FINAL ENVIRONMENTAL IMPACT STATEMENT
Volume II

TECHNICAL APPENDICES

THE COUNTRY COURSES AT KAHUKU

Punamano and Malaekahana, Koolauloa District, Oahu, Hawaii

Applicant:
Kuilima Resort Company
Honolulu, HI

April 1989

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APRIL 1989

Prepared for:

KUILIMA RESORT COMPANY
Honolulu, Hawaii

Prepared by:

GROUP 70 LIMITED
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SECTION 8
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THE COUNTRY COURSES AT KAHUKU

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FOR THE

PROPOSED PUNAMANO GOLF COURSES

Prepared for:

Kuilima Resort Company

Prepared by:

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Honolulu, Hawaii 96814

February 1989

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INTRODUCTION

Kuilima Resort Company is proposing the development of three 18-hole golf courses in the vicinity of Kahuku on the North Shore of Oahu (see Figure 1). This site, called Punamano, is located approximately 1.5 miles west of Kahuku Town. The site, containing approximately 605 acres, is located mauka of Kamehameha Highway across the Kuilima Resort.

The objective of this report is to present the necessary planning and preliminary engineering documentation for the proposed wastewater infrastructure to accommodate wastewater flows from the proposed Punamano Golf Courses. Specifically, this report addresses the following:

1. Background information on the proposed project
2. Wastewater flows
3. Identification of facilities
4. Facility design data and information

BACKGROUND

Proposed Project

Three 18-hole golf courses are planned for the site covering approximately 605 acres. The proposed site is shown on Figure 2. Each course will be designed for a different level of playing difficulty. Of the 605-acre site, approximately 270 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

At each of the three golf courses, a small clubhouse (12,000 to 14,000 square foot area) will be constructed. Each clubhouse would include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, and administrative offices. Small clubhouses are planned due to the proximity of extensive support facilities at the Kuilima Resort. A parking area will be provided at each clubhouse with approximately 130 to 160 spaces.

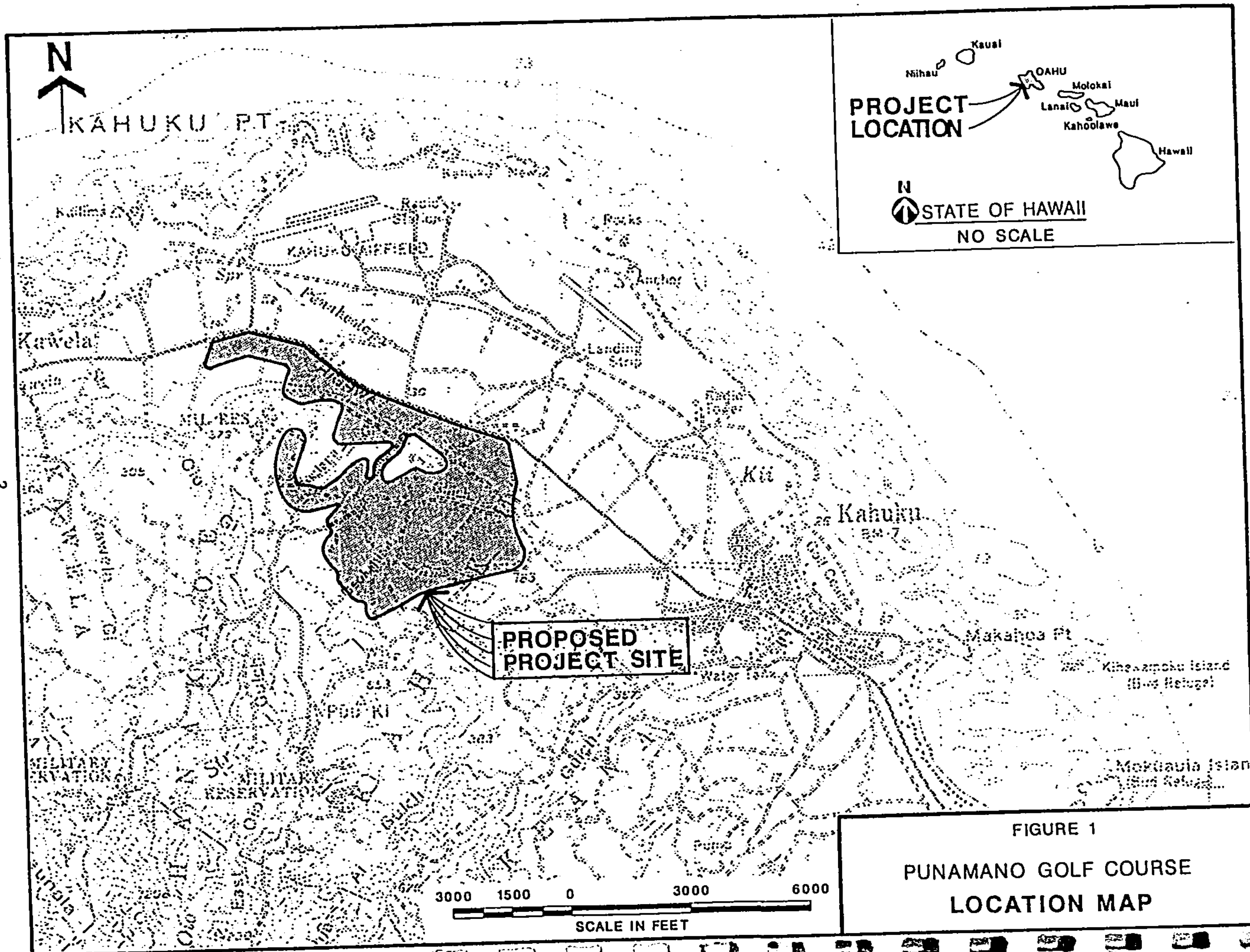

FIGURE 1

PUNAMANO GOLF COURSE

LOCATION MAP

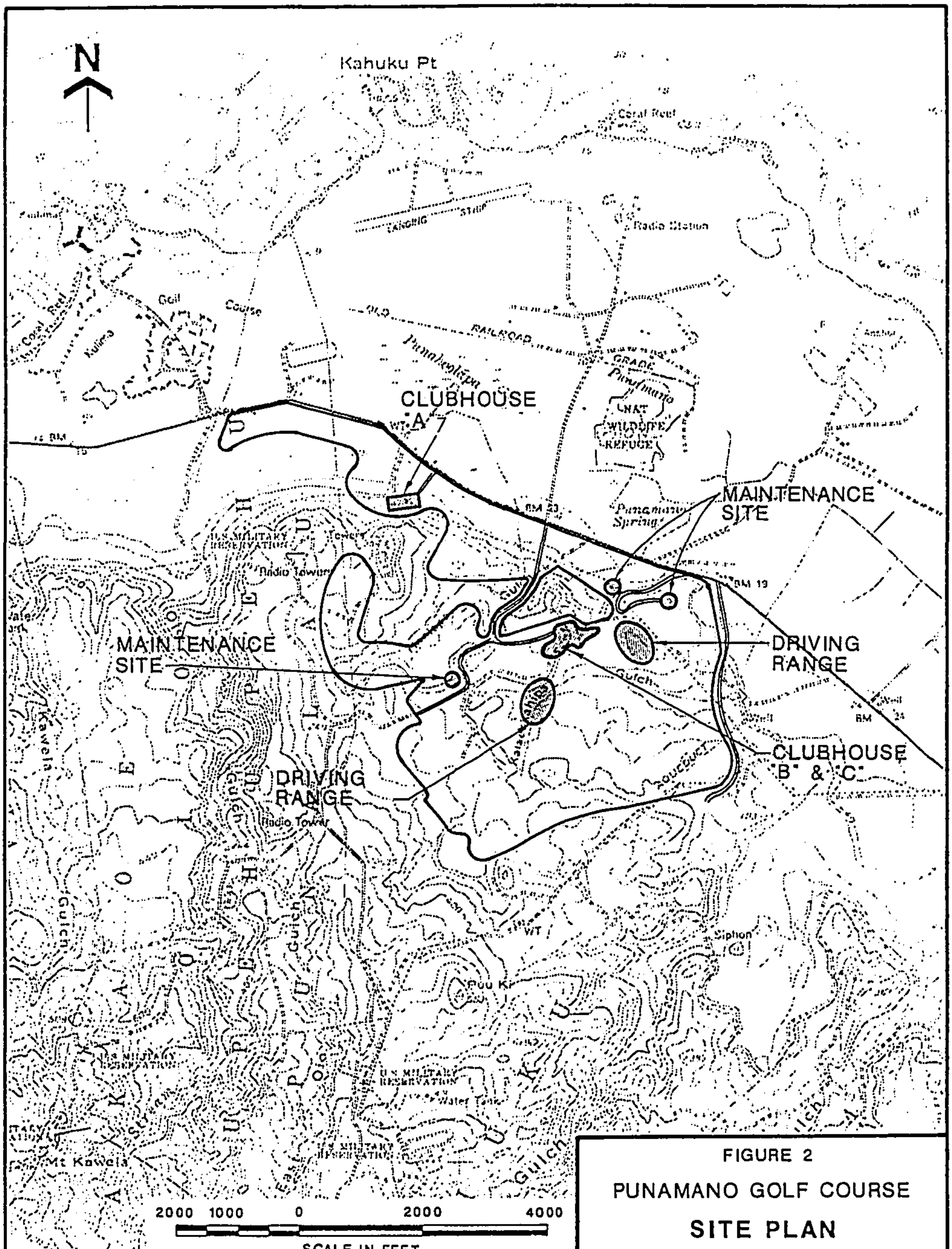

FIGURE 2
PUNAMANO GOLF COURSE
SITE PLAN

Two golf driving ranges will be constructed at the two upper (mauka) golf courses. Each driving range will have 20 to 26 tee positions. Parking for this facility will be accommodated at the clubhouse area for each course.

