes.

Samples of typical beach sediment usually have a few relatively large particles covering a wide range of diameters and many small particles within a small range of diameters. Thus, to distinguish one sample from another, it is necessary to consider the small differences (in absolute magnitude) among the finer sizes more than the same differences among the larger sizes. For this reason, all sediment size classifications exaggerate absolute differences in the finer sizes compared to absolute differences in the coarser sizes.

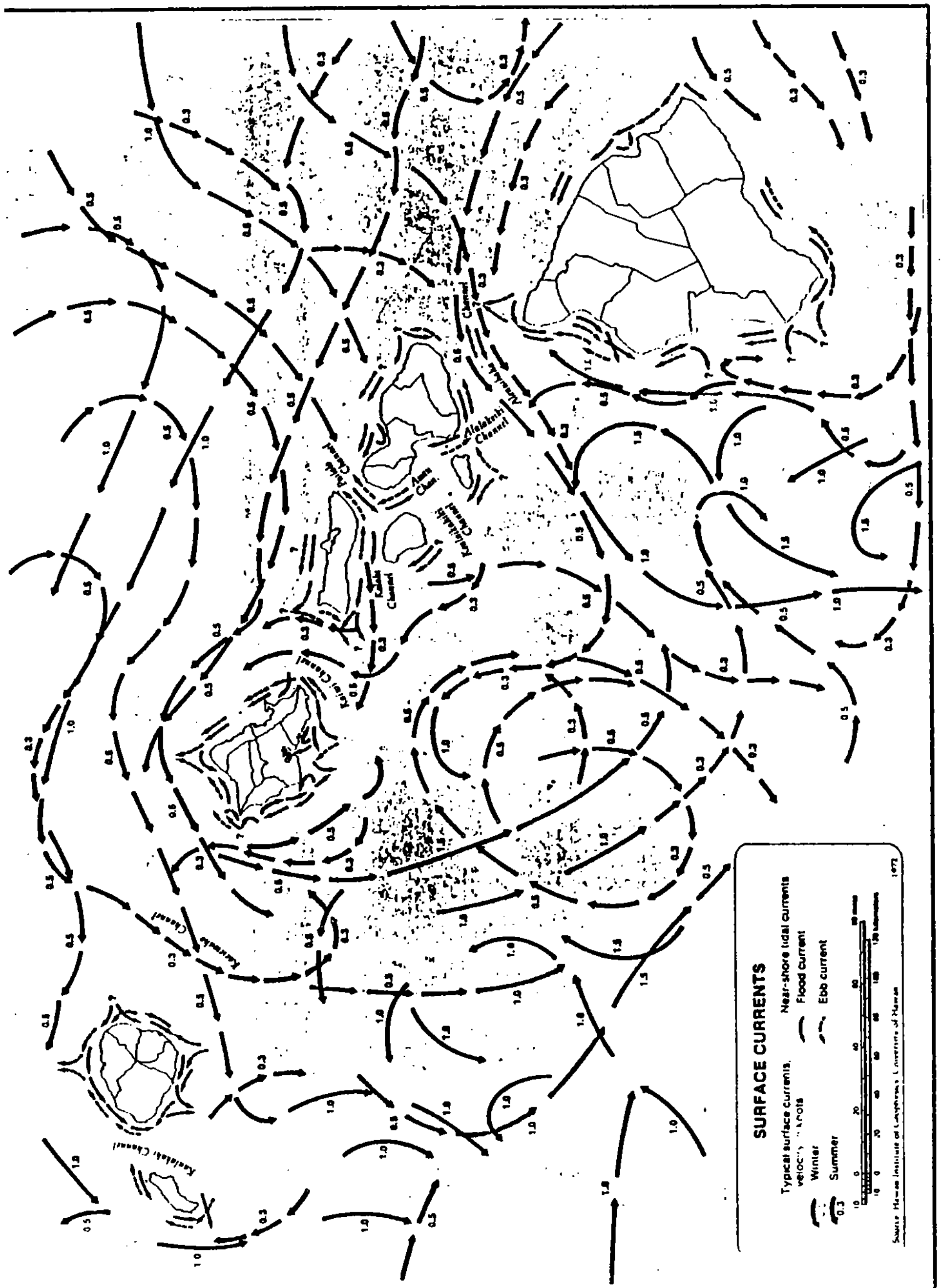

FIGURE 5

IV FIELD INVESTIGATIONS

CURRENTS AND CIRCULATION

Current speed and direction measurements and circulation pattern studies in the study area were made on August 15 and 16, 1986, and September 2, 1986. Current drift drogues and fluorescein dye were used to trace water movement within Punalu'u Harbor and along the shore within the vicinity of Ninole Cove, as well as to measure the prevailing offshore coastal currents. The studies were conducted during wind and wave conditions typically prevailing in the study area - moderate tradewinds and 2 to 4 foot deepwater waves. The studies were also conducted during periods of large tide elevation changes in order to better ascertain the tidal influences on the current systems, and measurements were made for both flood and ebb tide. A summary of the wind, wave and tide conditions during the measurements is provided on Table 1.

The drift drogues used were window shade type drogues with a cross-sectional area of 25 to 50 square feet. The drogues were suspended at various depths from a small surface float. The large area of the drogue relative to the small surface float minimizes undesireable influence on the drogue by wind and surface currents acting on the surface float. After release, the drogues were tracked and fix positions obtained by measuring horizontal sextant angles to known points on shore. In the surf zone, and very nearshore, partially filled gallon jugs and fluorescein dye were used to track the water movement.

Within Punalu'u Harbor the drift drogues were suspended from the surface to the 5-foot depth, and their movement tracked by their position relative to shore points. Nearshore at Ninole Cove the gallon jugs and dye were used because of the relatively shallow water and breaking waves. Offshore of both Punalu'u Harbor and Ninole Cove large drift drogues were suspended at the surface (0 -10 feet) and subsurface (20 - 30 feet) and tracked for several hours during both flood and ebb tide.

The results of the current and circulation field investigations are shown on Figure 6 through 11.

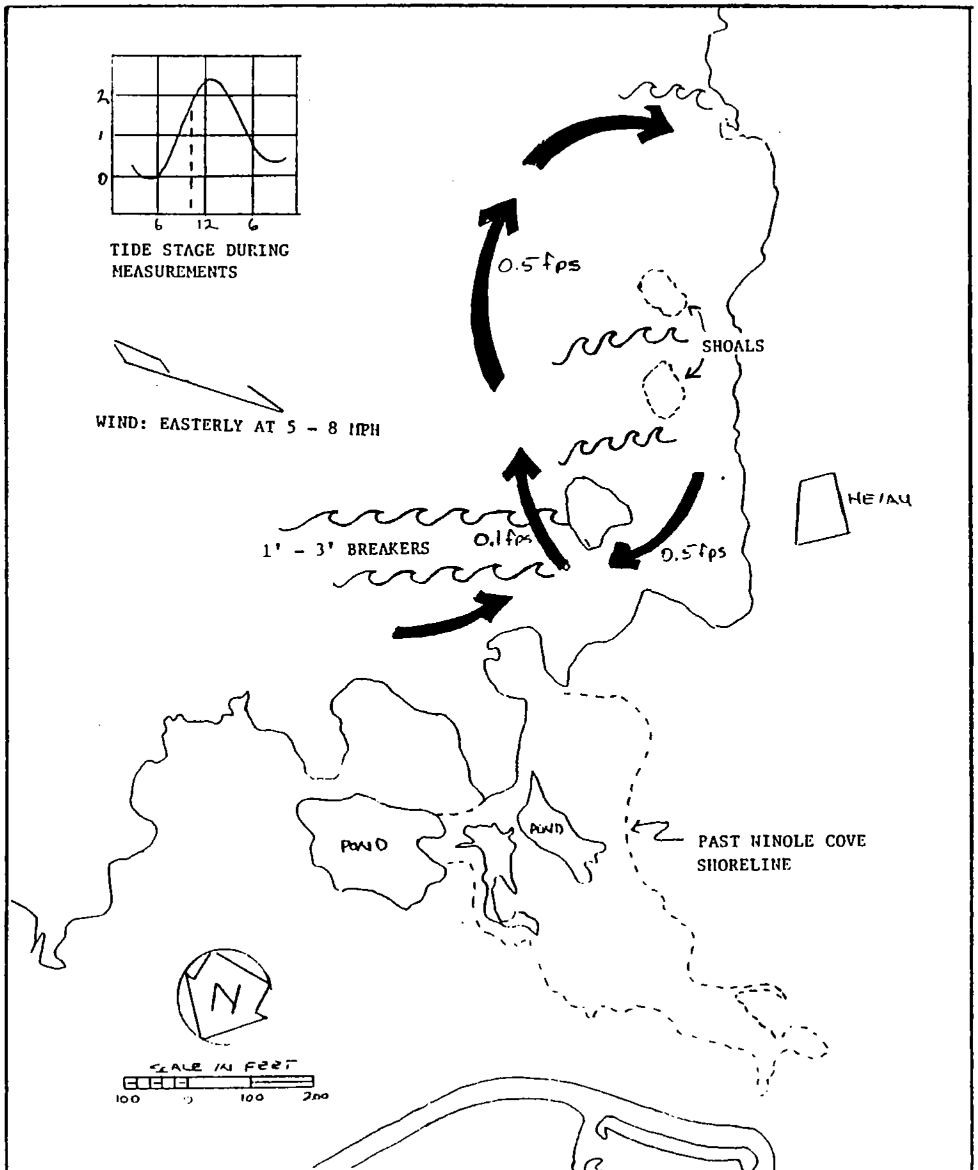

FIGURE 9
NINOLE COVE
SURFACE CURRENT DROGUE TRACK
AUG. 16, 1986 - FLOOD TIDE

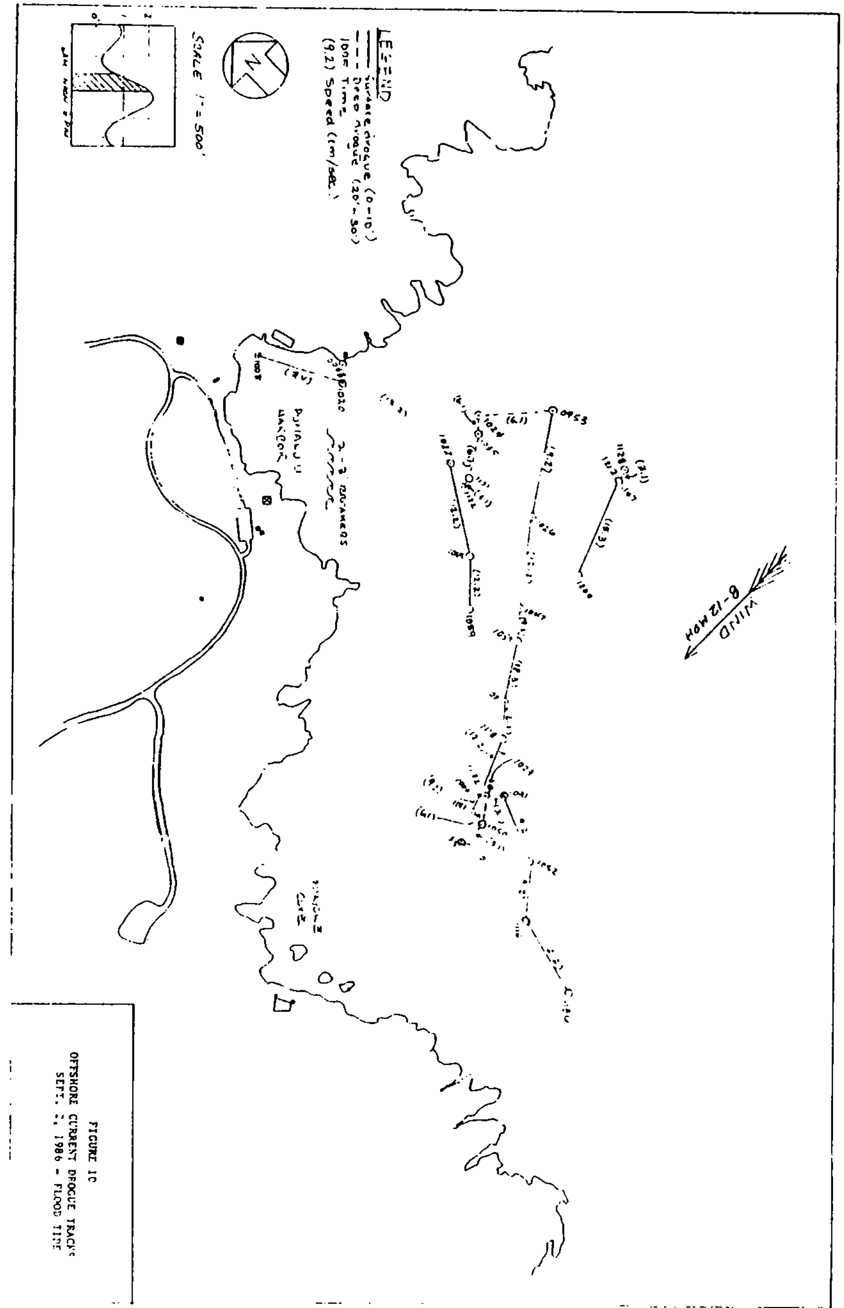

FIGURE 10
OFFSHORE CURRENT DROGUE TRACKS
SEPT. 2, 1986 - FLOOD TIDE

TABLE 1

OCEANOGRAPHIC AND METEOROLOGICAL CONDITIONS

DURING FIELD INVESTIGATIONS

Date/ Time	Wind Speed (mph)	Wind Dir. (°MN)	Wave Height Deepwtr (ft)	Wave Height Breakers (ft)	Tide Stage	Tide El. Change (ft)
8/15/86 1300-1600	5-10	80	2-4	2-4	Ebb	2.3-0.3
8/16/86 0800-1000	0-5	80	1-2	1-2	Flood	0-2.4
9/2/86 0930-1230	8-12	85	2-3	2-3	Flood	0.2-2.2
9/2/86	5	85	2-3	2-3	Ebb	2.2-0.4

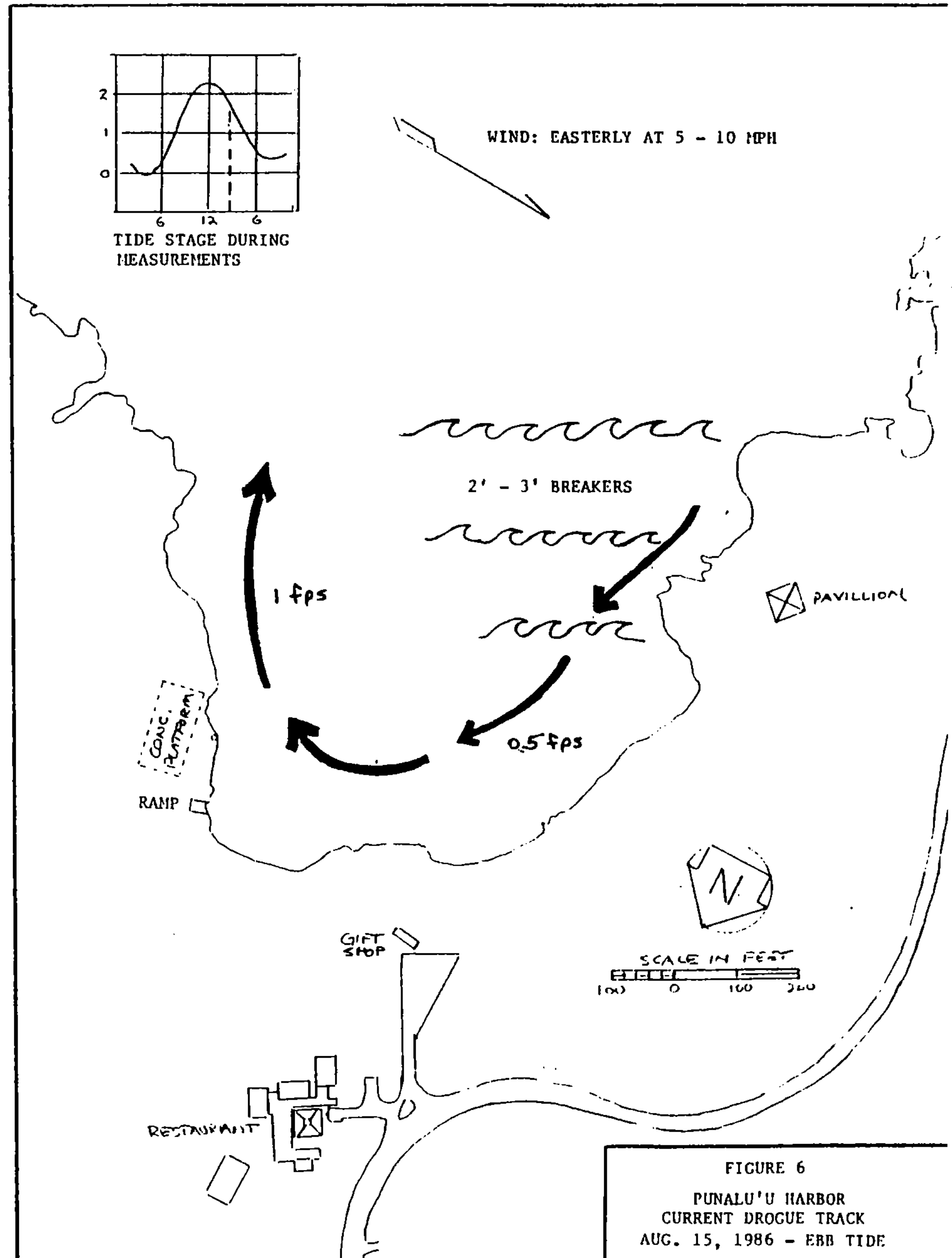

FIGURE 6

PUNALU'U HARBOR
CURRENT DROGUE TRACK
AUG. 15, 1986 - EBB TIDE

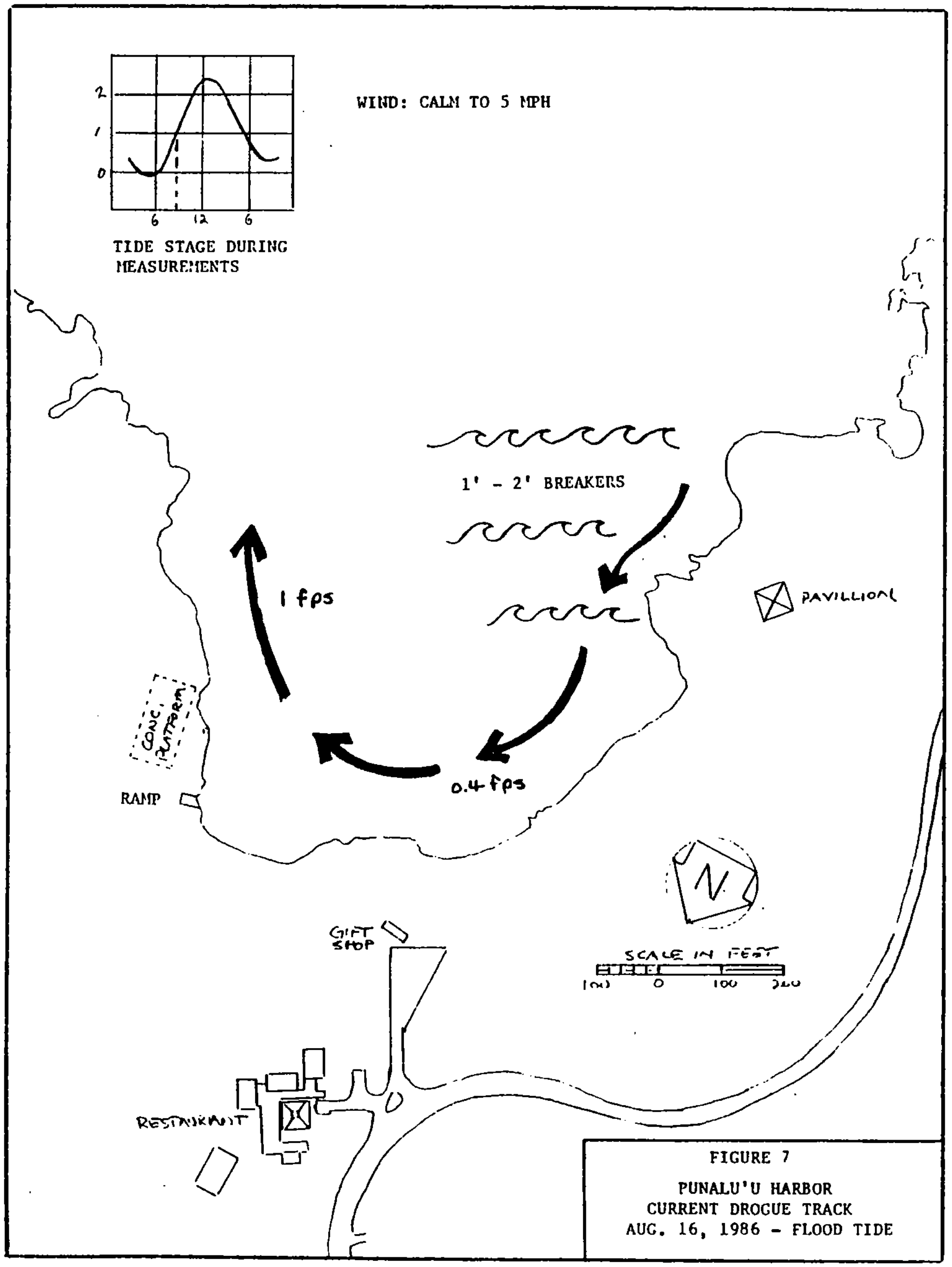

FIGURE 7

PUNALU'U HARBOR
CURRENT DROGUE TRACK
AUG. 16, 1986 - FLOOD TIDE

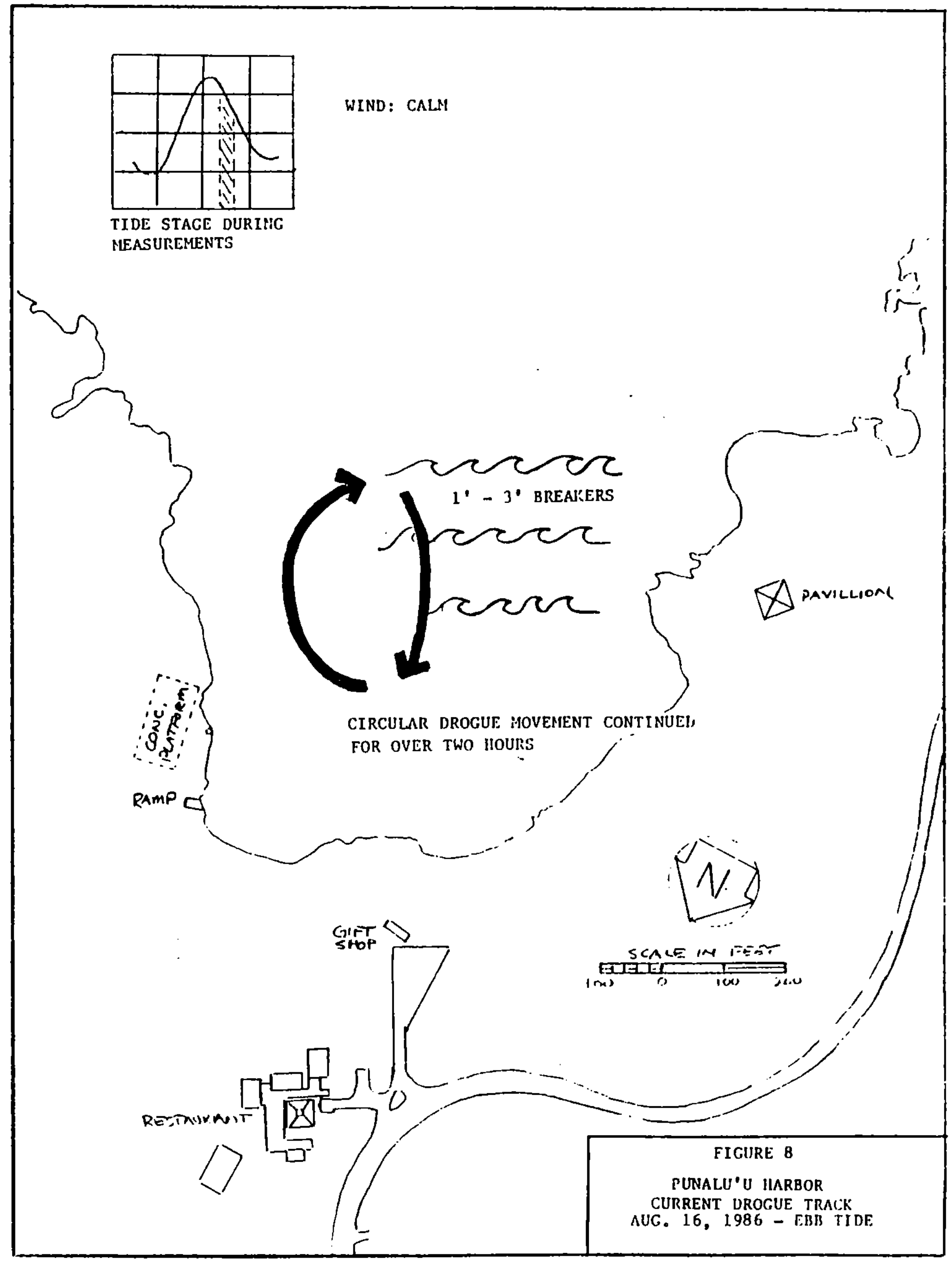

FIGURE 8

PUNALU'U HARBOR
CURRENT DROGUE TRACK
AUG. 16, 1986 - EBB TIDE

IMPACTS OF BIOCIDES AND FERTILIZERS
ON THE NEARSHORE MARINE ENVIRONMENT
AT PUNALU'U RESORT, KAU, HAWAII

Prepared by

GK & ASSOCIATES

Prepared For

PHILLIPS, BRANDT, REDDICK & ASSOCIATES, INC.

November 1987

1.0 Purpose and Scope of the Study

The purpose of this study is to examine several water quality related issues relevant to further development of the Punalu'u Resort, Kau District, Hawaii. Its use will be as an appendix to an Environmental Impact Statement. The scope of the study is a baseline literature review and assessment of the potential impacts of the application of biocides and fertilizers at the Resort on groundwater quality and nearshore marine ecosystems.

2.0 Existing Water Quality

The entire coast in the project area is highly porous, and large volumes of groundwater enter the sea through seeps and springs. Ninole Spring discharges about 20 mgd, and another 10-12 mgd enters the sea along the Punalu'u coast. Several wells tap the inland basal aquifer for drinking water, with higher quality water found farther from the coast.

Water quality in deep wells in the area is summarized in Table IV-1 in the body of the EIS. The basal water varies in chloride content from 8 to 1,300 mg/l, where 250 mg/l is the maximum allowable level in drinking water. The highest of these chloride measurements indicates water of less than 5% the typical salinity of seawater. Of interest to the present analysis is the nitrogen content of the groundwaters, also shown in Table IV-1. Nitrate-nitrogen concentrations vary from 0.0 to 1.9 mg/l, the latter representing a very large pool of available nitrogen. The nitrogen content of these waters is important because of the nutrients necessary for algal growth, in the ocean, nitrogen is in shortest supply and it therefore limits growth rates at the first trophic level. An addition of nitrogen to ocean waters has the potential to result in biostimulation because the first limit on algal growth is removed.

At Punalu'u, offshore water quality and indirectly the character of the offshore biotic community is greatly influenced by the groundwater discharges. Existing water quality at the project site is summarized by Brewer & Associates in Appendix C of this volume. Other information is collected in the body of the report, including the results of analyses done on samples from seven stations offshore and in the coastal ponds found on the property.

One of the stations sampled was a spring at the Punalu'u Harbor boat-launching ramp. These data are the most representative of the character of the groundwater at its point of entry to the sea. The nitrate-nitrogen concentration is 0.322 mg/l, and there is essentially no particulate matter in the water.

Pond 1 connects directly to the ocean through a small channel. Its nitrate-nitrogen concentration is about 0.19 mg/l, about one tenth that of the highest groundwater concentration reported in Table IV-1. It is a freshwater pond with a moderate phytoplankton population

Chemical and Biological Transformation of Arsenicals in Soil

Reactions and changes	Relative rate of change	Products produced	Biological activity	Occurrence probability	Conditions[a] for occurrence	Further possible changes
1. Salt formation	Fast	Insoluble arsenical salts	Insoluble and inactive	Very high	Presence of iron, aluminum, calcium, and magnesium in soil	Formation of an arsenic analog of fluoroapatite, an extremely insoluble complex mineral
2. Adsorbtion	Fast	Soil-arsenic complex	Fixed and inactive	High	Fine-textured soil (colloidal and organic matter)	Formation of sediment in aquatic systems
3. Ion exchange	Fast	Soil-arsenic complex	Reacted and inactive	High	Soil with high exchange capacity	Exchange release by other salts to react further as 1 or 2
4. Demethylation (oxidative)	Slow	Inorganic ortho-arsenic acid	Reacts as 1, 2, and 3	Low	Microorganisms for demethylation (aerobic)	Same as 1, 2, and 3
5. Reduction	Slow	Arsines	Very active	Low	Anaerobic conditions and/or specific microorganisms	Reacts rapidly to form pentavalent arsenical, then same as 1, 2, and 3
6. Oxidation[b]	Moderate	Pentavalent arsenicals	Reacts as 1, 2, and 3	High	Normal soil conditions—aerobic	Same as 1, 2, and 3
7. Methylation (reductive)	Slow	Methyl-arsines	Very active	Low	Presence of specific bacteria micro-organisms—anaerobic	Reacts rapidly to form pentavalent arsenical, then same as 1, 2, 3, and 4

[a]Soil type is important to 1, 2, and 3.

[b]Refers to oxidation of arsenic from trivalent to pentavalent.

Source: Kearney and Kaufman, 1975

(measured as chlorophyll a), noted as having exceptional underwater visibility. The flushing afforded by the channel evidently keeps the standing crop of phytoplankton to relatively low levels, even though nitrogen is abundant.

Pond 2, at Ninole Cove, has nutrient levels similar to those of Pond 1, but because it is not regularly flushed, contains a "noticeable green turbidity" (phytoplankton), and a dense growth of green filamentous algae.

Pond 3, the restaurant pond, has essentially no available nitrate-nitrogen, but large amounts of organic nitrogen from resident ducks and geese. Chlorophyll, suspended solids concentrations and water turbidity reflect a high level of organic enrichment.

Nearshore waters off Ninole Cove and Punalu'u Harbor are similar in water quality. Compared to the above pond waters, the nearshore waters have less nitrate, much less organic nitrogen, and less chlorophyll, but are high in suspended matter and relatively turbid. These stations are about two-thirds normal seawater salinity.

The offshore control station is nearly full-strength seawater. Its inorganic nutrient content is low and the water is clear.

3.0 Proposed Fertilizer Usage and Potential Impacts

3.1 Fertilizers, Application and Nutrient Contents

The table below summarizes data provided by C. Brewer Properties on fertilizers to be used and proposed application rates.

	Percent by Weight						Application		
Fertilizer	N	P	K	S	Fe	Zn	Amt.	Freq.	Use
DC 168	18	5	10				250 lb/ac	3 mo	F,R,T
Blade Bright	16	4	7	18	1.5	0.1	20-25 lb/ 1,000 sq ft	2 wks	G
Ferromec	15	0	0	4	6		128 oz/ 100 gal	2 mo	G

Annual usage of these fertilizers is reported by Brewer personnel to be as follows: DC 168--45 tons; Blade Bright--6 tons; and Ferromec--96 gallons. This represents an annual addition of approximately 20,415 pounds of nitrogen to the site. Assuming the nitrogen to be in the form of nitrate, this converts to a maximum daily addition of about 12.6 pounds of elemental nitrogen.

3.2 Biostimulatory Potential

Marine plants, or algae, require certain elements for their growth, as do their terrestrial counterparts. Some of these elements, particularly nitrogen, phosphorous and silicon, are required in relatively large amounts and are termed macro-nutrients. Most of these elements are abundantly available in seawater, however, in tropical and subtropical surface waters nitrogen, and to a lesser extent, phosphorous, are often present in concentrations limiting to algal growth.

In seawater, nitrogen occurs primarily as molecular nitrogen and as inorganic salts, such as nitrate, nitrite and ammonia. Nitrogen is used primarily as a structural component of cells, and in the ocean is the macro-nutrient most often limiting to algal growth.

The existing water quality in the ponds and offshore of Punalu'u is influenced greatly by the groundwater discharges. If we assume that 30 mgd of groundwater having a nitrate-nitrogen concentration of 0.322 mg/l enters the nearshore environment off Punalu'u, this is equivalent to fertilization with about 18 pounds of elemental nitrogen every day. The result, as seen in the water quality data, is that nitrogen is no longer limiting algal growth in the area. At each station sampled, abundant unutilized nitrogen remains after uptake. In such circumstances, either maximum growth rates are sustained, or a secondary factor such as the availability of light becomes limiting.