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-05: Por. 1, Por. 2, 5, 6, and Por. 7, and TMK: 5-7-01: Por. 21. The 605-acre project site at Punamano has been owned by The Estate of James Campbell since the 1890s.

The irregularly-shaped boundary of the Punamano site consists primarily of vacant grass and shrub meadows, rolling hillsides, intermittent stream gulches, and some steep slopes and cliffs. Portions of the site contain remnants of previous agricultural activities, including overgrown cultivated fields and an abandoned Christmas tree farm. Four abandoned windmill structures are located within the site near Kamehameha Highway. A road bisects the site, providing access from Kamehameha Highway to the U.S. Army Kahuku Training Area, located mauka of the site.

Land uses of property adjoining the Punamano site include military, agricultural, commercial, and resort activities. A U.S. Air Force telecommunications facility is also located adjacent to the property, along its western boundary. Also along the western boundary of the lower portion of the property is a small agricultural operation currently producing bananas and papayas. The Kuilima Resort is located across Kamehameha Highway from this site. Tanaka Store, a well-known local landmark, is a small grocery store and gas station located across Kamehameha Highway from the site at its Kahuku-side boundary. Vacant agricultural land adjoins the Kahuku-side boundary of the site. A major aquaculture operation exists just east of the Punamano site and makai of Kamehameha Highway.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall for Station No. 907.00, located at the Kuilima Resort, over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 280 feet at the western boundary. Slopes of 1 to 5 percent are found over most of the makai portion of the site, with moderate to steep slopes ranging from 5 to 20 percent over much of the mauka area. Steepest slopes occur around isolated peaks and along gulches, where slopes in excess of 30 percent occur. The southwest area is dominated by the steep hillsides and isolated peaks that border either side of Hoolapa Gulch. The southeast region has an undulating topography of minor gulches and ridges that intersect at Kalaeokahipa Gulch. Slopes are predominantly moderate in this region, except for the steep slopes along Kalaeokahipa Gulch.

The offsite watershed area mauka of the project site is characterized by moderate slopes near the project's southwest and southeast borders, with progressively steeper slopes at higher elevations. Typical slopes in the upper region are more than 20 percent. Elevations vary from 10 feet near the project's southwest border to 653 feet at the upper boundary of the watershed. The offsite area between the northeast side of the project boundary and Kamehameha Highway consists of uniformly sloping lands of 2 to 5 percent and is bisected by an existing drainageway. Elevations vary from 15 to 65 feet.

The vegetative cover is variable, ranging from open areas of short grasses to heavily vegetated areas consisting of tall grasses, scrub brushes, and trees. Uncovered areas in the form of dirt roads and pockets of erosion are also present.

EXISTING WASTEWATER FACILITIES

Currently, wastewater flows generated from the Turtle Bay Hilton Hotel and the resort condominiums, Kuilima East and Kuilima West, are treated at an existing waste stabilization pond. The pond is located east of the entrance to the Kuilima Resort complex and makai of Kamehameha Highway.

A new treatment facility is being constructed mauka of Kamehameha Highway to service the entire Kuilima Resort complex, including the existing Turtle Bay Hilton Hotel and the resort condominiums. Major elements of this sewerage system include (1) the wastewater collection and transmission system, (2) the wastewater treatment system, and (3) the effluent disposal system. Once this new treatment facility is completed, the existing waste stabilization pond will be abandoned.

Private residences at nearby Kawela Bay are served by individual cesspools. The Turtle Bay Resort Complex sewerage system has the capacity to serve this residential area.

Wastewater Collection and Transmission System

The Turtle Bay Resort Complex is served by underground sewers that collect and convey wastewater to a central sewage pump station located near the Turtle Bay Hilton Hotel. Via a 16-inch pressure main, this pump station conveys incoming wastewater from the hotels, condominiums, shopping village, and recreational spots to a wastewater treatment plant (WWTP) located on a 20-acre parcel mauka of Kamehameha Highway (Figure 3).

Wastewater Treatment System (currently under construction)

The treatment plant, an aerated facultative lagoon facility, is capable of handling 1.32 million gallons per day (mgd) of sewage. Figure 4 schematically depicts the treatment processes of the Turtle Bay Resort WWTP.

Raw wastewater is initially screened of large objects. An aerated grit separator then removes heavy inorganic particles before channeling the wastewater into the aerated lagoons. In large, 12-foot deep basins that provide 25-day detention time, naturally occurring bacteria decompose the wastes under controlled organic loading conditions to the point where, after chlorination, the treated product, or effluent, is reusable for irrigation or disposal by injection wells.

During unusual plant operating conditions, such as overcast skies or stormy weather, standby pressure filters add another treatment step, as needed, to clean and "polish" the effluent further.

Waste solids captured in the lagoons undergo virtually complete decomposition by bottom-living facultative bacteria.

Effluent Disposal System

Effluent is delivered in a 20-inch gravity pipeline from the treatment plant to the resort's golf course for irrigation reuse or diverted offsite to injection wells.

The Turtle Bay golf course and injection wells are situated makai of the "no pass" line established by the Board of Water Supply, whereas the proposed Punamano Golf Course will be located mauka of that line. The Hawaii State Department of Health's Underground Injection Control (UIC) line is makai of the Board of Water Supply's "no pass" line (Figure 5).