At Punalu'u, it is likely that algal growth rates are maximal. The biomass, or standing crop, of seaweed is not a function of nutrient input, but rather represents what's left after the effects of grazing by herbivores and physical destruction by wave surge. In the 1984 biological survey summarized in Appendix C, the offshore benthos was covered by dense stands of a diverse seaweed community, indicating considerable utilization of the groundwater nutrient subsidy. In the 1986 resurvey, the density of benthic algae was much reduced, presumably because of storm wave action prior to the survey. It is unlikely that any additional nutrients entering coastal waters from fertilization of surrounding lands would have a detectable effect on benthic algal standing crop. The factors limiting offshore benthic algal biomass appear to be availability of habitat, grazing pressure and physical disruption.

Nitrogen added to the nearshore waters could also be taken up by single-celled algae (phytoplankton). Uptake by phytoplankton would result in a net loss of nitrogen from the area as the cells are carried away by the prevailing currents. The study of water currents done for the project indicated efficient flushing of the offshore area, so excessive concentrations of phytoplankton would not result. This would likely be the fate of the bulk of the nitrogen entering the coastal waters as a result of golf course fertilization with inorganic fertilizers.

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Pond 1 would likely experience little observable impact because of its efficient flushing. Pond 2 could experience a further build-up of algal biomass, and could begin to experience night-time oxygen depletion problems. This pond has been greatly modified in recent years by flash flooding and storm-wave inundation, and presently supports a biological community of low diversity. The pond already supports a thick anaerobic benthic algal mat. Pond 3 is probably light-limited and additional nitrate would be unlikely to have noticeable effects.

In summary, in light of the large nutrient subsidies presently entering the coastal ponds and nearshore environment at Punalu'u with discharges of groundwater, it is unlikely that additional nutrient enrichment from shoreside fertilization would have significant impacts.

3.3 Mitigation Measures

Containment of surface runoff in settling basins will have the secondary effect of allowing algae and other plants there to utilize some percentage of the nutrients. More specific measures to reduce nutrient loading of coastal waters from inorganic fertilizer additions are not necessary.

The present condition of Pond 2 could be greatly improved by opening it to the ocean. It would eventually come to resemble Pond 1 in character. The condition of Pond 3 could be improved in several ways. Assuming the ducks and geese are desired as entertainment for resort and restaurant guests, appropriate fish, such as a mixture of carp species, could be introduced to balance productivity through the food web and improve the aesthetic aspects of the pond waters. This pond could alternatively also be opened to the sea, resulting in a great reduction in algal standing crop, but also reducing its suitability as habitat for ducks and geese.

4.0 Biocide Applications and Impacts

4.1 Regulatory Control

In 1947, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was enacted primarily to protect consumers from ineffective products. In 1972, the FIFRA was greatly amended by the Federal Environmental Pesticides Control Act which because of growing concerns about the risks of chemical pollutants shifted the act's emphasis to health and environmental safety issues. The act is administered by the Environmental Protection Agency as are the pesticide provisions of the Federal Food, Drug and Cosmetic Act.

The FIFRA contains several provisions of relevance to the present study. First, the act requires extensive testing of all new pesticide products prior to registration, and retroactive testing or recertification of older pesticides lacking adequate data upon which

to base risk assessments. Second, the act differentiated between two major categories of pesticides, general use and restricted use. Third, the act required certification of pesticide sales personnel and applicators of restricted pesticides.

In Hawaii, the Hawaii Economic Poisons Law, Chapter 149, HRS, was enacted in 1970. This law attempted to regulate pesticides before they were sold by assuring that labels on pesticide containers included proper use instructions, and that the pesticides performed as specified. The 1972 amendments to the FIFRA prompted passage of Hawaii's Pesticide Law, Chapter 149A, HRS. This law closely paralleled the FIFRA, but was even more stringent in its requirements for applicator certification.

The Administrative Rules established pursuant to Chapter 149A (Title 4, Chapter 66, Pesticides) establish toxicity categories for all pesticides. The category is assigned on the basis of the highest hazard shown by any of the indicators in the following table.

Toxicity Category	Indicator	Limits
I	Oral LD50	Up to and including 50 mg/kg
	Inhalation LC50	Up to and including 0.2 mg/liter
	Dermal LD50	Up to and including 200 mg/kg
	Eye effects	Corrosive; corneal opacity not reversible within 7 days
	Skin effects	Corrosive
II	Oral LD50	From 50 through 500 mg/kg
	Inhalation LC50	From 0.2 through 2 mg/liter
	Dermal LD50	From 200 through 2,000 mg/kg
	Eye effects	Corneal opacity reversible within 7 days
	Skin effects	Severe irritation at 72 hours
III	Oral LD50	From 500 through 5,000 mg/kg
	Inhalation LC50	From 2 through 20 mg/liter
	Dermal LD50	From 2,000 through 20,000 mg/kg
	Eye effects	No corneal opacity; irritation reversible within 7 days
	Skin effects	Moderate irritation at 72 hours
IV	Oral LD50	Greater than 5,000 mg/kg
	Inhalation LC50	Greater than 20 mg/liter
	Dermal LD50	Greater than 20,000 mg/kg
	Eye effects	No irritation
	Skin effects	Mild or slight irritation at 72 hours

LD50 means a single oral or dermal dose of a substance that is lethal to fifty per cent of the test population of animals under test excreted essentially unchanged by mammals and that irreversible accumulation of organic arsenic compounds does not occur in animal tissues. Bioaccumulation studies using cattle and hens failed to show any accumulation of arsenic above background levels in milk, eggs or edible tissue. In a model ecosystem containing daphnids, crayfish, algae and catfish, only the crayfish bioconcentrated arsenic (up to 10-fold) from water containing 1 ppm MSMA (EPA, 1975; 1981).

The acute oral LD50 of a 51.5% formulation of MSMA (Weed Hoe contains 47.8% MSMA) for rats was 1.8g/kg, slightly toxic. Rats fed 0, 3, 15, 30 and 100 ppm of commercial grade (97.7%) methanearsonic acid for 90 days showed no significant toxic response. Dogs fed 0, 3, 15 and 30 ppm methanearsonic acid for 90 days showed no significant toxic response (EPA,1981).

The FDA Surveillance Index Classification is Class IV - "Sufficiently low hazard potential, from the toxicological and/or exposure standpoint, justifies only intelligence related monitoring efforts." Methanearsonic acid and its salts are only slightly toxic on an acute basis.

The organic arsenical herbicides have LC50 values to bluegill sunfish of 1000 ppm and above, so that they are relatively nontoxic to fish (Kearney and Kaufman, 1975).

4.5.3 Proposed Applications

The methanearsonates are used as selective herbicides, and are usually applied as a directed post-emergence spray.

Two different formulations of Weed Hoe would be employed. On fringes, roughs and tees a formulation which includes a surfactant would be applied at the rate of 160 ounces/200 gallons/4 acres every 10-13 days. On greens a formulation without surfactant would be applied at the rate of 48 ounces/100 gallons every 7-10 days.

Information supplied by Brewer personnel indicates that a total of about 570 gallons would be used annually.

4.5.4 Fate in Soil and Water

Strong oxidizing agents convert methanearsonic acid and its salts to arsenic pentoxide, whereas reducing agents produce trivalent arsenic compounds (arsines) (EPA, 1981).

Microorganisms convert methanearsonic acid to either trimethylarsine or to arsenates (Menzie, 1980). Aerobic microbial degradation of MSMA produces carbon dioxide and sodium arsenate. In one study with four soils, 1.7 to 10% of the MSMA was degraded during a three-week period. Studies on the buildup of arsenic residues in soil after repeated annual applications show results varying from "no buildup" to "statistically significant buildup" (but less than applied). Microbial

reduction to the volatile methyl arsines has been suggested as the mechanism of loss (Enviro Control, Inc., 1981).

The mobility of MSMA in soil is generally low, and leaching appears to be inversely related to clay content. After six years of application to soil planted with cotton, there was little evidence of leaching below the plow depth (Enviro Control, Inc., 1981). The herbicidal effect of the arsenical is ultimately destroyed by formation of insoluble salts, adsorption on soil colloids, or ion-exchange reactions within the soil (Kearney and Kaufman, 1975). The attached table summarizes possible transformations of arsenicals in soils.

4.5.5 Impacts on the Marine Environment

The movement of MSMA from treated weeds to water is likely to be minimal because of the fixation phenomena in plants, soils and sediments discussed above. Insoluble arsenical salts would likely be formed in seawater. Toxicities to specific marine organisms are not available, but based on reported results in freshwater ecosystems, significant impacts to nearshore marine communities are not expected.

4.5.6 Mitigation Measures

Effective design of runoff retention basins on the golf course should contain excess MSMA until it can be degraded. Despite its low hazard potential to humans, manufacturer's instructions listed on the label should be strictly followed by applicators.

5.0 Literature Cited

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conditions acceptable for registration under FIFRA. LC50 means a concentration of a substance that is lethal to fifty per cent of the test population of animals under test conditions acceptable for registration under FIFRA.

Pesticides in toxicity categories I and II are automatically in the restricted use category. None of the pesticides considered in this study are restricted.

4.2 Diazinon

4.2.1 Description and Mode of Action

Diazinon AG500, the proposed formulation, is a non-systemic organophosphorous insecticide and nematicide. Compared to the organochlorines they have widely replaced, the organophosphates are much less persistent in the environment, they are more biodegradable, less subject to biomagnification and usually unstable in the presence of sunlight.

Organophosphates poison insects and mammals primarily by phosphorylation of the acetylcholinesterase enzyme at nerve endings. This enzyme is essential in the normal transmission of nerve impulses from nerve fibers to innervated tissues. Some critical proportion of the enzyme must be inactivated before symptoms of poisoning appear. Organophosphates also impair nerve impulse transmission in the brain, causing disturbances in sensorium, motor function, behavior and respiration. Depression of respiration is the usual cause of death in organophosphorous poisoning. Organophosphates may be absorbed by inhalation, ingestion and skin penetration (Morgan, 1982).

Diazinon is commonly used to control pests in corn and alfalfa, cockroaches and other insects in buildings, and a variety of insects attacking fruits and vegetables. Diazinon is the active ingredient in Spectracide.

4.2.2 Toxicology

The acute toxicity of organophosphorous compounds used as pesticides varies greatly; for example, the oral LD50 for rats varies from 10 mg/kg for chlorfenvinphos to more than 3,500 mg/kg for bromophos. The toxicity of diazinon falls about midway between these extremes, and it is classified as moderately toxic (Derache, 1977).

In rats, studies have shown that 50% of diazinon and its metabolites were excreted within 12 hours and that none was detectable after five days. Studies with dogs showed that the main sites of accumulation of unchanged diazinon were fat deposits. Considerable breakdown occurred in other tissues.

In two-year feeding trials, the "no-effect" level for rats was 0.1 mg/kg per day, and in rhesus monkeys was 0.05 mg/kg/day. Diazinon is

known to be toxic to fish and highly toxic to birds and honeybees (Worthing, 1979).

Studies by Nagata and Ohira (1986) using the small brown planthopper revealed a remarkable increase in resistence to diazinon over a period of about 12 years. Resistence increased 20- to 70-fold, as can be seen by comparing the planthopper and housefly LD50s given in the below table. Resistence to malathion increased 270-fold.

The information in the table below is excerpted from the Farm Chemicals Handbook '87 (Sine, 1987) except as noted.

Species	Test	Dose/Effects
Housefly(1)	Topical LD50	0.003 g/kg
Planthopper(2)	Topical LD50	0.03-0.06 g/kg
Mullet(3)	96-hr LC50	0.084 ppm
Sea Bream(3)	96-hr LC50	0.27 ppm
Rat	Acute oral LD50	0.3-0.4 g/kg, moderately toxic
	Inhalation LC50	3.5 mg/l for 4 hour exposure, slightly toxic
Rabbit	Acute dermal LD50	3.6 g/kg, practically non-toxic
	Eye irritation	mild
	Skin irritation	mild

(1) Pimentel, 19 ; (2) Nagata and Ohira, 1986; (3) Igarashi, et al., 1981

4.2.3 Proposed Applications

The proposed application rate is 8 ounces/100 gallons, once a month. Data provided by Brewer personnel indicate a total annual usage of 4 gallons.

4.2.4 Fate in Soil and Water

Most of the organophosphorus (and carbamate) insecticides are relatively short-lived in soil and water. Diazinon is classed "slightly residual." The percentage remaining in solution in non-sterilized water after 1,2,4,8,12 and 16 weeks was 94, 80,66,35,10 and 0, respectively (Pimentel, 19). Degradation in soil is more rapid, with only 10 percent remaining after three weeks (Spencer, 1982). Examination of the sediments of the Mississippi Sound revealed no pesticides present. Incubation of diazinon for 40 days in water from the study site resulted in a 66% decrease in concentration. Complete degradation was observed after a 10-day incubation with sediments present.

Species	Test	Dose/Effects
Rat	Acute oral LD50	5.4 g/kg, practically non-toxic
	Inhalation LC50	3.28 mg/l for 4 hour exposure, slightly toxic
Rabbit	Acute dermal LD50	>5.0 g/kg, practically non-toxic
	Eye irritation	FHSA scale 18.4 of 110, moderately irritating
	Skin irritation	FHSA scale 4.3 of 8.0, moderately irritating
Bluegill	96 h TL50	14 mg/l, slightly toxic
Carp	96 h TL50	3.9 mg/l, moderately toxic
Trout	96 h TL50	11 mg/l, slightly toxic
Catfish	96 h LC50	16 mg/l, slightly toxic
Crayfish	96 h LC50	>1000 mg/l, practically non-toxic
Fathead Minnow	96 h LC50	9.4 mg/l, moderately toxic
Daphnia	48 h LC50	5.3 mg/l, moderately toxic

Source: Monsanto, 1982

4.4.3 Proposed Applications

Roundup would be applied as needed at a concentration of 1 gal./100 gal. Information supplied by Brewer personnel indicates an annual usage of 90 gallons of Roundup at Punalu'u.

4.4.4 Fate in Soil and Water

A large proportion of an herbicide applied to vegetation reaches the soil where it may be bound to soil constituents including clay minerals, organic matter or metal oxides, transported elsewhere by evaporation, diffusion or mass transport by water or soil particles or degraded through photochemical, chemical and biological processes. Immediately after application, glyphosate is rendered biologically inactive by being rapidly bound to soil clay particles and organic matter. Glyphosate displaced from these binding sites is rapidly co-metabolized (degraded without being used as a food substrate) by soil microorganisms. Losses to photodecomposition or volitization are negligible (WSSA, 1979). The normal half-life of glyphosate is less than 60 days.

Glyphosate has a very low herbicidal activity through soil due to this rapid inactivation. The primary degradation product of glyphosate, phosphonic acid, competes with other inorganic phosphates for adsorption sites. Glyphosate is classed as immobile in soil, and therefore has little tendency to leach through soil.

Glyphosate may enter surface waters through drift from spraying or in runoff if rains occur soon after application. The principal mechanisms of dissipation are microbial and photolytic breakdown to

phosphonic acid and carbon dioxide, and adsorption to sediments giving bound residues which may break down more slowly.

4.4.5 Impacts on the Marine Environment

Toxicity data for specific marine organisms are lacking for Roundup, but assuming marine organisms react to the presence of the compound in similar ways to the freshwater organisms that have been tested, there does not appear to be a high risk of significant impacts on nearshore marine communities.

4.4.6 Mitigation Measures

The herbicide should be applied according to the manufacturer's directions given on the label. Protective eyewear, gloves and clothing are recommended, particularly when applying with pressurized sprayers. The only possible hazard in handling would be irritant effects on eyes and skin.

4.5 Weed Hoe

4.5.1 Description and Mode of Action

The chemical name for Weed Hoe is monosodium methanearsonate (MSMA). It is a moderately toxic, selective organic arsenical herbicide, particularly effective in killing crabgrass in turf. Arsenicals are compounds of the element arsenic. Various arsenicals have greatly differing degrees of toxicity, biological activity and effects on man and his environment. MSMA is a pentavalent organic arsenical. These compounds are used at low application rates and have the lowest mammalian toxicity of any of the arsenical pesticides. Both of these factors contribute to their being among the safest arsenical compounds in use as weed control agents (Kearney and Kaufman, 1975).

Organic arsenicals kill relatively slowly. They apparently act through enzyme systems to inhibit growth. The first symptoms are usually chlorosis, cessation of growth and gradual browning, followed by dehydration and death.

Studies with various plants indicate that MSMA forms conjugates with various plant compounds such as sugars and amino acids. There is no indication that MSMA is demethylated to form inorganic arsenicals or reduced to trivalent arsenic compounds. Arsenic residues are absorbed and translocated by plants following foliar or soil applications of methanearsonic acid or its salts (EPA, 1975; 1981). The carbon-arsenic bond of the organic arsenical herbicides remains intact within higher plants (Aston and Crofts, 1981).

4.5.2 Toxicology

Although metabolism studies of methanearsonic acid are not available, it is known that most pentavalent organic arsenic compounds are

The effect of temperature, salinity, and sterility on the degradation of diazinon in fresh and estuarine water was studied by Walker (1978). No differences between sterile and nonsterile treatments were observed, whereas the effect of increasing temperature was highly significant in increasing degradation. Salinity effects were also highly significant for diazinon. In fresh water, a 45-day half life for diazinon suggested a substantial resistance to degradation, especially at 30 C. In saline water, however, diazinon abatement was considerably accelerated, as indicated by a half-life of 24 days at 28 ppt salinity.

4.2.5 Impacts on the Marine Environment

In a study of heavy metals, organochlorine and organophosphorus compounds in Osaka Harbor, Kawai et al. (1984) consistently detected diazinon in seawater, but not in the plankton.

In studies to control grazing zooplankton in seaweed cultures, diazinon was found to be effective at a concentration of 1 ppm with a three-hour exposure (Shacklock and Croft, 1981).

Development of fertilized sea urchin eggs was interrupted by diazinon at a concentration of 0.01 ppm (Kosai, et al., 1978)

Toxicity tests with marine fish (mullet, Mugil cephalus, and sea bream, Pagurus major) revealed a higher sensitivity than with freshwater carp. Abnormal vertebral development was found, with the ED50 (effective dose) ranging from 11-67 % of the LC50 (Igarashi, et al., 1981). The toxicity of diazinon at 30°C to marine fish was found to be 22.4 times as high as at 15°C after a 48-hour exposure (Hirose, et al., 1979).

4.2.6 Mitigation Measures

Malathion is an organophosphorus compound which is metabolized differently in insects and mammals. In mammals it is rapidly deesterified to a harmless acid which is rapidly eliminated. It is classified only slightly toxic rather than moderately toxic as is diazinon. Malathion could be substituted for diazinon if necessary. The very small amounts of this insecticide proposed to be used and its relatively short persistence in soil and water, however, probably do not warrant the imposition of specific mitigation measures, despite its known toxicity to birds, bees and some marine organisms.

4.3 Tersan

4.3.1 Description and Mode of Action

Tersan is a systemic fungicide, one of the carbamate family of pesticides. Specifically, tersan is a bis dithiocarbamate, known as thiram. The dithiocarbamate fungicides are the most important and

most versatile group of organic fungicides yet discovered. Based on its affinity for water, thiram is a hydrophobe. It is sparingly soluble in water, but it is absorbed and metabolized to some extent by plants. It is very effective in the control of turf diseases (Torgeson, 1967), and it is non-phytotoxic (Worthing, 1979).

The root compound of all the carbamates is carbamic acid, the mono-amide of carbon dioxide. This acid does not exist in the free form, but spontaneously decomposes into carbon dioxide and ammonia. Salts of carbamic acid, the carbamates, are much more stable.

Thiram acts as an inhibitor of mitosis in eukaryotes, higher organisms having nuclei, nuclear membranes and chromosomes. Effects on lower organisms (prokaryotes) such as bacteria and blue-green algae are variable and indirect.

Thiram is the methyl analogue of disulfiram (Antabuse), an agent used to condition alcoholics against beverage alcohol. Thiram inhibits aldehyde dehydrogenase which blocks the in-vivo oxidation of ethanol at the acetaldehyde stage. It is therefore capable of inducing "Antabuse" reactions in persons who consume alcohol following substantial absorption of dithiocarbamates (Morgan, 1982).

Other uses of thiram (also called benomyl) are rubber accelerator, vulcanizer, seed disinfectant, bacteriostat in soap and animal repellant. It is the main ingredient of the antiseptic spray, Nobecutan (Windholz, et al., 1983).

4.3.2 Toxicology

Generally, the mammalian toxicity of carbamates is low, although occupational exposures have caused acute adverse effects, and laboratory investigations have suggested potential chronic effects from some of these compounds. Thiram is irritating to skin and mucous membranes.

Species	Test	Dose/Effects
Rat	Acute oral LD50	>10 g/kg, practically non-toxic
Rabbit	Acute dermal LD50	>10 g/kg, practically non-toxic
	Eye irritation	none

Unlike other categories of fungicides, systemic fungicides like thiram are intended to be retained within the tissues of the plant applied to. This includes a great many commercial crops. In order to be approved for such use, the compound itself and all possible degradation products within the plant must present no danger to the consumer if used as intended (Marsh, 1977).

According to the manufacturer's label, Tersan is toxic to fish, and should not be allowed to enter water. Aquatic toxicity studies performed with freshwater crustaceans (Daphnia magna) and Rainbow Trout (Salmo gardneri) exposed to dithiocarbamates showed (1) low bioaccumulation potential, (2) reduced survival, reproduction and growth of the crustacean at concentrations in the ppb range, and (3) teratogenicity to the trout (Van Leeuwen, 1986).

4.3.3 Proposed Applications

The anticipated application rate is 2 ounces/1000 sq. ft. every two weeks. Data supplied by Brewer personnel indicate a total proposed usage of 44 pounds of Tersan 1991 per year.

4.3.4 Fate in Soil and Water

Thiram is not highly soluble in water, and therefore leaching is not a major concern. Its persistence has been shown to vary from more than two months in sandy soil to less than one week in compost (Richardson, 1954). Major pathways of degradation of carbamates include hydrolysis, hydroxylation, dealkylation, sulfur oxidation and conjugate formation. Conjugates are commonly formed in plants by condensation of endogenous or exogenous substances with naturally occuring carbohydrates or amino acids. The result is a highly polar, water-soluble product which may easily be excreted or stored away from sensitive tissues (Kearney and Kaufman, 1969). Other major mechanisms involved in the disappearance of thiolcarbamates from soils include volatilization, photodecomposition and degradation by soil microorganisms.

4.3.5 Impacts on the Marine Environment

Exposure of marine plankton populations to thiram indicated (1) 98-100 % growth inhibition of a chrysomonad, (2) 90-100 % growth inhibition of a ciliate, and (3) a variable response of bacterioplankton. After three-day exposures, specific growth rates and instantaneous heterotrophic potential (carbon-14 labeled glucose uptake) were not consistently affected, but biosynthetic activity (RNA and DNA synthesis) was depressed. The researchers concluded that phytoplankton and nanozooplankton were directly inhibited, but bacterioplankton were indirectly inhibited (Taylor and Pace, 1987).

4.3.6 Mitigation Measures

The primary mitigation measure which should be employed in the use of Tersan is to avoid contamination of nearby waters, fresh or saline. The compound should not be applied when direct runoff to water bodies is likely. The creation of runoff retention basins within the golf course should allow in situ degradation of excess Tersan to occur.

4.4 Roundup

4.4.1 Description and Mode of Action

Roundup is an herbicide which uses the isopropylamine salt of glyphosate as its active ingredient. Glyphosate, first described as an herbicide in 1971, is a unique and remarkable chemical. It is a broad-spectrum, non-selective, post-emergence herbicide with high unit activity on essentially all annual and perennial plants. It shows no pre-emergence or residual soil activity because of its exceptionally strong binding to soil particles. In the soil, it is readily metabolized by microorganisms to phosphoric acid, ammonia and carbon dioxide, all common plant nutrients. Its exceptional effectiveness is due to its rapid translocation from the treated foliage to roots, rhizomes and apical meristems throughout the plant resulting in the total destruction of even the most resistant weeds (Grossbard and Atkinson,1985).

Roundup is registered for pre-emergent and pre-plant weed control use in crops such as corn, lettuce, onions and spinach; for noncrop weed control on sites such as ditch banks, rights-of-way, schools, nurseries, and Christmas tree farms; and for reduced till operations, pastures, and orchards. Tolerances for glyphosate residues set by EPA in 60 crops (40 CFR 180.364) range from 0.25 ppm in fish to 2 ppm in sugarcane and 200 ppm in grasses (DEA, 1986).

The State Environmental Council, under Chapter 343, HRS, has granted the City and County of Honolulu, Department of Public Works, an exemption from the environmental assessment process for the use of Roundup on stream banks, channels and ditches when dry. Direct application to water bodies is not included in the exemption.

Because of its remarkable properties and widespread use, the biochemical activity of glyphosate has been extensively studied. Glyphosate is a potent inhibitor of the shikimic acid pathway, thus stopping protein synthesis. More precisely, it is a competitive inhibitor of selected enzymes essential in the biosynthesis of aromatic amino acids. It also inhibits chlorophyll synthesis.

4.4.2 Toxicology

Glyphosate is practically non-toxic to mammals, birds, fish, insects and bacteria, organisms which do not utilize the shikimic acid pathway. The table below summarizes the physiological effects of Roundup. Tests on glyphosate have not indicated any mutagenic, carcinogenic, teratogenic (birth defects), adverse reproductive changes, or neurotoxic effects. Carp held in a static pond and exposed to Roundup at recommended use levels for 90 days were unaffected. Tissue residue analyses indicated that glyphosate will not bioaccumulate. Roundup is more toxic than glyphosate due to the formulants added, but in terms of single-dose injestion studies, the acute toxicity of Roundup is less than table salt and half as much as aspirin.

Appendix H: Draft Environmental Protection Plan

DRAFT

PUNALU'U RESORT

ENVIRONMENTAL PROTECTION PLAN

March 1988

I. INTRODUCTION/PURPOSE

Punalu'u Resort (formerly known as SeaMountain at Punalu'u), established in 1972, is located in Ka'u District on the island of Hawaii. Ka'u in general, and specifically Punalu'u, are rich in Hawaiian history, archaeological sites and environmentally sensitive areas and species. C. Brewer Properties, Inc. (CBP), in conformance with its overall corporate policies and objectives, has proposed the completion of Punalu'u Resort (Resort) to be a significant component of the visitor industry in East Hawaii and to provide needed stability to East Hawaii's economy. The specific objectives of the proposed Resort are: (1) to develop a high quality, low to medium density resort community at Punalu'u which is economically viable and integrated into the overall Ka'u community; (2) to continue to provide a range of employment opportunities within the community; and (3) to improve the overall economic and social well-being of the community. Further, it is CBP's intent to preserve and protect the significant cultural, social, recreational and ecological resources of the area.

The purpose of this Environmental Protection Plan is to provide the framework for and guidelines within which the desired environmental protection would be accomplished; to identify those elements of the Resort area environment that will be protected and preserved; to identify and describe the methods and procedures that will be used to provide the level of protection and preservation required; and to identify the governmental and private agencies and groups that will be involved with and contribute to the desired level of environmental protection and preservation and the formulation of specific plans to accomplish the desired level of environmental protection and preservation. It is recognized that the level of environmental protection desired may involve conflict between state and federal policies and local resident's past usage of the Punalu'u shoreline areas and may necessitate compromises by all affected groups and agencies. The primary goal of this Environmental Protection Plan will be to protect and preserve to the greatest extent possible, without detrimentally

affecting the economic viability of the Resort, those significant recreational and ecological features i.e., natural environment (including protection of threatened and endangered species) of the Resort area as determined and defined by recognized qualified and experienced professional environmental protection and resource management agencies, groups and individuals. Significant archaeological, cultural and historical resources of the Resort will be protected under a separate Historic Sites Management Plan.

II. SOCIAL CONCERNS, ISSUES AND VALUES

Environmental protection and social/cultural practices generally result in conflicts that require compromises to be made by all concerned groups and agencies. At Punalu'u, for example, present coastal pond fishing practices create an ecological imbalance in the ponds in that the population levels of the herbiverous species (fish and shellfish) are reduced to the point that (1) the algae, which flourishes in the naturally nutrient-rich waters, grows rapidly to create an imbalance in the pond's flora and fauna and (2) results in nothing being left for the next fisherman.

As noted in the Punalu'u Resort EIS text, the owner recognizes the need to protect and preserve present and traditional fishing and food gathering practices, as well as the need to protect and preserve the natural environment of the Resort area, without either adversely affecting the economic viability of the Resort. On one hand, protecting and preserving present and traditional fishing and food gathering practices benefits local residents <u>now</u> because these activities supplement food supplies while providing pleasant family outings and recreation. On the other hand, protecting and preserving the natural environment, and specifically the coastal ponds and shoreline of the Resort, is a longer term benefit that <u>will</u> accrue to future generations and it is not an immediately seen or perceived benefit. As such, this benefit is generally more difficult to comprehend and appreciate, and leads to conflicts between what should be done for now and what should be done for the future. Based on historical and archaeological investigations and surveys, Punalu'u was, at least prior to the seismic and tsunami activities experienced in 1868, an active and relatively large Hawaiian community. Evidence presented by Kelly (1972) and others (see Barrera and Hommon, 1972 and Crozier, 1972) suggests that following the earthquake and tsunami experienced in 1868, the majority of the Punalu'u community moved inland to higher elevations to escape future tsunamis and stormwave actions. It is likely that fishing and limu gathering, and probably turtle harvesting, were continued to be practiced. Given the conservation ethic generally generally known to be practiced by the early Hawaiians, it is thought that fishing and food gathering were limited to only that which was needed at the time. That is, the quantity and size of the species taken were limited and fishing and food gathering rotated between ponds and offshore areas so that population stocks could regenerate fairly quickly and perpetuate themselves without going through the wide ranges in population levels currently experienced. These are the practices that the owner seeks to protect and preserve through conservation programs and, if necessary, a series of specifically marked trails and pathways through the coastal areas. Public access to the shoreline will be maintained. However, to provide the level of environmental protection necessary to preserve and protect the coastal and strand plants and animals, and to provide the level of safety necessary to protect residents and visitors, access must be limited to pedestrians and access to some areas, which are on private property, must be limited. Public access to public areas will be retained and maintained and public area recreational facilities, such as Punalu'u Beach Park, will be enlarged and improved.

The resolution of apparent and perceived cultural/social/environmental issues and concerns is expected to be a major task during the development of the Final Environmental Protection Plan as provided for in Section III below. Further, the Historic Sites Management Plan that will be developed in concert with the Final Environmental Protection Plan will be designed to protect and preserve the significant archaeological and cultural resources of the Punalu'u area. In addition, the Historic Sites Management Plan will contain educational program guidelines necessary to develop programs that will inform residents and visitors of the value of the archaeological, historical and cultural resources of the area and the need to protect those resources as much as the need to protect and preserve the natural resources of the area.

III. ENVIRONMENTAL PROTECTION PLAN OBJECTIVES

In consideration of the environmentally sensitive features, areas and species found at Punalu'u, this Environmental Protection Plan has the following objectives:

1. Maintain and/or improve the environmental integrity and habitat value of the coastal ponds, shoreline and offshore waters at Punalu'u Resort for the aquatic and terrestrial species (including protected species) presently or potentially inhabiting or utilizing those areas;

2. Improve, through active or passive management, the habitat value of the coastal ponds and shoreline areas of Punalu'u for migratory and resident waterbirds;

3. Expand the scientific understanding of the coastal pond, shoreline and coastal water ecosystems and the effects of increased urban development on them.

4. Protect and actively or passively manage the habitat resources to provide increased educational and interpretive opportunities to the public regarding the unique nature and value of the wetland habitat, coastal pond, shoreline and coastal waters at Punalu'u Resort.

5. Provide a landscape setting that complements the aesthetic character of the coastal ponds and shoreline and provide adequate buffers to protect and preserve the environmental resources of Punalu'u from Resort and recreational uses.

6. Control and monitor construction and Resort operation activities at Punalu'u so that any primary, secondary or cumulative impacts may be identified and mitigated to avoid any detrimental impacts to the coastal ponds, shoreline and coastal waters;

7. Provide for a responsible, qualified, experienced resource protection manager to implement the Environmental Protection Plan and conduct scientific monitoring programs.