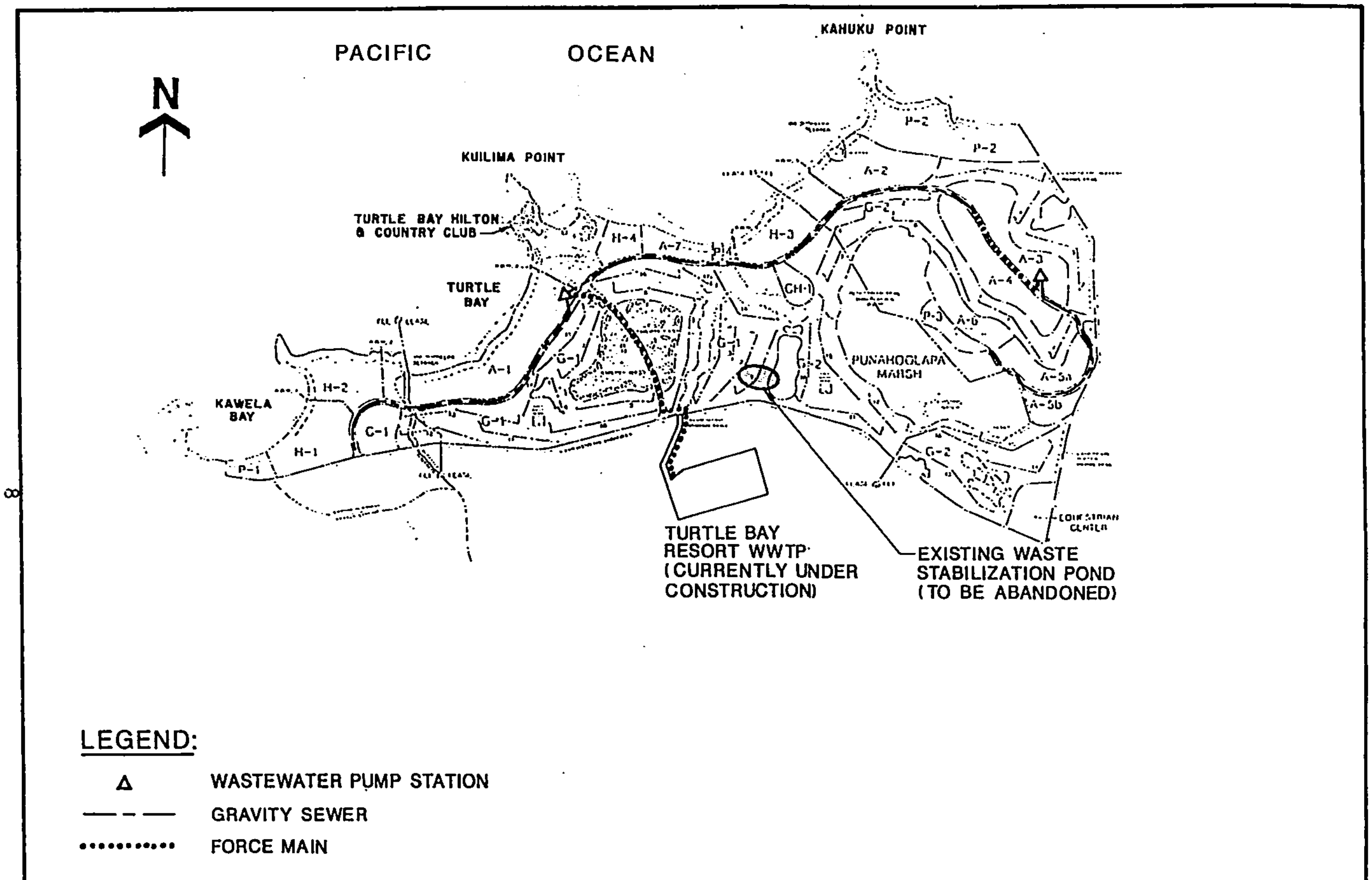

FIGURE 3

TURTLE BAY RESORT

WASTEWATER SYSTEM

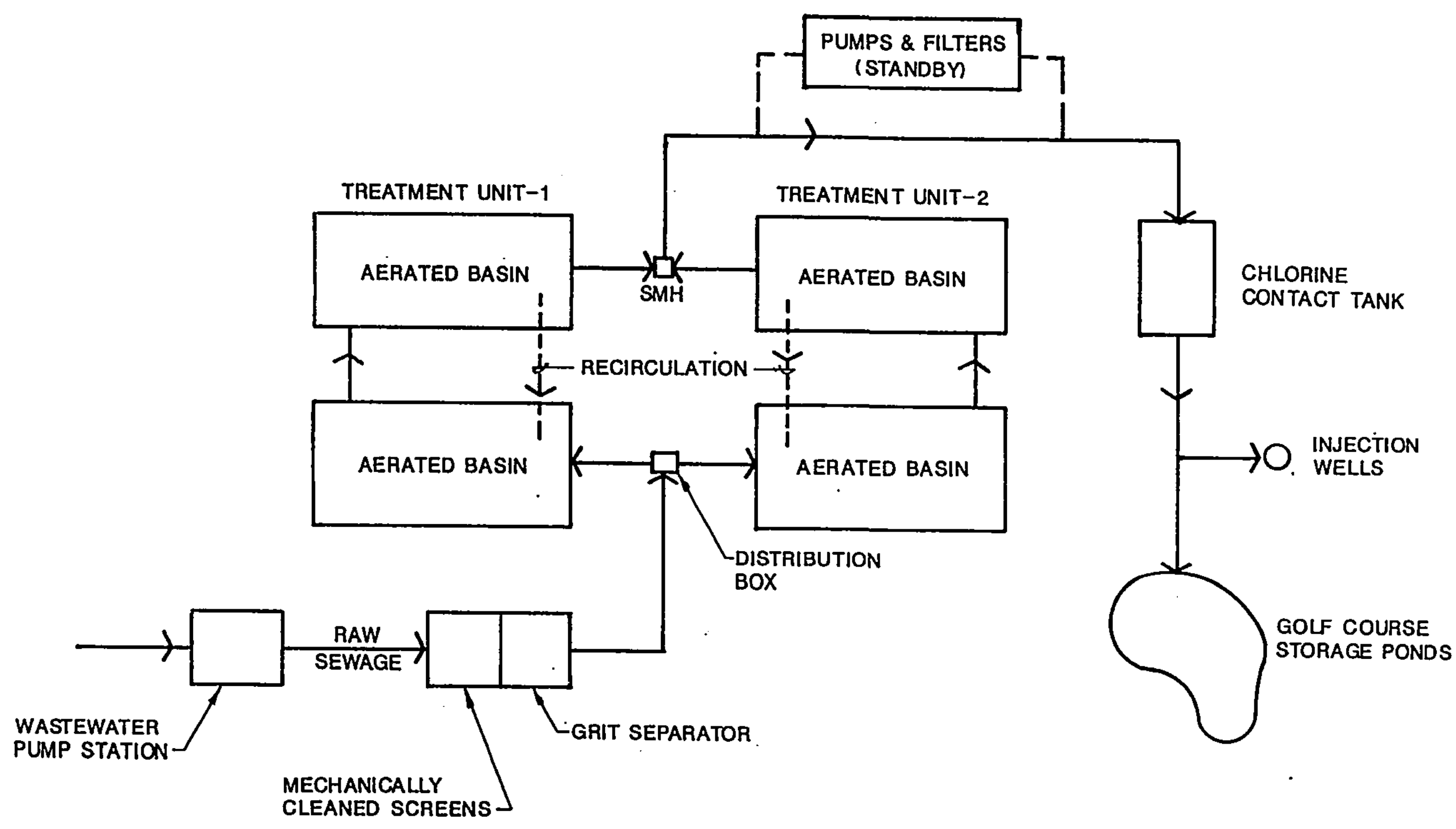

FIGURE 4
TURTLE BAY RESORT WWTP
PROCESS DIAGRAM

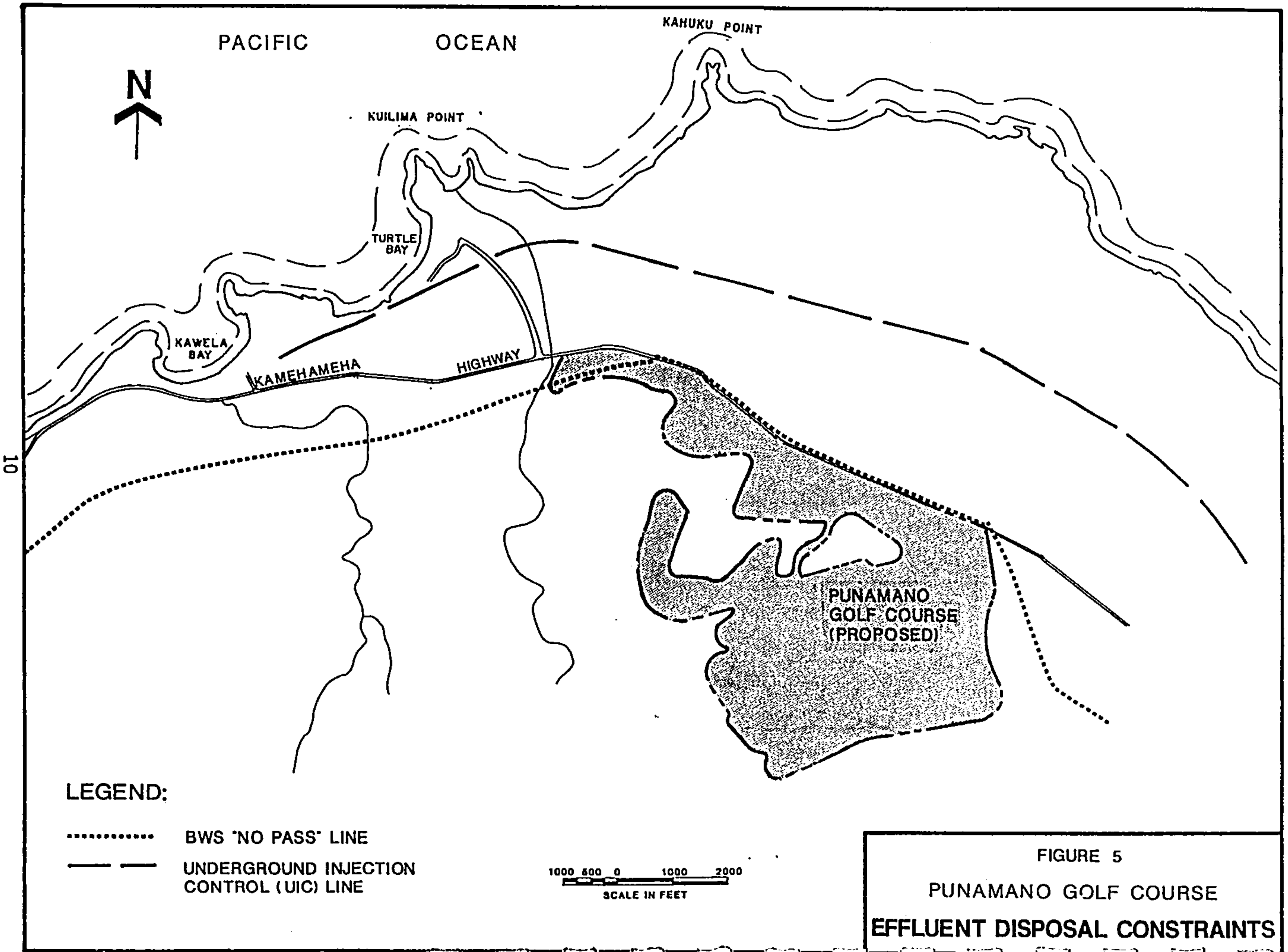

FIGURE 5

PUNAMANO GOLF COURSE

EFFLUENT DISPOSAL CONSTRAINTS

PROPOSED SEWER IMPROVEMENTS FOR THE NEW PUNAMANO GOLF COURSE DEVELOPMENT

The new golf course complex will generate approximately 50,000 gallons per day of domestic sewage requiring collection, transmission, treatment, and disposal. Approximately 10,000 lineal feet of small-diameter gravity sewers and force mains and two small sewage pump stations will be constructed within the golf course grounds to convey wastewater to the WWTP for treatment and disposal.

Figure 6 shows the proposed sewer improvement plan.

Effects of Punamano Golf Course Development on Turtle Bay Wastewater Treatment Facilities

Wastewater Treatment Plant

The WWTP is designed to handle up to 1.32 mgd. At this flow rate, its aerated lagoon systems are designed to remove up to 90 percent of the organic and waste solids in the sewage, or better than the 85 percent removal criteria of Hawaii's public health regulations.

Table 1 illustrates the breakdown of wastewater contributions by various resort land uses as derived in the basis of design for the WWTP[1]. Where the Resort Development Master Plan originally targeted 1,922 hotel rooms and 2,441 condominium apartments, actual figures are 3,000 and 1,368 respectively. With this redistribution in hotel and condominium units, the Master Plan's sewage flow is estimated to be 1.24 mgd compared to the original 1.32 mgd, meaning a reserve treatment capacity of 80,000 gallons per day for the Turtle Bay Resort WWTP.

Since the new Punamano golf course complex will contribute about 50,000 gallons per day of sewage, the WWTP and disposal system can easily accommodate the proposed development's wastewater.

Sewage Collection and Transmission

The proposed golf course development is situated on the mauka side of

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[1]EDP Hawaii, Inc., "Wastewater Master Plan for Kuilima Resort," October 1985.

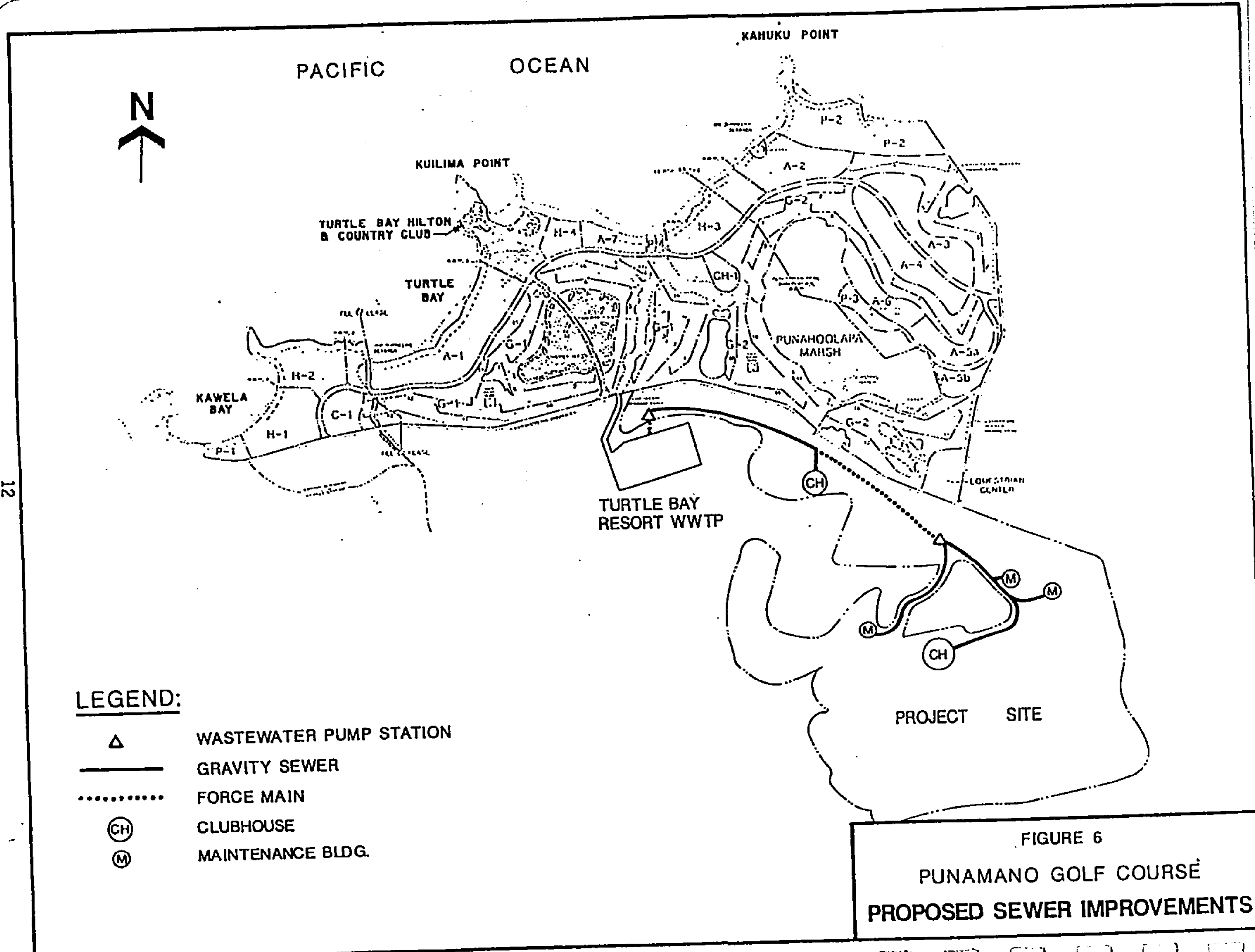

FIGURE 6
PUNAMANO GOLF COURSE
PROPOSED SEWER IMPROVEMENTS

TABLE 1

WASTEWATER QUANTITIES
(Turtle Bay Resort WWTP)

Land Use*	Resort Development Master Plan[1]				Revised Resort Development Master Plan[2]			
	No. of Units	WW (mgd)	Infil (mgd)	Ave Daily Q (mgd)	No of Units	WW (mgd)	Infil (mgd)	Ave Daily Q (mgd)
Hotel	1,922	0.31	0.13	0.44	3,000	0.48	0.21	0.69
Condo/Apt	2,441	0.55	0.24	0.79	1,368	0.31	0.13	0.44
Commercial	5 Ac.	0.01	0.01	0.02	8.5	0.03	0.01	0.04
Kawela Bay Residential	145 (18 Ac)	0.05	0.02	0.07	145	0.05	0.02	0.07
TOTALS		0.92	0.40	1.32		0.87	0.37	1.24

Reserve Plant Capacity = Planned Q Minus Revised Q = 1.32 - 1.24 = 0.08 mgd

* Per capita density: Hotel - 2.0 persons/unit; Condo/Apt - 2.8 persons/unit;
Residential - 4.0 persons/unit; Commercial - 3,000 gpd/acre
Per capita flows: Sewage - 80 gpcd; Infiltration - 35 gpcd or 1,300 gpd/acre (commercial)

1 EDP Hawaii, Inc., "Wastewater Master Plan for Kuilima Resort," October 1985.

2 Group 70, Inc., January 1989.

Since sewage from the new golf courses will be delivered to the WWTP headworks by its own sewerage system, the existing sewage collection and transmission system of the makai resort development will not be affected in any way.

PROJECT IMPACTS

Short-Term Impacts and Mitigation

Short-term impacts will be construction related and may include dust, noise, and traffic disruption along Kamehameha Highway. Although dust and noise will unavoidably occur from construction activities, the spread of dust can be controlled by a watering program, and the problems of noise can be mitigated by regulating the hours of construction work. Traffic disruptions can be controlled by limiting hauling only during nonpeak hours of traffic. Much of the sitework will be confined to the mauka side of Kamehameha Highway. Consequently, inconveniences to motorists should be minimal.

Long-Term Impacts and Mitigation

No long-term public impacts are expected due to operation and maintenance of the sewerage system. Sewers are underground, and the sewage pump stations will be situated well within the golf course grounds, away from Kamehameha Highway.

Nuisance odors from the pump stations are not expected since sewage retention times in an enclosed wet well will be short enough to prevent sewage septicity. Existing pump stations of the Turtle Bay Resort have not created odor problems and none are expected with this much smaller development.

Similarly, noise from the station's small horsepower pump motor should not pose any problems because of its containment in an underground chamber and the station's location far away from any facility.

APPENDIX B

WASTEWATER MANAGEMENT PLAN

FOR THE

PROPOSED MALAEKAHANA GOLF COURSE

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February 1989

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INTRODUCTION

Kuilima Resort Company is proposing the development of an 18-hole golf course in the vicinity of Kahuku-Laie on the North Shore of Oahu. This site, called Malaekahana, is located between Kahuku Town and Laie. The site, containing approximately 228 acres, is located mauka of Kamehameha Highway across Malaekahana State Park (see Figures 1 and 2).

The objective of this report is to present the necessary planning and preliminary engineering documentation for wastewater collection, treatment, and disposal at the proposed Malaekahana Golf Course. Specifically, this report addresses the following:

1. Background information on the proposed project
2. Existing site conditions
3. Proposed method of wastewater treatment and disposal
4. Impacts of effluent disposal

BACKGROUND

Proposed Project

An 18-hole golf course is planned for the site. Of the 228-acre site, approximately 90 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

The clubhouse (approximately 20,000 square feet) will include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, small meeting rooms, and administrative offices. A parking area will be provided, with approximately 160 to 200 spaces.

A golf driving range will be constructed at the upper portion of the golf course near the clubhouse. The driving range will have 24 to 30 tee positions. Parking for this facility will be accommodated at the clubhouse parking area.

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-06: Por. 6 and TMK: 5-6-07: Por. 1. The 228-acre