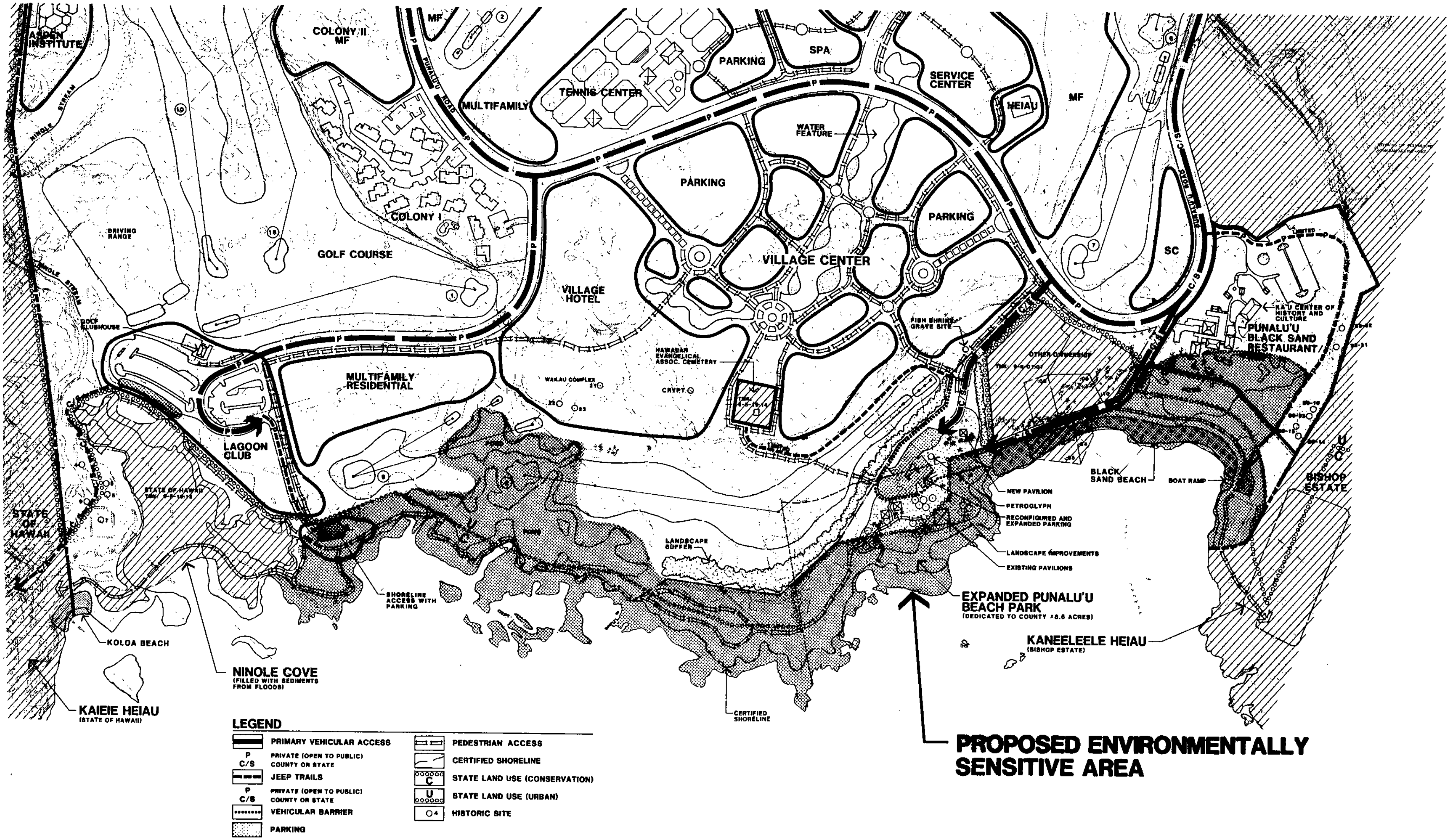
The Final Environmental Protection Plan to be developed and the designation of a manager will be accomplished prior to any construction and/or development activities that may adversely affect the environmentally sensitive areas described herein. The final Environmental Protection Plan will be prepared by CBP in cooperation with technical, social/cultural input from appropriate federal, state, county and private agencies and groups, including the U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, State Department of Land and Natural Resources, County Planning Department, County Department of Parks and Recreation and Ka'u district community associations and other concerned Ka'u district community groups that are requested by CBP to participate.

IV. DEFINITIONS

1. Adjacent Sites. Those parcels that share a common border with Punalu'u Resort as shown on and defined by official tax and property ownership maps.

2. Owner. C. Brewer Properties, Inc. (CBP), and their authorized representatives and their successors.

3. Sensitive Environmental Areas and/or Sites. Those coastal ponds, shoreline and offshore waters described below (See Section V) and/or in the Punalu'u Resort Environmental Impact Statement (See Figure H-1 attached hereto and Section V below).



PROPOSED ENVIRONMENTALLY SENSITIVE AREA

Punalu'u Resort

KA'U, ISLAND OF HAWAII

NORTH SCALE FEET

pbr

FIGURE H-1

4. Policing. The collection and carrying away of trash and other refuse and implementation of the Environmental Protection Plan.

5. Manager. That person, organization or agency designated by the owner as being responsible for management duties contained herein of the environmentally sensitive areas and/or sites. The Manager will be an individual, organization or governmental agency with a record of experience in the protection and preservation of environmentally sensitive areas and/or sites, wildlife conservation and management, environmental awareness, education and public relations.

V. ENVIRONMENTALLY SENSITIVE AREAS AND/OR SITES

The environmentally sensitive areas of Punalu'u Resort are described below and shown on Figure H-1 attached hereto. These areas and/or sites are variously referred to as "environmentally sensitive areas and/or sites", "environmentally sensitive areas", "Management Area" and "Management Area Buffer Zone." Specifically excluded from these areas are sites and/or other features that are not located within the Resort property boundaries or under the direct control of C. Brewer Properties, Inc. with the exception of items 1 through 4 as described below.

1. Coastal Ponds: Coastal Ponds Nos. 1 and 3 as described in the Punalu'u Resort Draft Environmental Impact Statement, December, 1987. Coastal Pond No. 1 will include the dry "mauka" pond as described in the Environmental Impact Statement. Coastal Pond No. 2 is outside the proposed project boundaries and under the jurisdiction of the State of Hawaii. Pond No. 3 (Punalu'u Lagoon) will be cleaned of debris and periodically maintained.

2. Shoreline: The environmentally sensitive shoreline includes the shoreline and areas extending from the existing boat launch ramp to Ninole Cove. Included herein is the area from the low water mark to the proposed landscape buffer along the 8th and 9th golf hole fairways, the seaward (makai) boundary of Pond No. 1 and the black sand beach from the low water mark to the point inland where the black sand terminates and the vegetation begins, including the inland extent of Pond No. 3.

3. Coastal Waters: The environmentally sensitive coastal waters of the Punalu'u Resort area are defined as those waters inshore of a straight line drawn from Nahuluhulu Point to Kohaahu Point to the low water mark along the shoreline.

4. Sites: The environmentally sensitive sites include those significant archaeological, cultural and historical sites within the Punalu'u Resort property as defined and described by the Resort's consulting archaeologist in the Full Archaeological Reconnaissance Survey report included as Appendix A to the Punalu'u Resort Environmental Impact Statement, December, 1987. The protection and preservation of these sites will be the subject of a separate Historic Sites Management Plan to be developed in concert with this Environmental Protection Plan.

VI. DEVELOPMENT AND CONSTRUCTION IN AND/OR AROUND THE MANAGEMENT AREA

1. Notification: The Owner shall notify the Manager at least two weeks prior to the start of any new major development and/or construction activities or earth moving within the Resort property. Specifically excluded from this provision are standard golf course and Resort operation and maintenance activities and necessary emergency cleanup or restoration activities that may be associated with storms or other natural causes.

2. Management Area Buffer Zone: A Management Area Buffer Zone shall be established and maintained adjacent to the Management Area. The width of the Management Area Buffer Zone shall be determined by the preparers of the Final Environmental Protection Plan via on-site inspection of the various edge conditions and may vary in width depending on natural site features and adjacent land use and development activities. The width shall be measured from the perpendicular plane of the Management Area boundary. The specific purpose of the Management Area Buffer Zone shall be to provide adequate protection to environmentally sensitive areas and/or sites located within and/or adjacent to the development or construction area.

3. Construction within the Management Area Buffer Zone: The following guidelines shall apply to construction within the Management Area Buffer Zone:

   (a) Major above grade structures, such as hotel, condominium units, restaurants or snack bars, single family residential units and shops are not allowed within the Management Area Buffer Zone.

   (b) Walkways, bench areas, trash receptacles, drinking fountains, picnic pavilions and areas, restrooms, outdoor showers, landscaping, utility lines and other necessary utilities, display areas and other similar necessary facilities and improvements are allowed within the Management Area Buffer Zone.

quency shall then be reduced to a frequency necessary to detect any long-term trends in coastal pond, shoreline and coastal water quality, faunal assemblages or conditions as applicable.

3. Parameters to be Monitored by the Manager.

(a) Physical parameters to be monitored shall include, but are not limited to: salinity, temperature, water clarity and dissolved oxygen profiles.

(b) Chemical parameters to be monitored shall include, but are not limited to: nitrates, nitrites, phosphates, ammonia, petrochemicals, chlorinated hydrocarbons and biocides.

(c) Physical and chemical water quality measurements shall be taken during various tidal cycles and lunar phases to detect any correlation between physical and chemical parameters and tidal/lunar influences.

(d) Wildlife surveys of protected species shall be conducted seasonally to determine the use of the Punalu'u Resort Management Area and Management Area Buffer Zone by those species.

(e) Other plant and animal populations shall be inventoried to develop detailed species lists and to calculate population biomass density, distribution and frequency of occurrence. These inventories will be used as necessary to detect short- and long-term changes in habitat characteristics and population biomass density, distribution and frequency of occurrence.

(f) Chlorophyll levels will be measured to monitor phytoplankton growth in the coastal ponds.

4. Data Analysis. The data gathered in the monitoring program shall be used to further the scientific understanding of coastal pond, shoreline, coastal waters and wetland habitat ecology.

XI. REMEDIAL AND CORRECTIVE MEASURES

1. If there is the occurrence of an unforeseen deleterious event, the Manager shall determine the need for remedial and corrective action and shall undertake such action using monies provided for in Section XII herein following notification to the Owner that such action will be taken.

2. The Manager shall be responsible for implementing any corrective action or measures when any unforeseen deleterious event or occurrence impacts the ecological viability of the Management Area or Management Area Buffer Zone.

3. Notwithstanding any further permit or regulatory approval conditions dealing with liability or responsibility of the Owner, the Owner shall be liable for funding any corrective work directed by the Manager when an unauthorized action by the Owner or its employees or agents, within the scope of employment, which may harm the ecological viability or integrity of habitats within the Management Area or Management Area Buffer Zone occurs.

XII. FINANCIAL OBLIGATIONS

The purpose of this section is to provide sufficient money to administer the procedures contemplated under this Environmental Protection Plan.

1. The Owner shall contribute the initial funding required and pay annual costs, in accordance with the following schedule subject to adjustments based on the Consumer Price Index, to administer the procedures contemplated under this Environmental Protection Plan:

   (a) Initial Funding $__________
   (b) Estimated Annual Costs $__________/year

2. The Manager shall become knowledgeable of public and/or private funding programs, grants, etc. applicable to the management and implementation of environmental protection programs or specific elements of this Environmental Protection Plan and apply as appropriate for such public and/or private funds for supplemental funding of this Environmental Protection Plan.

3. The administration of the funds contributed by the Owner under this section shall be determined during the preparation of the Final Environmental Protection Plan and shall be used to conduct the affairs of this Environmental Protection Plan as set forth herein. The funds shall be managed under the doctrine of cy pres.

4. Office Facilities. Because of the necessity for the Manager to be on-site for extended periods during monitoring, the Owner will provide, without cost to the Manager, space within Punalu'u Resort, suitable for use by the Manager on a non-exclusive basis, an office and equipment storage area. The Manager shall also be granted ready access to available toilet facilities maintained by the Owner.

(c) Landscaping within the Management Area Buffer Zone shall utilize a preponderance of native or naturally occuring vegetation.

4. Other Construction and Design Restrictions: The following guidelines shall apply:

(a) Site grading shall be such that stormwater drainage from walkways, roadways, buildings and other covered areas shall not flow into the Management Area or Management Area Buffer Zone except that which is directed to specifically designed retention basins or ponds within the Resort golf course.

(b) The wastewater collection, treatment and disposal system shall be designed to prevent overflow during power outages or other emergencies from entering into the Management Area or Management Area Buffer Zone except that which is directed towards specifically designed retention basins or ponds within the Resort golf course.

(c) All structures, whether above or below grade, used for the storage of chemicals and petroleum products shall be designed to prevent spillage or leakage from entering the Management Area or Management Area Buffer Zone.

VII. <u>MANAGEMENT AREA USE RESTRICTIONS</u>

1. Activities specifically prohibited within the Management Area and/or Management Area Buffer Zone include:

(a) Disposal of trash, stormwater (except as described above) or other unauthorized material of any kind.

(b) Introduction of organisms of any kind into the coastal ponds, shoreline or coastal waters without the express written consent of the Manager.

(c) Unauthorized feeding of coastal pond, shoreline or coastal organisms or terrestrial wildlife.

(d) Unauthorized removal, including fishing (for purposes other than recreation or substantiated subsistence), gathering, collecting or netting of coastal pond, shoreline or coastal organisms or terrestrial wildlife without the express written consent of the Manager.

(e) Unauthorized use of coastal pond, shoreline or coastal organisms or terrestrial wildlife.

(f) Any physical, biological or hydrological modification in the Management Area or Management Area Buffer Zone without the express written consent of the Manager.

2. Controlled scientific collecting shall be limited to those experiments and/or monitoring determined necessary for understanding the coastal pond, shoreline and coastal water ecosystems and organism life cycle requirements as determined and authorized by the Manager.

VIII. <u>RESPONSIBILITIES OF THE MANAGER</u>

1. Management:

(a) The Manager shall manage the coastal ponds, shoreline and coastal waters fronting Punalu'u Resort.

(b) The Manager may contract services to accomplish its responsibilities and duties.

(c) In the event that the Manager is unable to fulfill its management responsibilities and duties, following consultation with appropriate agencies, a replacement individual, organization or governmental agency with a record of experience in wildlife conservation and management, environmental awareness and environmental education and public relations will be designated by the Owner.

2. Duties:

(a) Implement the programs required under the Environmental Protection Plan, including the Management Area use restrictions described herein.

(b) Initiate programs to communicate the management objectives and use restrictions to adjacent land owners and their employees, users of adjacent lands and residents and visitors to Punalu'u Resort.

(c) Develop, schedule and conduct resident and visitor education seminars, tours and other programs to achieve the management objectives.

(d) Monitor groundskeeping activities by the applicable hotel, condominium, commercial, golf course and other Resort recreational areas grounds keepers and maintenance personnel in the Management Area or Management Area Buffer Zone to insure that their activities do not adversely affect the Management Area or Management Area Buffer Zone and to enforce the use restrictions.

(e) Conduct surveillance programs to monitor the presence or absence of exotic (introduced) fish and other marine organisms and birds in the coastal ponds, shoreline, coastal waters and wetlands and, if exotic fish or other marine organisms or bird species are found that are determined to be detrimental to the ecology of the area, formulate and execute corrective measures as appropriate and necessary.

(f) Monitor and regulate human activities in the Management Area and Management Area Buffer Zone to prevent human disruption of the wetland, coastal pond, shoreline and coastal waters and the unauthorized introduction of organisms.

(g) Conduct or assist in carrying out the monitoring programs described in this plan.

(h) Conduct, assist, facilitate, schedule or coordinate scientific or educational activities in the Management Area and Management Area Buffer Zone.

(i) Provide semi-annual update and annual status reports concerning activities undertaken and actions occurring in the Management Area and Management Area Buffer Zone and provide results of the monitoring programs to the Owner.

(j) Notify the Owner of any unforeseen, deleterious events or occurrences in the Management Area or Management Area Buffer Zone.

(k) After all contemplated development or construction within Punalu'u Resort has been completed, the Manager will:

(1) Assume maintenance and replacement responsibility for signs or educational displays posted.

(2) Undertake and administer the policing of the Management Area and Management Area Buffer Zone. Provide all equipment and consumable supplies required for such activities.

IX. RESPONSIBILITIES OF THE OWNER

The Owner shall carry out or cause to be carried out the following duties:

(a) Through completion of development and construction of the Resort, the Owner shall post and maintain signs around the Management Area and Management Area Buffer Zone informing viewers of the intent of the Management Area and Management Area Buffer Zone, use restrictions and the availability of educational materials, seminars and tours presented by the Manager. The design of the signs shall be consistent with signage to be used elsewhere within Punalu'u Resort. Their

informational content will be determined in consultation with the Manager.

(b) The Owner shall cooperate with the Manager's efforts to assure that Resort employees are made aware of the value and environmentally sensitive nature of the Management Area and Management Area Buffer Zone.

(c) The Owner shall be responsible for providing funding support for the Environmental Protection Plan to the extent stipulated in Section XII below.

(d) The Owner shall provide all notifications required from the Owner by this Environmental Protection Plan, including advance notification of intended development and construction activity.

X. MONITORING REQUIREMENTS

The general and construction period environmental monitoring described below shall be carried out or caused to be carried out by the Manager.

1. General. The Manager shall monitor water quality and faunal assemblages within the Management Area and Management Area Buffer Zone on a periodic basis to assess the ecological viability and conditions of the ecosystems and wetland habitat.

2. Construction Monitoring Requirements.

(a) Prior to beginning substantial new development or construction within the Resort, the Owner shall notify the Manager of the nature of the proposed development or construction activity. This information will be used by the Manager to determine the need for and the appropriate duration of additional monitoring needed to establish baseline conditions and to detect and characterize variations.