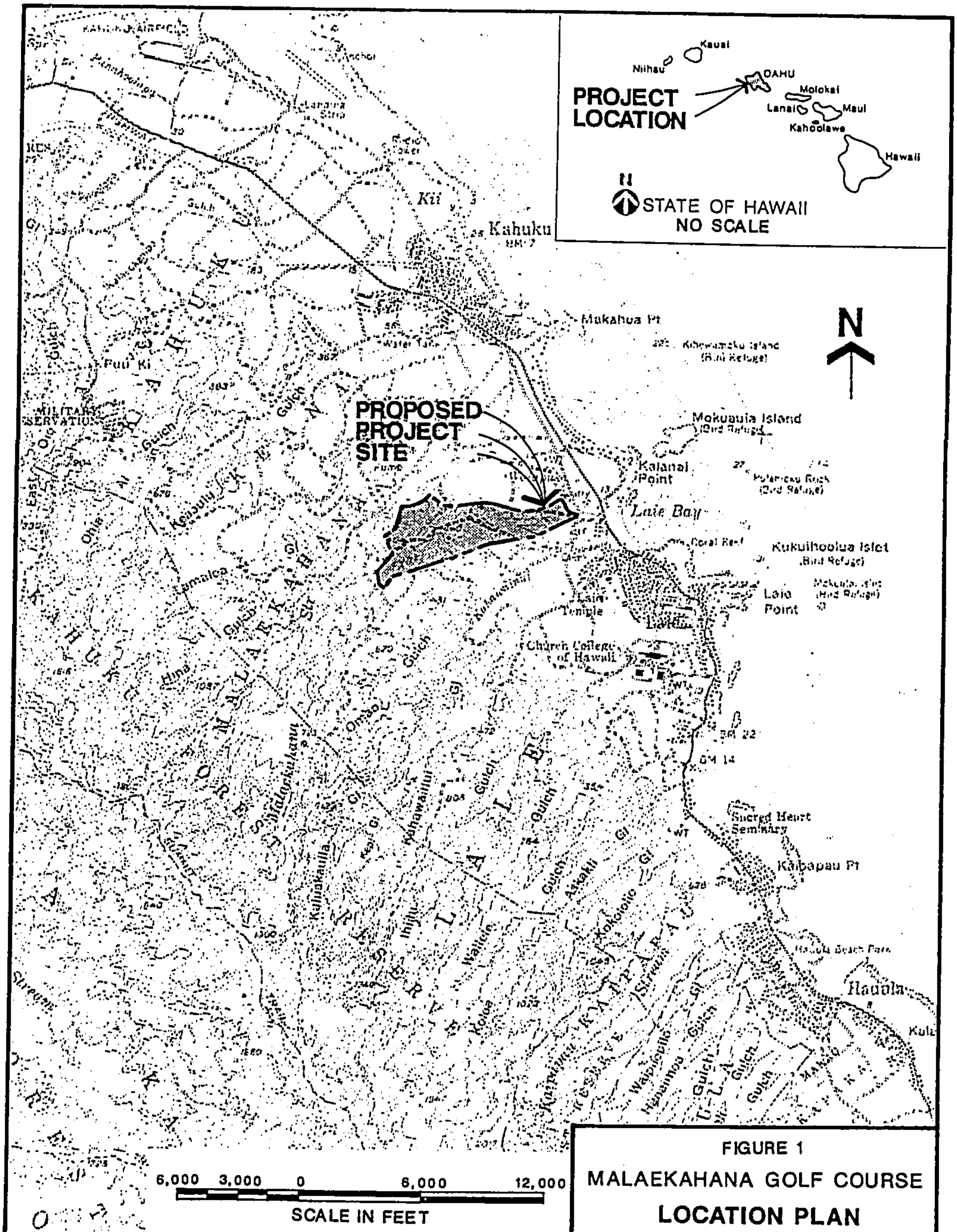


FIGURE 1
MALAEKAHANA GOLF COURSE
LOCATION PLAN

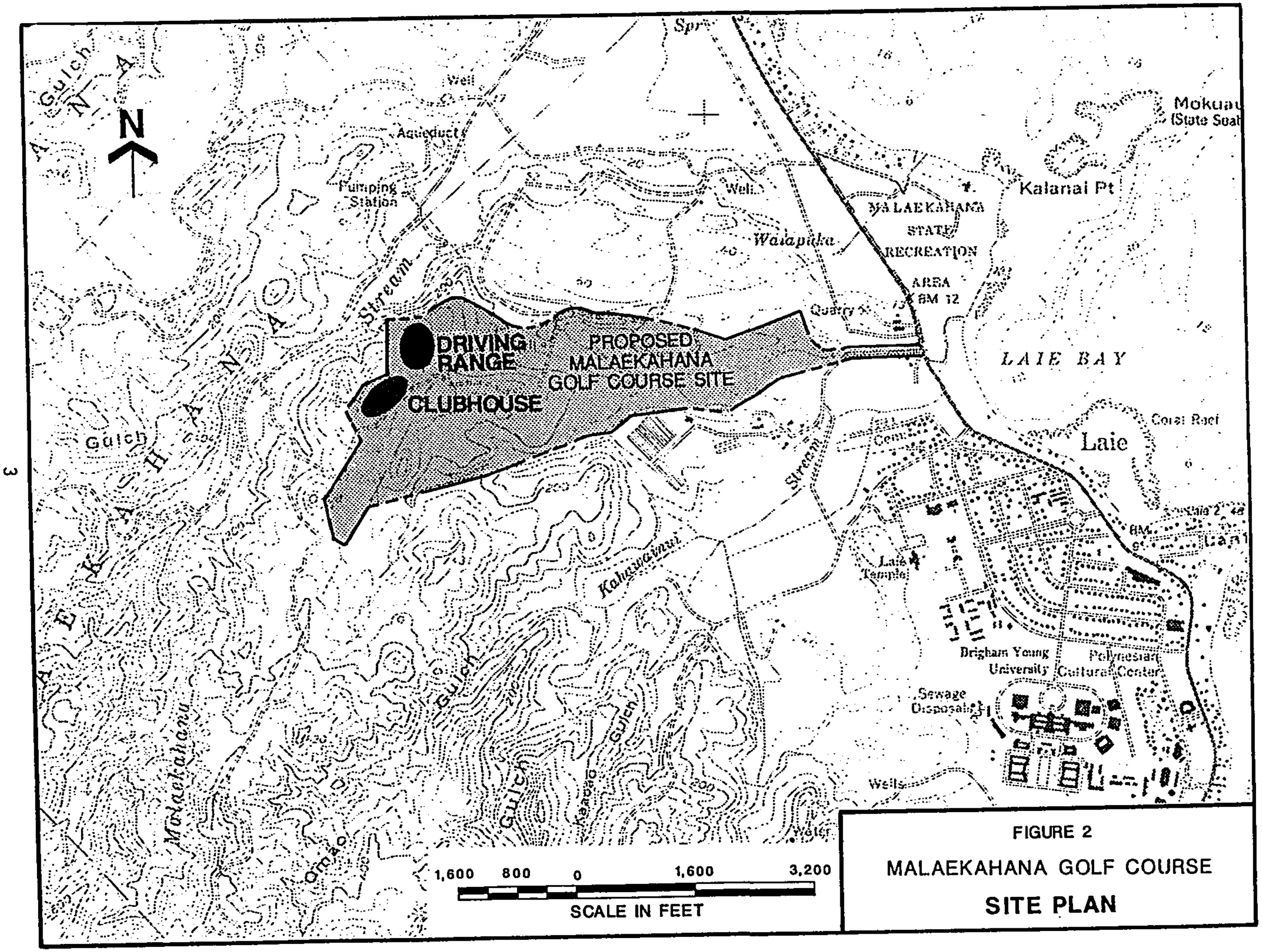


FIGURE 2
MALAEKAHANA GOLF COURSE
SITE PLAN

project site at Malaekahana has been owned by The Estate of James Campbell since the 1890s.

This site consists of many small hills that rise to elevations of 450 feet above mean sea level (MSL). The site is connected to Kamehameha Highway by a narrow strip of land extending mauka to the main portion of the property. The site is currently vacant, with the exception of some grazing uses. Formerly used extensively for grazing and some sugar cane production, the open pastures have become overgrown, reflecting the low-level activities of the site. No stream gulches cross the site; instead, concrete-lined water ditches cross parts of the lowlands, once performing an irrigation purpose, but now also overgrown and generally disintegrated. Barbed wire fences extend through much of the site and are maintained by the ranch tenants.

Land uses of adjoining properties are generally agricultural, military, recreational, and vacant. Makai of the site lies agricultural lands used for grazing that extend to Kamehameha Highway. Across the highway is Malaekahana State park. Along the southern boundary of the site is Cackle Fresh Egg Farm. The mauka boundary of the site adjoins other grazing lands and military use lands of the Kahuku Training Area. At the northern boundary of the site, agriculture and aquaculture operations are currently active, utilizing lowlands for their culture ponds.

The nearby communities of Kahuku and Laie are primarily low density residential areas with small village commercial shopping centers, churches, schools, and similar institutions. Malaekahana State Park is a large ocean-front park with picnic and camping facilities. Further south from this site in Laie Village are located Brigham Young University (Hawaii campus), the Mormon Temple, and the Polynesian Cultural Center.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 375 feet at the mauka boundary. Slopes of 3 to 10 percent are found over most of the central-mauka portions of the site. Steeper slopes of 20 to 30 percent occur around isolated peaks and along gulches. The central area is dominated by a wide, shallow gulch that begins near the mauka boundary and traverses 75 percent of the project site's length before exiting along the southeast boundary.

EXISTING WASTEWATER SYSTEM

The Kahuku Wastewater Treatment Plant (WWTP), approximately 1.2 miles from the project site, is the only municipal wastewater handling facility near the project area. The WWTP uses an oxidation ditch process to treat 0.2 million gallons per day (mgd) of domestic sewage, with provisions for expansion to 0.8 mgd. Sewered areas are entirely within Kahuku Town, with no plans during future plant expansion to extend municipal trunk sewers into the project area.

The Laie area, only partially sewered, is served by a privately-owned WWTP at Brigham Young University-Hawaii. Zion Securities owns and operates the 0.5 mgd "packaged" activated sludge plant and sewage collection system. This private system is rapidly nearing its design capacity of 0.5 mgd. Presently, flows amount to approximately 0.4 mgd, generated from the BYU-Hawaii campus, the Polynesian Cultural Center, and approximately 145 homes located mauka of Kamehameha Highway. The extremity of the Laie sewerage system ends about one-half mile away from the proposed project.

Homes not sewered in Kahuku and Laie are served by cesspools.

Figure 3 illustrates the location of the Kahuku and Laie sewerage systems in relation to the project area.