(b) During the course of development and construction on land within the Resort, the coastal ponds, shoreline, coastal waters and archaeological, cultural and historical sites shall be monitored at a frequency necessary to detect any adverse impacts.

(c) The Management Area and Management Area Buffer Zone shall be monitored at least once every calendar quarter for a period of two years following completion of a development or construction project within the Resort. The monitoring fre-

Appendix I: Draft Punalu'u Resort Planning Process For A Program To Maximize Ka'u Resident Employment and Economic Benefits

COMMUNITY RESOURCES, INC.

DRAFT PUNALU'U RESORT PLANNING PROCESS
FOR A PROGRAM TO MAXIMIZE
KA'U RESIDENT EMPLOYMENT AND ECONOMIC BENEFITS

I. PURPOSE

A. Overall Purpose

The overall purpose of the recommended planning process is to formulate a realistic plan which could be implemented in the community to maximize employment and other economic benefits for Ka'u area residents in both the construction and operational phases of the proposed Punalu'u Resort. The program would take a broad approach, encompassing traditional job training elements; attention to supervisory and entrepreneurial skill development; and also removal of obstacles to employment through actions such as child care and transportation assistance.

Target populations, in order of priority, would include:

- o current Ka'u residents, with particular attention to the disadvantaged, unemployed, or underemployed;
- o other Big Island residents, with particular attention to areas nearest to Ka'u (South Kona and Volcano-Hilo);
- o on a tertiary basis, people likely to be socially compatible with current area residents -- e.g., former residents, residents of other Hawaiian islands, family of current residents, etc.

B. Levels of Training

Particularly for entry-levels jobs, training and education can take place at several general levels:

(1) Job-Specific Training: When a hotel operator has identified its prospective employees, the operator will generally provide its own training program for the specific jobs for which people have been tentatively hired. Thus, the social issue at this level has less to do with training than with selection and placement.

While Hawaii hotels generally prefer to hire longtime area residents (for reasons of stability, local area knowledge, and reduced turnover), it is unconstitutional to require them to do so. Similarly, construction unions cannot legally be forced to hire area workers. In order to achieve the previously-described overall purpose, then, planning

must focus on (a) securing operators' voluntary cooperation (particularly for elements such as upgrade training), and/or (b) assuring that residents are maximally qualified and competitive before submitting their job applications (see below).

(2) Job Preparation: Typically, government is responsible for basic education and broad vocational training, and agencies such as Alu Like may provide additional services for certain target groups. However, in remote and lightly populated areas such as Ka'u, these services may not always be easily accessible to residents or economical to provide.

In this regard, a resort Master Developer (and/or association of operators) can play a useful role in the facilitation and coordination of existing services, as well as limited provision of supplemental services, as required.

Because this planning effort is for a program to be implemented by the Master Developer, it is recommended that the effort be primarily focused on the second level (facilitating job readiness) and secondarily on the first level (i.e., assuring that each hotel operator's individual training effort is compatible with overall goals).

C. Planning Phases

The level of planning detail is determined by the certainty that the program will be needed and how soon it may be implemented. Thus, three phases may be identified:

(1) Research/Resource Assessment: This is the current phase, now ending. The resort itself is planned, but governmental approvals are still pending for a General Plan amendment, Change of Zone, and Special Management Area permit. For job training, appropriate planning is limited to identifying existing agencies and programs, and formulating very general concepts of what will be necessary through the subsequent phases.

(2) Preliminary Action Plan: As approval is sought and obtained for resort zoning and SMA permits, the project moves nearer to reality. During this phase, it is appropriate to begin specific planning for job training by bringing together affected agencies, developing a broad outline, and other related tasks as described below.

(3) Final Planning and Implementation: When the project is assured of government approvals and all conditions are known, specific and detailed plans are appropriately completed prior to actual construction and availability of jobs. Because the resort will develop over a 15 to 20 year period, some elements of the plan may need to be revised as conditions change.

This document focuses on initiation of the Preliminary Action Plan. It outlines general steps needed to get from already-established general concepts and needs to the point of being ready to complete final detailed plans and implement them.

II. SUMMARY OF CONCEPTS AND ACTIVITIES TO DATE

A. Agency Contacts

Punalu'u Resort development personnel have held preliminary discussions over the past two years with the following agencies:

- Alu Like: Former Hilo director Betty Snowden expressed particular interest in needs assessment efforts and suggested that Alu Like could help in this regard.
- Hawaii Community College: The dean noted the possible applicability of current West Hawaii culinary arts programs to the Ka'u situation. In light of the distance from Hilo or Kona facilities, and given the small population in Ka'u, the major concern is whether there will be enough residents at first to justify classes in Ka'u.
- Department of Education: The coordinator of vocational education for the area indicates food service and other resort-related courses at Ka'u High School can be developed in response to teacher recommendations. This indicates a need for further discussions with high school faculty.

Additionally, C. Brewer has attempted to help build leadership skills within the community through such actions as co-hosting a Family-Community Leadership Conference, helping found a Ka'u Jaycees chapter, and generally remaining active in community organizations.

B. Established General Concepts

(1) The developer's potential role is to facilitate and coordinate existing services, not duplicate them.

(2) This can be done cost efficiently by a small staff having a thorough understanding of the Ka'u community and good lines of communication with service providers.

(3) Many Ka'u residents will not need additional training or education to compete effectively for jobs or other economic opportunities generated by the resort. They may, however, need accurate information about characteristics of jobs and business opportunities, as well as abundant advance communication about job openings and application procedures.

(4) C. Brewer regards development of the job training plan as primarily a technical process, but community review and response will be needed prior to finalization.

III. ACTIVITIES TO BE COMPLETED PENDING REGULATORY PROCESSING

A. Objectives

Major objectives of the Preliminary Action Plan phase are:

(1) Researching both practical constraints and potential levels of commitment for all future parties to job training (developer, hotel operators, and service providing agencies);

(2) Defining preliminary priorities among the various specific activities which might constitute a "job training" or "job readiness" program;

(3) Establishing in broad outline the sort of mechanism which would be created to implement the final job training program, including a tentative description of the roles and relationships among developer, operators, existing service providers, and new private training-oriented entities (if any);

(4) Identifying gaps in data needed for final needs assessment and detailed planning;

(5) Producing a detailed outline for the final planning process. This outline would list the remaining specific studies and planning tasks to be undertaken once required regulatory approvals and economic resources are in place. Such an outline would include a timeline and budget for completion of this final, detailed needs assessment and planning process.

B. Process

The required process involves three phases:

(1) Initial Preparations: The following would be developed as reference documents for use in the second phase of the process:

- Draft list of data required for ultimate needs assessment;
- Draft outline for the final planning process;
- List of all possible components of job training program;
- List of possible alternative new organizations or mechanisms for accomplishing overall job training goals.

(2) Research and Communication: This primarily involves interviews with appropriate organizations to obtain response to the foregoing reference documents. Key steps would be:

- o Present draft materials from first phase to developer and to a sampling of Hawaii resort operators, in order to determine practical economic constraints.
- o Prepare thorough inventories of (a) agencies which would have data for needs assessment, and (b) existing educational and training resources. The latter would include a listing of resources which are either currently available in the region or which might reasonably be expected to commit more resources to Ka'u as the region develops.
- o Interviews with the identified groups or individuals.
- o Interviews with elected officials and key community leaders, both as a form of rough preliminary needs assessment and to get recommendations for development of a citizen input component to final planning after SMA and zoning approvals are obtained.

(3) Preparation of Final Document

- o Draft report documenting all Preliminary Action Plan contacts and activities and reporting findings and recommendations regarding the five objectives previously noted.
- o Review by C. Brewer and key government agencies.
- o Revision and final plan with implementation program and schedule.

C. Timeframe

The foregoing Preliminary Planning process would require approximately three months to complete.

IV. ACTIVITIES TO BE COMPLETED AFTER SMA/ZONING APPROVALS

A. Activities

The major activities to be completed after SMA/zoning approvals would include:

- o Final detailed needs assessment studies.
- o Completion of detailed planning, according to the outline produced at the end of the Preliminary Action Plan phase.

- o Community review and input, through mechanisms to be determined in Preliminary Action Plan phase.
- o Preparation of training workplan and budget (determined by preceding steps and in concurrence with government regulatory agencies).
- o Implementation of plan.

Developer and operator commitments to carry out these post-approval steps can be assured through agreements reached in conjunction with the SMA and zoning approvals.

B. Potential Components of Final Job Training Program

Although it is subject to revision during the recommended upcoming Preliminary Action Plan phase, following is a list of potential job training program components:

-- construction employment liaison;
-- community job awareness and publicity;
-- vocational counseling and referral;
-- basic skills remedial education;
-- attitudinal and job search counseling;
-- in-service upgrade (promotion) training;
-- contingency programs to retrain former sugar workers;
-- support services (e.g., child care, transportation);
-- travel industry management career educational support;
-- business development technical information/assistance;
-- community placement advocacy (i.e., liaison between hotel personnel and Ka'u organizations most likely to be aware of people needing jobs).

The foregoing is a broad "menu" of potential components, not all of which may be required or economically feasible. The recommended Preliminary Action Plan would establish a preliminary sense of priorities among these components, with finalization of these priorities to take place in the subsequent detailed program planning phase.

- END -

Appendix J: Traffic Impact Assessment

TRAFFIC ASSESSMENT

PUNALU'U RESORT

March 1988

The development of the Punalu'u Resort will provide additional hotels, condominiums, multi-family and single-family residential units, and other visitor-related amenities, such as a golf course and commercial services. These additional resort facilities will increase traffic on the nearby roadways.

The cross-intersection of the Hawaii Belt Highway (Mamalahoa Highway) with west Punalu'u Road and Alakahi Road serves as the primary access for the resort. The single-family residential units would be placed mauka of the highway and the hotels and other facilities would be located makai of the highway. Existing two-way traffic (1986) volumes on the Hawaii Belt Highway are about 1,730 vehicles per day (vpd); the peak hour occurs during the afternoon (PM) with two-way volumes of 180 vehicles per hour (vph). Traffic volumes on west Punalu'u Road were 490 vpd and 40 vph during the PM peak hour.

Project Traffic

A range of 2,051 to 2,981 total hotel, condominium, and residential units are currently being planned. The trip generation rates, shown in Table 1, are based on rates complied by the Institute of Transportation Engineers in its report, Trip Generation, fourth edition, 1987. Estimates of the traffic generated by the low range and high range of development are also identified in Table 1.

Future Traffic Conditions

Future conditions refer to the year 2005, when the project is expected to be completed. Existing traffic volumes at intersection of west Punalu'u Road, Alakahi Road and Hawaii Belt Highway were increased to account for general growth on the island; a rate of two percent per year, based on State population projections, was used for future conditions. Traffic generated by the nearby Hawaiian Riviera and spaceport projects were also included. The traffic data in the Final Environmental Impact Statement for the Hawaiian Riviera project indicated that it would increase two-way traffic volumes on the Hawaii Belt Highway in Punalu'u by about 400 vehicles per hour. For the spaceport project, an estimated 300 daily trips could be expected, with about 40 percent of these trips occuring during the PM peak hour. Thus, traffic from the Hawaiian Rivera and spaceport projects would result in an additional increase in two-way traffic volumes on the Hawaii Belt Highway near Punalu'u of about 460 vph. Figure 1 shows the PM peak hour traffic assignment.

The two-lane Hawaii Belt Highway and the intersection of west Punalu'u Road, Alakahi Road and Hawaii Belt Highway were analyzed by the appropriate methodology from the 1985 Highway Capacity Manual. Definitions for levels of service are described in the attached appendix.

Traffic volumes and physical characteristics are used to indicate highway levels of service. In addition, a volume-to-capacity ratio measures the highway's ability to serve the traffic demand. Table 2 contains the results of the highway analyses. Although the Hawaii Belt Highway would operate at Level of Service E, the highway has adequate capacity to accommodate the expected traffic volumes.

For unsignalized intersections, the delays encountered by drivers on a stop or yield controlled approach determine the level of service. With separate turn lanes, an unsignalized west Punalu'u Road/Alakahi Road/Hawaii Belt Highway intersection would be able to accommodate traffic generated by up to 56 percent of the proposed high range (or about 1,670 units). However, if the Punalu'u development proceeds at a slower rate, the increasing highway traffic will cause over-capacity conditions at this intersection with the

APPENDIX

The 1985 Highway Capacity Manual defines Levels of Service as qualitative measures which describe traffic operational conditions considering speed and travel time, freedom to maneuver, traffic interruptions and delays, comfort and convenience, and safety. Six levels of service, from 'A' (best) to 'F' (worst), are defined.

Level of Service A represents free flow. Individual users are virtually unaffected by the presence of others. For a two-lane highway, passing demand is well below passing capacity; platooning of three or more vehicles is rare. For unsignalized intersections, little or no delay is experienced. At signalized intersections, average delays are less than 5.0 seconds per vehicle; progression is extremely favorable with short cycle lengths and most vehicles do not stop at all.

Level of Service B represents stable flow where the presence of other users in traffic becomes noticeable. On a two-lane highway, platooning is common as passing demand approaches passing capacity. Short traffic delays occur at unsignalized intersections. Delays at signalized intersections range from 5.1 to 15.0 seconds per vehicle with generally good progression.

Level of Service C describes stable flow with greater constraints on maneuvering. Long platoons and low speeds are experienced on two-lane highways. Delays at unsignalized intersections are described as "average". Delays at signalized intersections range from 15.1 to 25.0 seconds per vehicle; fair progression occurs and cycle lengths may become longer.

Level of Service D represents high density, stable flow. Significant restrictions in speed and maneuverability begin to occur. The opposing traffic streams of a two-lane highway operate separately as passing capacity approaches zero. Delays at unsignalized intersections are long as acceptable gaps in the main traffic stream become infrequent. At signalized intersections, delays range from 25.1 to 40.0 seconds per vehicle and the influence of congestion becomes more noticeable; many vehicles must stop at the signal and the proportion of vehicles not stopping declines.

Level of Service E represents capacity or near-capacity conditions. Speeds are low and flow is considered unstable. Passing on two-lane highways is virtually impossible and platooning becomes intense where there are slow moving vehicles or other interruptions. Very long delays occur at unsignalized intersections. Delays at signalized intersections range from 40.1 to 60.0 seconds per vehicle, which is considered to be the limit of acceptable delay.

Level of Service F describes a condition in which traffic demands exceed capacity. Forced flow, with extreme delays and long queues may cause severe congestion. In two-lane highways, volumes are lower than capacity and speeds are lower than capacity speeds. At unsignalized intersections, queueing may affect other movements. Delays at signalized intersections exceed 60.0 seconds and poor progression and long cycle lengths occur; this condition is unacceptable to most drivers.

completion of as few as 1,450 units (71 percent of the low-range). The Level of Service F, shown in Table 2, for the west Punalu'u Road and Alakahi Road approaches indicate that full development of the resort would create over-capacity conditions at this unsignalized intersection of west Punalu'u Road, Alakahi Road, and Hawaii Belt Highway.

For signalized intersections, levels of service are determined by the average length of delay in seconds; delay is a measure of driver discomfort, frustration, fuel consumption and lost travel time. Table 3 summarizes the results from the signalized analysis of the west Punalu'u Road/Alakahi Road/ Hawaii Belt Highway intersection. With the signals, this intersection would be able to handle all of the traffic generated by the proposed development if turn lanes are provided. For the west Punaluu Road approach, a separate right turn lane would be needed. On the Hawaii Belt Highway, separate left and right turn lanes should be provided at the Hilo-bound appproach, while the addition of a separate left turn lane would be sufficient for the Kona-bound approach. A single lane to serve all movements would be adequate for the Alakahi Road approach. Overall, the signalized intersection would operate with good conditions at Level of Service B.

An unsignalized east Punalu'u Road/Hawaii Belt Highway intersection could provide secondary access for the Punalu'u Resort. With the increasing traffic volumes on the Hawaii Belt Highway, a separate left turn lane would be needed at the east Punalu'u intersection for Kona-bound traffic. The increase in traffic could be from general island-wide growth or any development in the vicinity, such as the Hawaiian Riviera, spaceport, or the Punalu'u Resort. The separate left turn lane would be warranted when peak hour traffic volumes on the Hawaii Belt Highway reach approximately 700 vehicles per hour; the lane would allow through traffic at the intersection to continue in the Kona-bound direction even when there are cars waiting to turn left off of the highway.

Alternative control measures, such as the prohibition of left turns at the east intersection, could alleviate the need to construct additional highway improvements. As indicated earlier, the west intersection, if signalized, would have adequate capacity to serve the project traffic.

Table 1

PROJECT TRAFFIC GENERATION

	Trip Rate	Project Traffic Low Range	Project Traffic High Range
Proposed Units			
Residential	—	71	78
Resort	—	1,980	2,903
Daily Traffic			
Residential (In and Out)	3.162	225	247
Resort (In and Out)	6.6	13,068	19,160
Peak Hour Traffic			
Residential			
In	0.107	8	8
Out	0.155	11	12
Resort			
In	0.277	549	803
Out	0.226	448	657

Table 2

HIGHWAY CONDITIONS

	Highway Condition Low Range	Highway Condition High Range
Hawaii Belt Highway, Pahala side		
Two-way volume	1,372	1,672
Level of Service	E	E
Approximate volume-to-capacity ratio	0.58	0.71
Hawaii Belt Highway, Naalehu side		
Two-way volume	1,099	1,265
Level of Service	E	E
Approximate volume-to-capacity ratio	0.46	0.53

Table 3
UNSIGNALIZED INTERSECTION
HAWAII BELT HIGHWAY/PUNALUU ROAD/ALAKAHI ROAD
LEVELS OF SERVICE

Controlled Approaches	Level of Service: Low Range	Level of Service: High Range
Maukabound: West Punalu'u Road		
Left/through lane	F	F
Right turn lane	B	D
Makaibound: Alakahi Road	E	F
Hawaii Belt Highway left turns		
To makai (from Hilo)	B	C
To mauka (from Kona)	A	A

Table 4
SIGNALIZED INTERSECTION
HAWAII BELT HIGHWAY/PUNALUU ROAD/ALAKAHI ROAD
LEVELS OF SERVICE

Approach	Level of Service: Low Range	Level of Service: High Range
Maukabound: West Punalu'u Road		
Left/through lane	B	C
Right lane	B	B
Makaibound: Alakahi Road	B	B
Hilo-bound: Hawaii Belt Highway		
Left turn lane	A	B
Through lane	A	B
Right turn lane	A	B
Kona-bound: Hawaii Belt Highway		
Left turn lane	C	C
Through/right turn lane	A	B
Overall Intersection	B	B

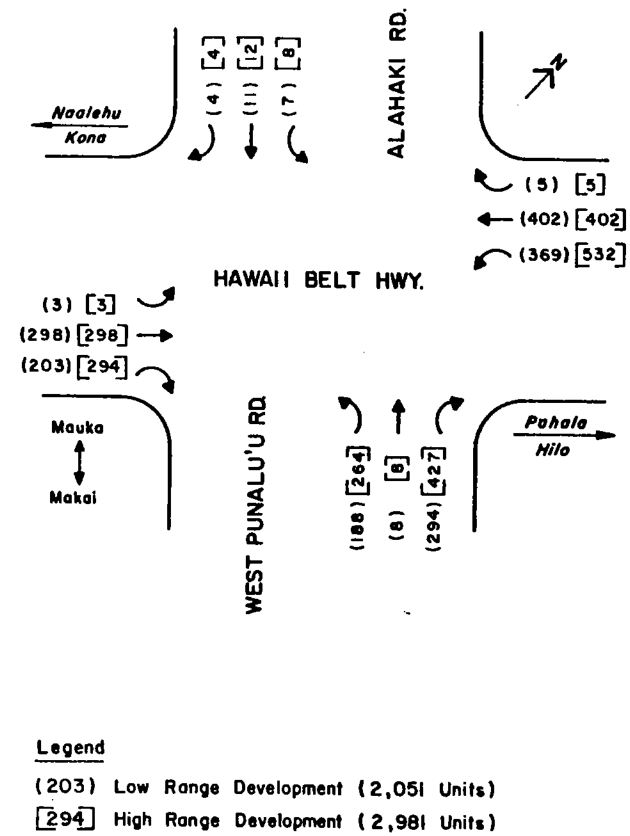


FIGURE 1
TRAFFIC ASSIGNMENT
Peak Hour

Appendix K: Historical Sites Management Plan

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

<u>OUTLINE FOR HISTORIC SITES MANAGEMENT PLAN</u>

HISTORIC SITES MANAGEMENT AT PUNALU'U RESORT

Ka'u District, Island of Hawai'i

by

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Prepared for

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February 1988

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CONTENTS

INTRODUCTION

BACKGROUND

A full archaeological reconnaissance survey of the Resort Master Plan project area at Punalu'u Resort, Kau District, Island of Hawaii was conducted from August 25 through September 4, 1986, by Paul H. Rosendahl, Ph.D., Inc. (PHRI) for C. Brewer Properties, Inc. This work was done in connection with preparation of a Chapter 343 (Haw. Rev. St.) Environmental Impact Statement (EIS) done in connection with a General Plan Amendment (GPA) application made to the Hawaii County Planning Department. The reconnaissance survey findings identified a total of 32 sites (83+ component features) within the overall 435-ac project area. Of these, 25 sites (66+ component features) had been previously recorded and seven sites (17+ component features) were newly identified. In addition to the reconnaissance survey findings, a scope of work and content outline for a Historic Sites Resource Management Plan (HSMP) was included as Appendix A (Rosendahl and Rosendahl 1986). This scope of work and content outline are expanded in the present document.

CULTURAL RESOURCE MANAGEMENT: AN OVERVIEW

Only recently (within the last ten years) has cultural resource management (CRM) become an integral part of public and private planning. Below is a statement by Tomonari-Tuggle which provides a general overview of the purpose for preparing such a management plan:

> The basic premise of cultural resource management is that cultural resources are nonrenewable and are becoming increasingly endangered by activities that modify the landscape (McGimsey and Davis 1977:22). Generated largely by federal, state, and local laws which require the mitigation of adverse impacts on cultural resources, CRM involves a delicate balance between the immediate needs of today and the long-term benefits of caring for one's history and cultural past. In this sense, archaeologists take responsibility for resource conservation in the larger context of present day concerns for progress and development (1985:4).

THE APPROACH OF THE PUNALU'U RESORT HSMP

The Historic Sites Management Plan (HSMP) will focus on the historic properties within the entire project area, and will provide the framework to responsibly manage these resources. This plan is envisioned as a non-static program that can be supplemented and revised to respond to additional information and concerns.

The following outline is presented as a preliminary format to be followed during preparation of the Punalu'u Resort HSMP. It is offered in advance of the actual document so that modifications, additions or deletions can be suggested and incorporated into the finished product. The final HSMP will be prepared following issuance of requested land use approvals and prior to actual construction in the vicinity of documented archaeological sites.

INTRODUCTION

A. Purpose of the HSMP: as organizational framework for dealing with archaeological and historical resources in the context of the Punalu'u Resort properties, particularly those areas that would be affected by development

1. Document as described is a working plan, to be amended and altered as new information is collected within the project area

2. Scope of Work for HSMP as proposed and agreed upon by consultant and client

3. Background to development of HSMP within project area and implications of past programs for future management

B. Objectives of the HSMP

1. To identify the nature and extent of cultural resources within the Punalu'u Resort properties (sites identified during 1986 reconnaissance survey).

2. To establish a data base of cultural resources that will be adapted for use with a variety of management activities (completed as part of 1986 reconnaissance survey).

3. To assess the significance of identified cultural resources and set standards for the assessment of resources identified in the future (general significance assessments have been made for all existing sites within the Punaluu resort project area [Rosendahl and Rosendahl 1986:43-44]; these assessments would be subject to re-evaluation during subsequent intensive archaeological studies); and

4. To discuss the various alternatives available for managing cultural resources and to determine which management alternatives best suit the context of the Punalu'u Resort, given existing historic preservation facilities and development plans

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C. Approach of the HSMP

1. Definition of project area--identify areas to be impacted by development

2. Application of archaeological data base to project area, use of environmental, chronological and cartographic data in developing project area profile

3. Consideration of programs for the three components of resource management: research, interpretation and conservation

D. Organization of the HSMP

1. Data base cross-referenced for use with specific and general problems, data summarized to serve as baseline for comparisons and site evaluations

2. Site locational data upgraded and stored on standardized base maps which contain additional management information

3. Background information and support documents such as annotated bibliography presented as appendices to the core document

PUNALU'U: ENVIRONMENT AND HISTORY

This section provides background data and a profile of the project area, and presents the historical data and narrative of the history of Punalu'u. The information will be gathered from documentary evidence (previous historical research, land records, historical maps) as well as from informant interviews with knowledgeable individuals from the area. The following outline is presented as a preliminary format.

ENVIRONMENTAL SETTING

A. This section, to be completed, will include a summary of the natural environment as it exists today and as it may have existed in the past. Of particular interest are those aspects of the environment that were most integral to prehistoric and historic culture systems. These include the offshore fish/crustacean resources, endemic plant species, unique resource areas such as the coastal ponds, and geomorphological formations, particularly the various lava flows.

B. Current description of the project area in terms of current land use with attention to impacted areas and nature of any land modification

PREVIOUS HISTORICAL RESEARCH

A. Legends

B. Traditional History

C. Annotated Bibliography of Historical Maps

PRELIMINARY CULTURAL HISTORY OF NINOLE, WAILAU, AND PUNALU'U

A. Information Sources for a Cultural History

B. Initial Settlement

C. Traditional Period

D. The Early 1800s: Missionaries and Merchants

E. The Mid-1800s: Government Land Records

F. The Late 1800s: Impact of the Natural Disasters

G. the 1900s to Present: Shipping, Ranching, Sugar, and Resort

SUMMARY OF PAST LAND USE

Integrate the archaeological, historical, and oral historical information to describe what is known and what is not yet know for the Punalu'u Resort lands at Ninole, Wailau, and Punalu'u.

NATURE AND SIGNIFICANCE OF HISTORIC SITES IN THE PUNALU'U RESORT

This section provides a context for understanding both the cultural resources and the present status of their treatment with the Punalu'u Resort.

PREVIOUS ARCHAEOLOGICAL WORK

This section reviews all previous archaeological work conducted within the project area. Much of the basic information is summarized in the reconnaissance survey findings (Rosendahl and Rosendahl 1986). Major topics to be addressed include the nature of work description of project findings, project area limits, location of records and recovered materials, and final report references.

2. Research design--an archaeological planning tool which prioritizes research in a framework of goals, objectives and hypotheses/questions; proposes specific research problems, kinds of data to expect or look for, and the means to collect that data; should be explicitly stated in preliminary and final reports

HISTORIC SITES SELECTED FOR DATA RECOVERY

1. List of historic properties and specific plans for each site. Identify what archaeological work would be required.

OVERALL RESOURCE MANAGEMENT CONSIDERATIONS

A. Periodic review/monitoring of management plan programs--represents ability of plan to respond to changes in development plans, environment, condition of sites, new information, unforeseen situations; review should:

1. Assess the strengths and weaknesses of various programs

2. Assess the kinds and extent of adverse impacts on preservation areas (both natural and human-induced)

3. Assess the condition of sites in preservation and interpretive areas, and

4. Recommend changes to management programs to mitigate any problems

B. Administration--HSMP implementation should be overseen on a long-term basis by a regular employee or consultant of Punalu'u Resort who would act as a liaison among archaeological consultants, County and State Officials, Punalu'u Resort and the community; should not act as archaeologist *per se* but as project manager or planner, initiating program review but not actually carrying it out

HISTORIC SITES ON ADJACENT PROPERTIES

1. Summary of Historic Sites on adjacent properties--brief description of individual sites, property owner, and locational information, as well as potential impacts and mitigation measures.

TENTATIVE SCHEDULING

TASK	SCHEDULE
A. Prepare HSMP	4-6 months
B. Implement HSMP	6-12 months
1. Intensive survey field work	3-6 months
2. Develop interpretive program	3-6 months
3. Identify conservation areas	Included in Tasks B1 and B2

A. Annotated Bibliography of Archaeological Reports

INVENTORY OF CULTURAL RESOURCES

A. Introduction--establishes the data base for both specific and general management decisions, documents nature and extent of known resources (the bulk of site specific information will be presented in a separate format, possibly a series of individual files, located in a designated repository).

B. Archaeological evidence--discusses various sources, problems with consistency in site definitions and descriptions, limitations of certain locational data sets

1. Summarize inventories, drawing from tabulated data and support documents

   a. Indicate areas which have: no potential for contributing new information, i.e., totally developed or altered; low potential for contributing new information or containing significant sites; high potential for contributing new information

   b. Tabulate and summarize activities that have or may affect cultural resources within project areas

2. Discuss master site file, an item separate from the HSMP, which will minimally contain the following categories

   a. Site number(s), including BPBM, HRHP, project-specific temporary numbers and HSMP temporary numbers

   b. Formal site/feature category or categories present - must account for individual features

   c. Functional interpretation designation(s) assigned by original site recorder; alternative designations

   d. Status; not relocated, destroyed, intact, preserved/undeveloped for interpretation, preserved/developed for interpretation

   e. Physical condition; excellent, good, fair, poor

   f. Integrity; unaltered, partially altered, extensively altered

   g. Level of completed work at site; verbal description with measurements, mapped, surface collected, tested, excavated, accurately located, stabilized, reconstructed

   h. Presence of portable remains noted; subsistence remains, artifacts, other materials

3. Summarize site data by formal categories, functional categories and locational categories, drawn from master site file, appended to HSMP

   a. Formal categories: terraces, rock-shelters, heiau, petroglyphs, trails, footpaths, walls, structures, enclosures, platforms, and so on

   b. Functional categories: permanent habitation, temporary habitation, ceremonial, recreation, transportation

   c. Locational categories: environmental zone (coastal, inland), adjacent sites (trail, similar sites/features, isolated)

   d. Approximate age (if known)

4. Discuss destruction rate of sites, past and projected; assess representative or non-representative nature of sites currently preserved

CURATION

A. Introduction--summary of kinds of curated materials (written records and artifactual material) and discussion of repository and access

B. Inventory of curated materials with respective location.

FRAMEWORK FOR SITE SIGNIFICANCE EVALUATION

A. Introduction--purpose of section is to synthesize existing data and offer preliminary summary of culture history and succinct research design for further work

B. Evaluation of Significance

1. Significance categories used in the site evaluation process are based on the National Register criteria for evaluation, outlined in the Code of Federal Regulations (36 CFR Part 60); the Hawaii State Historic Preservation Office (SHPO) uses these criteria for evaluating cultural resources:

b. Intensive survey and testing--no approved standards have been established that are comparable to the Reconnaissance level guidelines; Hawaii County Planning Department has draft guidelines; national professional organization has prepared a basic outline (McGimsey and Davis 1977)

c. Excavation--no approved standards currently exist as for Reconnaissance level; McGimsey and Davis (1977) contains a basic outline; special conditions exist for excavation of burials

1) Burials--sensitive issue; high research value and high cultural value; must be dealt with in such a way as to address the needs of both culture and research, coordinate with Office of Hawaiian Affairs (OHA)

a) Preparatory--obtain special permit from State Department of Health; place public notice in newspaper of general circulation to notify any possible legal claimants to buried remains

b) Excavation and exhumation--carried out by professional archaeologists with intent to record structural characteristics of interment, posture of skeleton, location and description of any associated artifacts, and any other characteristics of location and general nature of interment

c) Analysis--carried out in laboratory with sufficient time to record in detail metric/discrete traits of skeleton by physical anthropologist; analysis and recording of associated artifacts

d) Reinterment--legitimate claimants take own responsibility for reinterment; for all others, local community should be approached for consultation; burial should be reinterred; if possible, in the same land division

d. Data analysis and interpretation--carried out in timely manner; standard forms, numbering system for artifacts and other material; single repository should be established for recovered material, maps, drawings, field notes

1) Significant sites--following excavation and analysis, sites may be of such significance that preservation is warranted; if so, justification must be presented in terms of how site can fit into management programs

2) Reports should explicitly address research questions of overall research design as well as bring to light any

new research questions; should address issue of updating research design and cultural history, and reassessment of any pertinent or associated recommendations of preservation

e. Dissemination of findings--carried out in timely manner upon approval of the land owner; copies of reports sent to Hawaii County Planning Department, State DLNR, OHA, Archaeology archive of Public Library, UH-Hilo Library; arrangements for use of data in scholarly publication arranged as part of contract agreement between archaeologist and client

f. Cumulative analysis/final summarization following completion of all archaeological work/development, or periodically; should also address, review and assess the ongoing programs and recommend modifications to best suit the current needs of preservation and development

g. Review--as project-specific activities are carried out, reports of those activities should be submitted for review and comment to the Hawaii County Planning Department and State DLNR; intent is to keep them informed of current CRM activities within the properties and fulfill any permit application conditions

3. Oral history--high potential for productive oral history collection; should be carried out simultaneously with continuing historical and ethnohistorical research