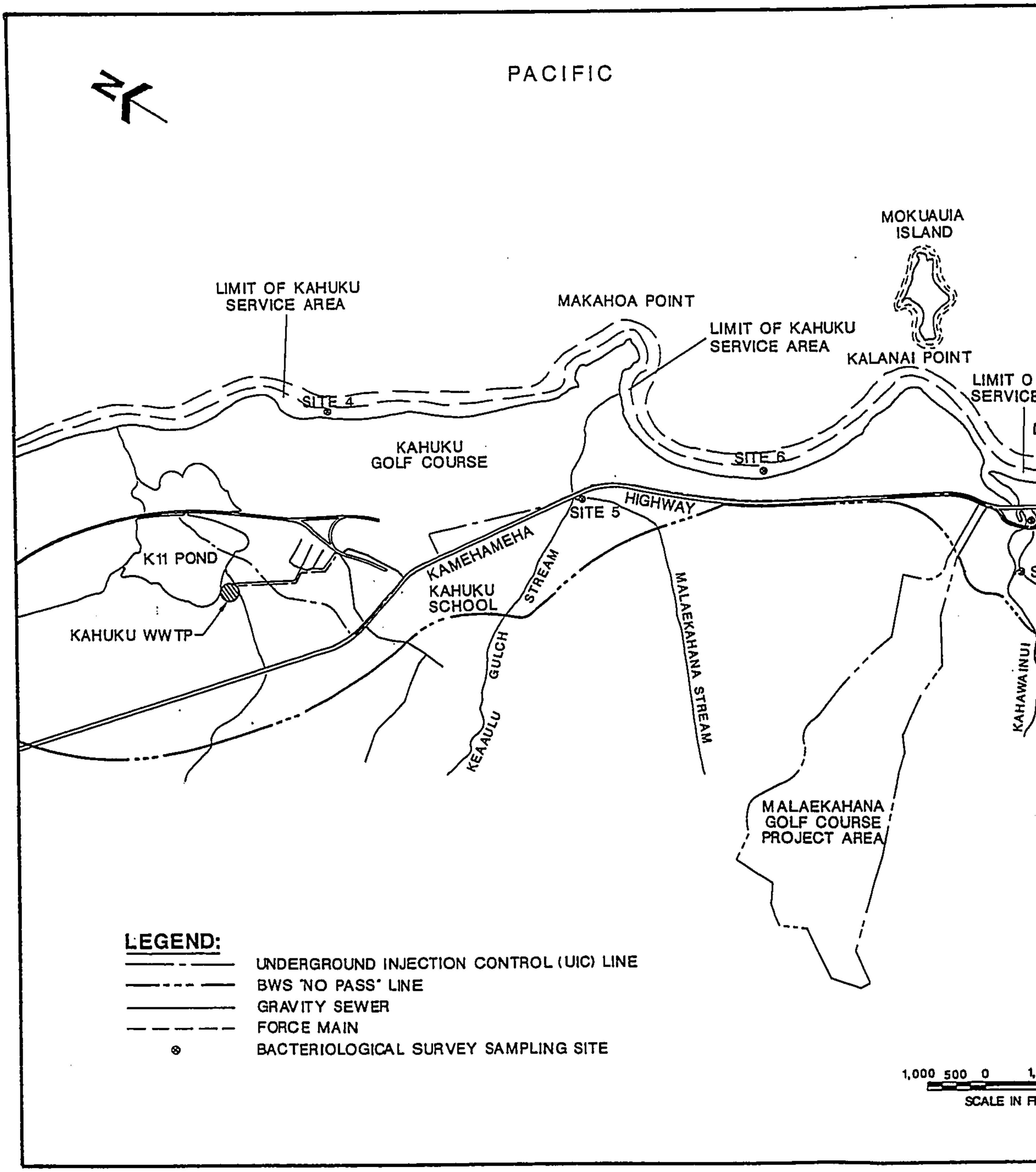
EXISTING COASTAL WATER QUALITY

In the North Oahu Facility Plan by R.M. Towill Corp. (1985), a limited bacteriological survey was conducted in selected locations in the waters along the shoreline and in Malaekahana and Kahawainui streams. The locations of the sampling sites are shown on Figure 3 and the results of the survey are shown in Table 1.

Data indicate that the shoreline water meets the Hawaii State Department of Health water quality standards of 200 coliform per 100 ml for recreational activity, except for sites 10 and 11 at Laie. Two storm water discharge pipes are located at these sites. Coliform levels in the streams were also elevated and in excess of state water quality standards. The report attributes the elevated levels to animal farm and agricultural land storm runoff and cesspool seepage from homes.

PROPOSED WASTEWATER HANDLING FACILITIES

Neither the Kahuku municipal sewerage system nor the privately-owned Laie sewerage system is available to handle wastewater flows generated by the proposed Malaekahana Golf Course. Consequently, the proposed Malaekahana Golf Course will have its own sewage collection, treatment, and disposal system.


PACIFIC
N
MOKUAUIA ISLAND
LIMIT OF KAHUKU SERVICE AREA
MAKAHOA POINT
LIMIT OF KAHUKU SERVICE AREA
KALANAI POINT
SITE 4
KAHUKU GOLF COURSE
SITE 6
SITE 5
HIGHWAY
KAMEHAMEHA
K11 POND
KAHUKU SCHOOL
STREAM
KAHUKU WWTP
GULCH
KEAAULU
MALAEKAHANA STREAM
KAHAWAINUI
MALAEKAHANA GOLF COURSE PROJECT AREA
LEGEND:
UNDERGROUND INJECTION CONTROL (UIC) LINE
BWS 'NO PASS' LINE
GRAVITY SEWER
FORCE MAIN
BACTERIOLOGICAL SURVEY SAMPLING SITE
1,000 500 0

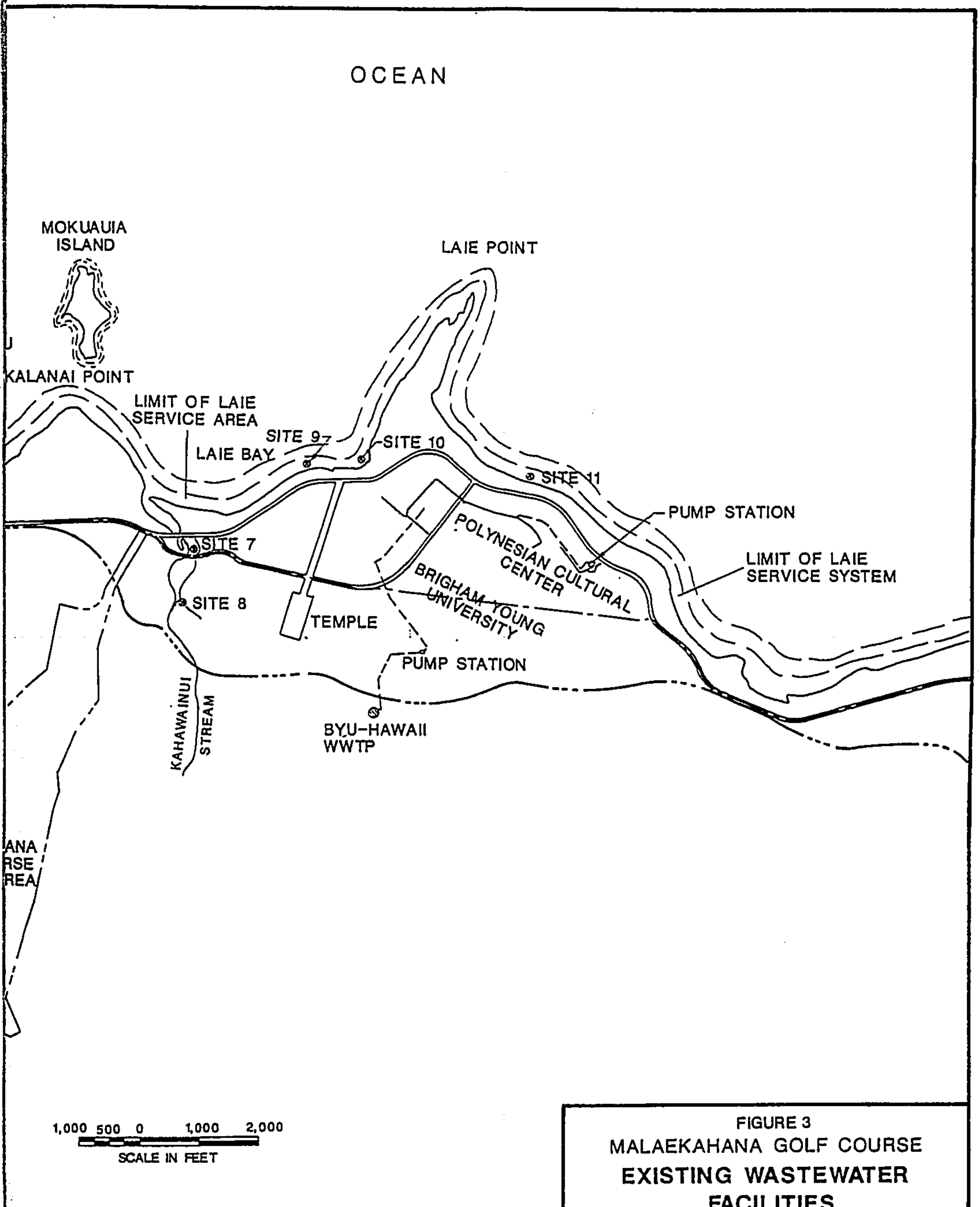


FIGURE 3
MALAEKAHANA GOLF COURSE
EXISTING WASTEWATER FACILITIES

TABLE 1

BACTERIOLOGICAL SURVEY DATA ANALYSIS[1]

				5/13/82 - 5/19/82 (Wet Season)					8/24/82 - 9/14/82 (Dry Season)				
Sub Area	Site No.	Site Location	Sample No.	TC 100 ml	FC 100 ml	FS 100 ml	FC/TC	FC/FS	TC 100 ml	FC 100 ml	FS 100 ml	FC/TC	FC/FS
Kahuku	4	Reef Area	1	1	1	410	--	--	1	1	50	--	--
			2	1	1	10	--	--	1	1	90	--	--
	5	Malaekahana Stream	1	800	210	2,200	0.26	--	4,400	2,600	7,200	0.59	0.36
			2	1,500	200	1,500	0.13	--	4,000	3,400	2,100	0.85	1.60
	6	Shoreline	1	1	1	70	--	--	1	1	190	--	--
			2	1	1	10	--	--	1	1	43	--	--
Laie	7	Kahawainui Stream	1	16,000	7,200	2,700	0.45	2.7	2,700	500	3,700	0.19	0.14
			2	39,000	1,800	1,500	0.46	1.2	7,300	2,000	4,100	0.27	0.49
	8	Upstream of Site 7	1	800	300	800	0.38	0.38	6,000	400	500	0.07	0.80
	9	Shoreline	1	30	20	200	0.67	--	50	40	240	0.80	--
			2	60	20	40	0.33	--	340	180	180	0.53	--
	10	Shoreline	1	8,000	5,000	3,200	0.63	1.6	13,000	2,900	2,600	0.22	1.1
			2	30,000	12,000	1,000	0.04	1.2	50,000	30,000	4,100	0.60	7.3
	11	Shoreline	1	1,400	600	1,350	0.43	0.44	6,300	800	900	0.13	0.89
			2	3,600	630	560	0.18	1.1	6,900	3,400	6,400	0.49	0.53

Notes:
1. TC = Total Coliform; FC = Fecal Coliform; FS = Fecal Streptococcus
2. Dash (--) indicates ratios not meaningful.
3. For recreational use, FC≤ 200/100 ml.
4. FC/TC approaching 1.0 indicates fecal contamination.
5. FC/FS >4 indicates human wastes.
   FC/FS <1 indicates animal wastes.
   1< FC/FS <4 indicates inconclusive; probably a mixture of human and animal wastes.

[1] Source of Data: City and County of Honolulu

Wastewater Flow Rates

The estimated average wastewater design flow is based on estimated water use calculations for facilities at the clubhouse (namely restrooms, showers, restaurant, and snack bar) and for a maintenance facility. The total average wastewater flow rate for the project is estimated to be 10,000 to 20,000 gpd.

Wastewater Collection

Wastewater from the clubhouse and maintenance building will be collected in gravity sewers and conveyed to a small sewage pump station. Intermittently, as sewage collects in the station's wet well, pumps will automatically activate and transfer the wastewater to the golf course's WWTP for treatment and disposal (see Figure 4).

Wastewater Characteristics

Wastewater generated at the project site is expected to be of typical domestic composition. Thus, the following characteristics apply:

Biochemical Oxygen Demand (BOD)	=	200 mg/l
Suspended Solids (SS)	=	200 mg/l

Wastewater Treatment Scheme

The proposed method of wastewater treatment is the activated sludge process. This biological wastewater treatment technique consists of the following major components:

1. Aeration tanks with mechanical or diffused aeration equipment
2. Settling tanks
3. Return and waste sludge pumps

A flow diagram of the activated sludge treatment scheme proposed for the project is illustrated on Figure 5 and is described below.

1. <u>Flow equalization</u>. The flow equalization basin serves to balance the normal fluctuations in quality and quantity of wastewater into the treatment facility. Contact time in the treatment processes can be controlled, thereby minimizing chances of biological upsets. This feature can be expected to produce treated effluent of consistent quality.

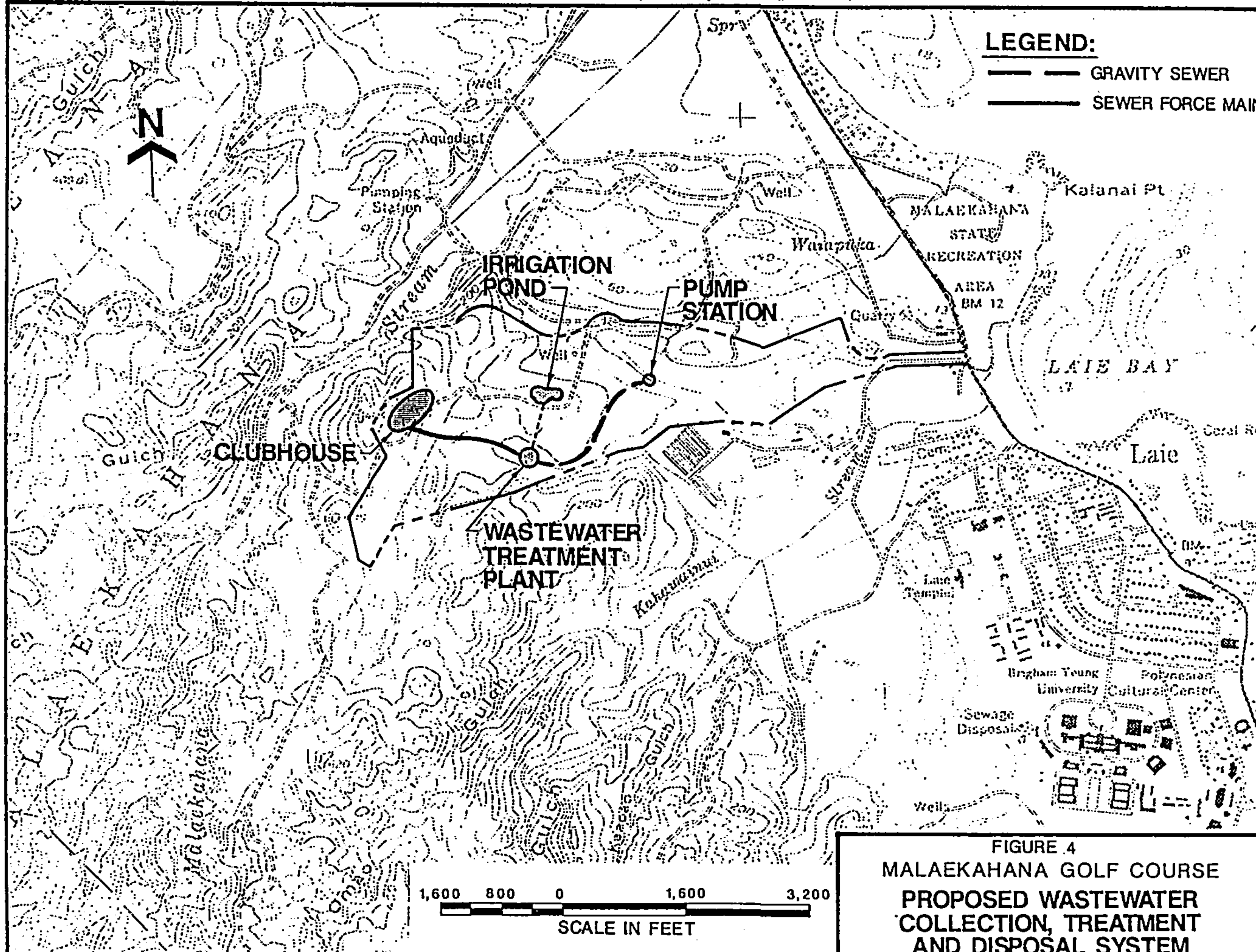


FIGURE 4
MALAEKAHANA GOLF COURSE
PROPOSED WASTEWATER COLLECTION, TREATMENT AND DISPOSAL SYSTEM

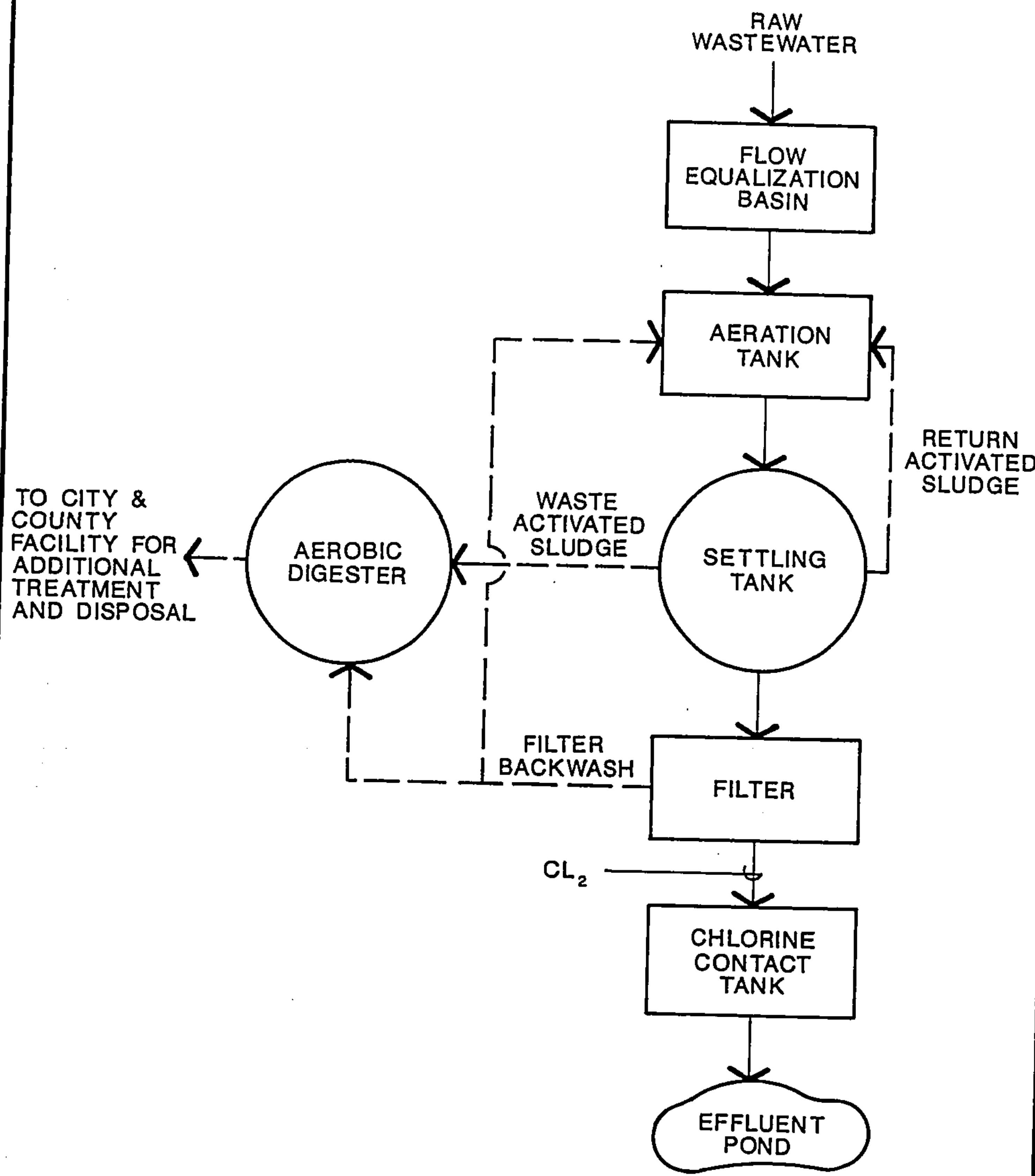


FIGURE 5

MALAEKAHANA GOLF COURSE

PROCESS FLOW DIAGRAM ACTIVATED SLUDGE

2. Aeration tank. The aeration tank is a holding chamber where a suspension of microorganisms is maintained in the presence of oxygen. Organic material in wastewater from the equalization basin is utilized by the microorganisms as a food source for growth and reproduction, thus reducing the organics to inoffensive end products. Aeration is necessary to maintain oxygen levels required by the microorganisms. Mixing is required to maintain suspension of solids and to ensure direct contact between the activated sludge microorganisms and the incoming wastewater.