B. Research concerns and research design--integral parts of cultural resource management

1. Research as ongoing process of discovery that contributes to understanding the archaeology, prehistory and history of an area; two common areas for research--client-sponsored contract work and academic form; both can be executed in same framework of multi-phased data collection; both can be organized by a scientific research design; major difference in researcher's control over study area location and sampling strategy; in client sponsored work, there is the implicit understanding that data not collected or recorded will be most likely destroyed

a. Data recovery on Punalu'u Resort property will primarily follow the direction of client sponsored investigations; however, legitimate academic research should not be discouraged in parcels not planned for immediate development--such research might possibly even be encouraged

a. Evaluation of sites significant for information content

1) Resources that have yielded or may be likely to yield, information important in prehistory or history (36 CFR Sec. 60.4)

b. Evaluation of sites potentially significant as representative examples of site types

1) Resources which embody the distinctive characteristics of a type, period, or method of construction, or

2) Resources that may represent a significant and distinguishable entity whose components may lack individual distinction (36 CFR Sec. 60.4)

c. Evaluation of sites with potential cultural significance (under the guidelines prepared by the Advisory Council on Historic Preservation [ACHP]; Draft Report, August 1985)

1) Potential cultural significance is evaluated by 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; a property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value (ACHP 1985:1, 7)

2. In order to facilitate future client management decisions regarding site treatments, sites are further evaluated in terms of three value modes which are derived from the previously mentioned State and Federal evaluation criteria

a. 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

b. Interpretive value--potential of archaeological resources for public education and recreation; ability of site to inform the general public about the past and about how and why that past is studied; generally derivative in nature--often, though not always, obtained from the investigation and delineation of research value

c. Cultural value--refers to the potential of archaeological resources to preserve and promote cultural and ethnic identity and values

3. Evaluative discussion--will include the potential for research, interpretation and cultural enhancement at the following levels:

a. Punalu'u Resort property as a sub-area of Kau, Hawaii

b. Individual sites--known significant sites

CONSERVATION PROGRAM CONSIDERATIONS

A. Introduction--intent is to preserve cultural resources for present and future uses; to allow for upgrading interpretive possibilities; to provide for future advances in archaeological method and theory; conservation is the best alternative from a historic preservation viewpoint and is the execution of a public trust to the highest degree

B. Conservation methods--conservation not restricted to preservation of specific sites; entails a program of preservation combined with local community interaction and education

1. Preservation--specific act of protecting a site and its surroundings, i.e., maintaining the integrity of a site and the qualities which contribute to its significance; in interpretive terms, the point of preservation is lost when modern structures are constructed against or immediately adjacent to a site, thus detracting from or undermining its interpretive value; implementation actions include:

a. Resource banking--site is set aside for preservation; no work is done on the site, except necessary stabilization; buffer zone established around site to protect and maintain integrity

b. Adaptive reuse without interpretation--site set aside within a multiple use area, i.e., park, resort landscaping; no work is done on site except necessary stabilization

c. Periodic monitoring to review site condition and reassess preservation status; conservation status may change if additional work is required to maintain integrity

d. Nomination of significant sites to the State and National Registers of Historic Places--in recognition of exceptional significance; may be able to apply for Federal grant monies for later interpretive or research activities; implications of nomination in terms of review process, Advisory Council on Historic Preservation/SHPO roles

2. Community involvement--historic preservation cannot succeed if it involves only professionals; both the community and the site generally benefit from personal involvement of community members in site preservation and presentation

DATA RECOVERY PROGRAM CONSIDERATIONS

A. Introduction--purpose of program is to organize future archaeological work in a coherent, scientific-based plan to meet the requirements of the management needs of Punalu'u Resort and the scholarly needs of the archaeological community, as well as standards established by the Society for Hawaiian Archaeology; because Punalu'u Resort lands will be developed on a project-specific basis, it is probable that archaeological work will be carried out by different archaeologists; the program must be adaptable to this condition and follow generally accepted procedural phases

B. Implementation stategy--process for carrying out archaeological work

1. Levels of archaeological work--archaeology is a process of discovery in which the results of one level of work leads to the next; any one level may also be the end of the process; without proceeding on a step-by-step basis, it is difficult to predict how much work will ultimately be required; in all cases where further work is carried out, significance evaluations and recommendations made in previous levels should be reassessed:

a. Reconnaissance survey and background research--purpose is to locate available historical and archaeological evidence about the subject area; to evaluate the general nature of the resources (i.e., presence/ absence, general distribution); preliminary site significance evaluations can be made in some cases at the reconnaissance level; should be carried out concurrent with management plan preparation or as immediate first step of management plan implementation. The archaeological reconnaissance survey was carried out August-September 1986 (Rosendahl and Rosendahl 1986). Previous archaeological work conducted on the project area is summarized in Rosendahl and Rosendahl (1986:5-11). Briefly, earlier major projects in the project area included a heiau and petroglyph inventory by Stokes in the early 1900s (Kelly 1980:69-77) (Cox and Stasack 1970:80-81), numerous surveys by Hansen (1974a, b, c, 1978, 1980, n.d.) conducted in 1968 thru 1980, survey and excavations by Barrera and Hommon (1972), and Crozier and Barrera (1974), and salvage excavations at Site 50-Ha-B9-21 by Kaschko (1973).

b. Intensive survey--systematic recording (mapping, written descriptions, photographs) and subsurface testing or surface collection; purpose is to identify area with the most potential for research excavation or preservation and

to document evaluations of significance; recommendation from this level of work should be integral to one of the management plan programs (research, interpretation, conservation) or a recommendation of no further work is warranted

If recommendation is for one of the management alternatives, specific suggestions should be included

1) Research/data recovery--preliminary research design for specific site(s) should be prepared concurrent with testing phase; should show how information from site will contribute to knowledge about the Punalu'u area

2) Interpretation--should discuss the applicable theme and how the site(s) will fit into existing interpretive program, with detailed recommendations for incorporating site(s) into program

3) Conservation--should discuss how the site(s) will benefit future programs; justify preservation over any other alternative

c. Excavation--last stage of archaeological work before any construction impact on site; purpose is to collect data from subsurface context in coherent and organized manner; to answer questions pertaining to history and culture; based on research design formulated from information collected from preceding levels of work; research design is essential for organizing excavation strategy

d. Data analysis and interpretation--(also applies to testing phase) analysis of recovered material and interpretation of data, in context of research questions posed at beginning of work; must also address any unpredicted findings that could have implications for future research

e. Dissemination of findings--(also applies to reconnaissance and testing) preparation and distribution of professional reports on archaeological activities; can also include interpretation of findings for non-professionals

2. Guidelines for data recovery--should any guidelines or standards be approved by any review agency or by a professional organization, they should be reviewed for possible incorporation into this HSMP

a. Reconnaissance survey--follow guidelines approved by the State Board of Land and Natural Resources; where Federal monies are involved, conform to any Federal guidelines (Code of Federal Regulations); guidelines of the Society for Hawaiian Archaeology and Hawaii County Planning Department

a. Custodianship--encourages community members or group to share upkeep responsibility; most effective with sites of high cultural value

b. Education/public outreach--encourages interaction between the resort and local community in historic sites management through school visitations; may involve interaction of consulting archaeologist with school visitors

C. Application to parcel and known sites--based on assessment of background information and overview, with consideration of the potential for conservation efforts at Punalu'u Resort

D. Criteria for selecting conservation option for sites--all values (research, interpretive, cultural) of significance are considered in selection of areas or sites for conservation; conservation areas should be designed with an effort to preserve a representative sample of the whole resource base, since all values change; elements for considering a representative sample include variety, quantity, clarity, integrity and environmental context; additional elements for consideration include:

1. Site which has high interpretive potential but does not fit into existing interpretive theme

2. Site with high research value but there is insufficient time, personnel, financial support, or expertise to carry out adequate research, but no immediate development pressures

3. Site with high cultural value, particularly if in a significant local context

4. Site lends itself to educational purposes

5. Site is in an area which can be set aside for preservation, such as open landscape, which can be maintained over time; and

6. Conservation must minimize potential for vandalism at the site, or erosion due to excessive and previously absent exposure

INTERPRETIVE PROGRAM CONSIDERATIONS

A. Introduction--the most publicly visible of the three management alternatives; intent is to inform the public about the past and the cultural resources which are tangible elements of the past; successful interpretive program conveys a sense of history and continuity to people who are often transient visitors to a place; performs a function of site preservation

1. Benefits of an interpretive program--potential for stimulating tourism through amplifying special historic quality of resort area; provide visitor with a means for understanding the cultural background and heritage of an area in a tangible sense; is a form of public relations in local context if interpretation is sensitive and not overly commercialized; public interest in historical interpretive programs is high and such a program generally serves to attract rather than decrease resort visitation

There is considerable potential for developing a successful interpretive program at the Punalu'u Resort, based on the following:

a. Size of the property lends itself to broad aerial and thematic interpretive possibilities

b. Presence of archaeological site types that are not obscure, and are appreciated for their aesthetic qualities as well as their historic context, such as the heiau and historic site(s)

c. the artifact collection recovered from previous excavations, could be displayed in a variety of possible contexts within resort facility; and

d. The environmental setting of the resort provides an excellent backdrop for the appreciation of human adaptability to this area

2. General implications of an interpretive program

a. Expenses--relatively large, short-term expenses to carry out the research on which interpretations are built; relatively small long-term expenses to adequately maintain interpretive areas, i.e., public access, landowner liability, updating and revising interpretation, staffing

b. Responsibility--accuracy and truth in interpretation and restoration; site security and protection

B. Elements of interpretation--there are five essential aspects to an interpretive program which cannot be addressed in a step-by-step approach; rather, they must be dealt with as interacting elements; they are discussed below in no order of priority, each is equally important

1. Levels of interpretation--degree to which interaction between visitor-viewer and archaeological resources is designed; establishes the "stage" or location of interpretive activity

a. Off-site--overview of site is permitted but actual contact is discouraged; interpretive activity takes place away from but in view of site, which is essentially a static exhibit; signage and printed material provide interpretation

b. On-site--interpretive activity takes place within the site area; visitor is encouraged to walk through and view site at close range; wide range of interpretive options with on-site interpretation; primary problem is increased potential for site deterioration from visitor use

1) Self-guided--visitor is independent along established trails through site; guided by signs or brochure/guidebook

2) Guided--organized, escorted tour through site along established trails; led by trained guides; on-site staff provides better protection for site, more contact with visitors, better potential for public relations

3) Limited access--on-site access limited to educational groups, community groups, select tours; led by trained guides equipped with manuals and guidebooks

4) Non-site--interpretive option focused away from archaeological site toward graphics, artifact display, media in another facility; loses the effect of the site itself; can be incorporated into hotel interiors and/or landscaping

2. Mechanisms to convey information--primary goal is to convey information in easily disseminated fashion; range of methods dependent on level of interpretation involved

a. Printed material--brochures, leaflets, books; items which can be removed and taken home as souvenir; can be designed for specific target groups; flexible interpretive medium

b. Exhibit--stationary medium; broad range of locational, structural options

c. Trails--channels visitor through site or exhibit; can be used to help protect fragile site areas and to connect spatially separated interpretive areas; can be meaningful feature of the overall interpretive program

d. Guides--staff trained in history and archaeology of area; role is to verbally communicate site background and answer questions; provides added protection for site

3. Theme--unifies, gives coherence to interpretive efforts; essential part of organizing program, particularly in selecting sites to be used;

a. Relation of economic activities to natural environment;

b. Aesthetic values as expressed in architecture, landscaping, and locational choices--exhibited in house platforms, heiau, various site clusters along the coast; and

c. View of death--inferred from burial platforms

4. Site selection--characteristics of good interpretive sites

a. Those sites which best illustrate the interpretive theme

b. Those sites which are stable enough to withstand direct and potentially intensive impact from visitor traffic

c. Those sites which are easily accessible and whose use in an interpretive program will not endanger other less stable sites

d. Those sites, especially near high use areas, where an active interpretation program may serve to best preserve it

5. Site preparation--range of preparatory work dependent upon the level and method of interpretation; primary goal is to protect site integrity, secondary goal is to establish the setting for interpretation

a. Stabilization--reinforcing section of a site to prevent further deterioration; vegetation clearance and maintenance; presents archaeological site as it existed when found by archaeologist; should be carried out for all sites used in an interpretive program

b. Restoration--replacement and repair of portion of the site disturbed or damaged; presents site as it was after abandonment, before deterioration occurred; applicable to on-site and off-site interpretation

c. Reconstruction--reproduction of site with superstructure, i.e., pole and grass house with interior paraphernalia; presently site as it could have been during use; especially effective for on-site interpretation

HISTORIC SITES SELECTED FOR INTERPRETIVE PROGRAMS

1. List of historic properties and specific plans for each site. Identify what archaeological work would be required.

Appendix L: Geologic Hazards At Punalu'u Resort Site

GEOLOGIC HAZARDS
AT PUNALU'U RESORT SITE, KA'U, HAWAII

EXISTING CONDITIONS

The project site is located on the south flank of Mauna Loa, an active volcano, about one mile west of the contact between Mauna Loa and Kilauea near the latter's southwest rift zone. This location poses certain risks from possible future volcanic and seismic events.

Volcanic hazards include lava flows, deposition of tephra (volcanic ash), pyroclastic surges (explosive eruptions), volcanic gases, and ground fracture and subsidence. These hazards have all been addressed and evaluated for the island of Hawaii in a recent publication (Mullineaux, et al, 1987). In general, the site has not been significantly affected in historical times by any of these volcanic hazards.

The site is located in Zone 3 (the third most hazardous of 9) relative to lava flow hazards as defined by Mullineaux, et al. They state that only about 1-3 percent of the Mauna Loa area in Zone 3 has been covered by lava in historical time and about 15-20 percent in the last 750 years. Also, the hazard decreases with distance from Mauna Loa's summit, and is less on the southeast flank than on the northwest. No historic flows have reached the ocean on Mauna Loa's southern flank. Lipman and Swenson (1984) shows the latest lava flows at the site to be in Age Units 2 and 1, about 2,400 years old and 3,900 years old, respectively.

Mullineaux, et al place the site in Zone 2 (of 3) for tephra fall hazards. Tephra is produced primarily at the source of a volcanic eruption, and the hazard dissipates rapidly with distance from the eruption site, although less quickly in the downwind direction. Tephra falls in zone 2 are expected to be "frequent but thin." At the site, light ash falls from upwind eruptions along Kilauea's southwest rift zone would likely be the most severe occurrence.

The hazard zones for volcanic gases shown by Mullineaux, et al are the same as for tephra falls. Effects of volcanic gases on vegetation in the Ka'u area have been reported for Kilauea eruptions, but apparently there have been no significant effects on humans.

Deposits from pyroclastic surges have been recognized on Hawaii only adjacent to Kilauea's caldera, so Mullineaux, et al consider a hazard zone to exist only within 10 km. from the caldera which is about 22 miles from the site. Although without precedent, explosive eruptions are theoretically possible closer to the site where Kilauea's southwest rift zone meets the coastline.

The south flanks of both Mauna Loa and Kilauea volcanos are cut by faults, some of which have shown movement during historic earthquakes. The Honuapo fault system (Stearns and Macdonald, 1946), is approximately 3 miles west and north of the site, and may be an extension of the seismically active Kaoiki fault system, also on Manua Loa's flank to the northeast. These faults may represent scarps of landslide-type movement, similar to the south flank of Kilauea (Swanson, et al, 1976), and represent one reason for the region including the site to be placed in hazard zone 3 (of 4) for ground fracturing and subsidence by Mullineaux, et al. Lipman and Swenson (1984) state that geologic evidence indicates the faults have been largely inactive for tens of thousands of years.

Risk of coastal subsidence on Mauna Loa is less severe than on Kilauea, however, where as much as 3.5 meters of subsidence occurred at the coastline during the 1975 magnitude 7.2 earthquake (Lipman et al, 1985). In contrast, approximately 0.1 meters of uplift, essentially no movement within the accuracy of the measurements, was estimated to have occurred during the same event at Punaluu. No other historical vertical movements at the site area are known to have been documented, but the geologic structural setting appears to be similar to that on Kilauea, so that similar subsidence may be possible.

Long-term gradual subsidence is also occurring on the entire island of Hawaii with rates of 1.5 and 1.9 mm/yr. calculated at Honaunau and Kealakekua, respectively (Moore, 1987). These rates are in addition to a worldwide rise of sea level of about 1.5 mm/yr. Thus, total long-term subsidence is expected to be on the order of 0.3 to 0.45 meters in a century.

The southern portion of Hawaii island is the most seismically active area in the state. The two largest historical earthquakes occurred in the region, one on April 2, 1868 estimated to be magnitude 7-1/2 with an epicenter probably in the Ka'u district, and a magnitude 7.2 event on November 29, 1975, with an epicenter near Kalapana. Other large earthquakes with epicenters near the project included a magnitude 6 event near