3. Settling tank. Settling tanks rely on gravity to separate the mixture into a clear, treated effluent (overflow) and a heavier, concentrated activated sludge (underflow). An active culture of microorganisms in the settled sludge can then be continuously returned to the aeration tank to maintain the proper amount of "bugs" for efficient treatment. The remaining settled sludge is "wasted" into the aerobic digester for treatment.

4. Filter. Filtration of the settling tank overflow removes additional solids by deposition on the filter media. Thus, effluent quality can be improved by further reduction of BOD and SS concentrations and bacterial numbers. Periodic backwashing of the filter media is required to loosen and remove the accumulated solids from the media. Filter backwash can be returned to the liquid treatment process by recirculation to the aeration tank or directed to the aerobic digester for solids treatment.

5. Chlorination. Chlorination of effluent provides disinfection, prevents the spread of waterborne diseases, and controls algae growth and odors. Chlorination can be accomplished by in-line chemical injection to ensure good mixing of chlorine in the effluent. Mixing followed by adequate contact time in a chamber prior to disposal ensures effective disinfection.

In the treatment scheme for solids treatment and disposal, waste activated sludge will be pumped to an aerobic digester-holding tank for sludge stabilization. Additional sludge treatment will be accomplished by transporting the aerobically digested sludge to a City and County treatment facility via tanker trucks. There are currently four locations-

-Kalihi, Pearl City, Waianae, and Ewa Beach--that accept sludge from private facilities for treatment and disposal. Disposal of sludge at the approved locations is free of charge and requires a permit from the City and County of Honolulu Division of Wastewater Management.

For treatment reliability, each unit process at the WWTP will be designed for redundancy to provide backup capability during times of equipment failure or repair. Two tanks of equal volume will be constructed for each of the following unit processes.

- Aeration
- Settling
- Aerobic digestion

The filtration units will be sized so that the average design flow can be accommodated if one unit is off line. One backup pump will be provided at the SPS and the WWTP.

Effluent Characteristics

The WWTP will be designed to achieve the following effluent characteristics:

BOD	-	10 to 15 mg/l
SS	-	10 to 15 mg/l
Nitrogen	-	20 mg/l
Phosphorus	-	6 mg/l
Total coliform bacteria	-	23/100 ml

The effluent quality will meet criteria stated in the proposed Hawaii Administrative Rules, Title 11, Department of Health, Chapter 62, Wastewater Systems (to be promulgated in the near future). The total coliform organisms in five grab samples of reclaimed water used for golf course irrigation taken during a 30-day period shall not exceed a median figure of 23 per 100 ml. Adequate disinfection will also insure coliform counts in any sample do not exceed 240 per 100 ml.

PROPOSED METHOD OF EFFLUENT DISPOSAL

The proposed method of effluent disposal is irrigation of the golf course. Chlorinated effluent will be pumped to an irrigation storage pond. The pond capacity, estimated at one to two million gallons, will contain a blend of wastewater effluent and nonpotable irrigation water from onsite wells. Two to three feet of freeboard will be provided as additional storage during periods of prolonged inclement weather. The pond will be lined to prevent infiltration of irrigation water.

Reclaimed effluent will comprise about 4 to 10 percent of the total daily irrigation water demand.

IMPACTS OF EFFLUENT DISPOSAL

The project area is within the Board of Water Supply's "pass-zone;" i.e., makai of the "no-pass" line. The Hawaii State Department of Health's Underground Injection Control (UIC) line is situated along Kamehameha. Thus, the project site is located mauka of and within this injection control zone (see Figure 3).

Effluent disposal may remotely impact the groundwater and coastal waters if irrigation water should percolate and reach near sea level elevations. An evaluation of three elements (nitrogen, phosphorus, and biological organisms) will be discussed further.

Nitrogen

Based on typical secondary effluent data, a nitrogen concentration of 20 mg/l is expected. At a flow rate of 20,000 gpd, approximately 3 pounds per day of nitrogen will be contributed by effluent. The irrigation requirement for an 18-hole golf course is between 0.2 and 0.5 mgd. Thus, it is assumed that all 3 pounds per day of nitrogen will be applied to the golf course turf. A typical 18-hole golf course requires an average of 77 pounds of nitrogen per day. Thus, effluent will supply 4 percent of the nitrogen requirement, reducing fertilizer application rates to 74 pounds of nitrogen per day.

Typically, 5 to 10 percent of applied nitrogen eventually moves through the soil; the other 90 to 95 percent is used in plant uptake. Thus, it is assumed that less than 1 pound per day of nitrogen from wastewater effluent will eventually move toward the groundwater. The impact of nitrogen from the treated effluent should not be detrimental to the groundwater or coastal water quality due to the following factors:

1. The quantity of percolate and its corresponding quantity of nitrogen is relatively small in comparison to the groundwater lens.

2. The immense "mixing" and "net transport" characteristics of the coastal waters fronting the project significantly dilute and disperse any percolate entering the coastal waters.
3. The amount of nitrogen introduced by the effluent is small in comparison to other sources.

Phosphorus

A typical phosphorus concentration for secondary effluent averages 6 mg/l. At a flow rate of 20,000 gpd, approximately 1 pound per day of phosphorus will be applied to golf course turf. Unlike nitrogen, phosphorus remains fixed to soil particles; thus, groundwater infiltration of phosphorus is not expected.

Bacteria and Viruses

Disinfection of effluent by chlorination will reduce total coliform counts to no more than 23 per 100 ml, as specified by the State Department of Health. Thus, the maximum bacteria and virus levels in the effluent will be within allowable limits for landscape irrigation and better than those in Malaekahana and Kahawainui streams and Laie Bay[1]. Studies conducted by the Water Resources Research Center of the University of Hawaii reported that bacteria and viruses were not present in percolate from secondary effluent irrigation. Researchers attributed the removal of these organisms to soil adsorption, dessication, elevated temperatures, and exposure to sunlight. Thus, infiltration of these organisms to deep aquifers is not probable.

Conclusion

Significant adverse impacts due to effluent disposal by irrigation of the golf course are not foreseen. Mitigation measures include--

1. Storage of excess effluent in irrigation pond during periods of inclement weather; and
2. Incorporation of a filter in the process treatment scheme to provide reliable treatment efficiency.

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[1]R.M. Towill Corp., "North Oahu Facility Plan," March 1985.

OTHER PROJECT IMPACTS

Short-Term Impacts and Mitigation

Short-term impacts will be construction related and may include dust, noise, and traffic disruption along Kamehameha Highway. Although dust and noise will occur from construction activities, the spread of dust can be controlled by a watering program. Noise problems can be mitigated by regulating the hours of construction work; likewise, traffic disruptions can be controlled by limiting hauling only during nonpeak hours of traffic. Much of the sitework will be confined to the mauka side of Kamehameha Highway. Consequently, inconveniences to motorists should be minimal.

Long-Term Impacts and Mitigation

Irrigation of portions of the golf course with treated effluent will reduce the demand for irrigation water from nonpotable onsite wells.

Possible negative impacts due to the wastewater treatment and disposal plan are:

1. Odors generated from the wastewater treatment facility;
2. Noise from equipment at the wastewater treatment facility; and
3. Visual impacts due to the location of the wastewater treatment facility on the golf course grounds.

With proper operation, objectionable odors should not be generated from the wastewater treatment facility. Maintenance of aerobic conditions will minimize odor generation; thus, portions of the facility prone to septic conditions will be aerated for odor control. The exclusion of solids treatment units is another odor control measure.

Pumps and blowers are the primary noise-generating equipment at the wastewater treatment facility requiring noise abatement. Enclosures for pumps and locating blowers within the blower room of the control building will reduce the impact of operating noises.

Landscaping around the wastewater treatment facility perimeter fence will reduce the visual impact of the facility on the golf course users.

APPENDIX C

WATER SUPPLY REPORT

FOR THE

PROPOSED PUNAMANO GOLF COURSES

Prepared for:

Kuilima Resort Company

Prepared by:

Engineering Concepts, Inc.
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Honolulu, Hawaii 96814

February 1989

CONTENTS

CONTENTS (Cont.)

INTRODUCTION

Kuilima Resort Company is proposing the development of three 18-hole golf courses in the vicinity of Kahuku on the North Shore of Oahu (see Figure 1). This site, called Punamano, is located approximately 1.5 miles west of Kahuku Town. The site contains approximately 605 acres and is located mauka of Kamehameha Highway across the Kuilima Resort (see Figure 1).

The objective of this report is to present the necessary planning and preliminary engineering documentation for the water system at the proposed Punamano Golf Courses. The domestic, fire protection, and irrigation water needs of the proposed project will be addressed. Specifically, this report includes the following:

1. Background information on the proposed project
2. Water resources in the area
3. Existing infrastructure
4. Projected water demand and proposed water system
5. Impacts and mitigation of the proposed water system

BACKGROUND

Proposed Project

Three 18-hole golf courses are planned for the site covering approximately 605 acres. The proposed site is shown on Figure 2. Each course will be designed for a different level of playing difficulty. Of the 605-acre site, approximately 270 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

At each of the three golf courses, a small clubhouse (12,000 to 14,000 square foot area) will be constructed. Each clubhouse would include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, and administrative offices. Small clubhouses are planned due to the proximity of extensive support facilities at the Kuilima Resort. A parking area will be provided at each clubhouse with approximately 130 to 160 spaces.

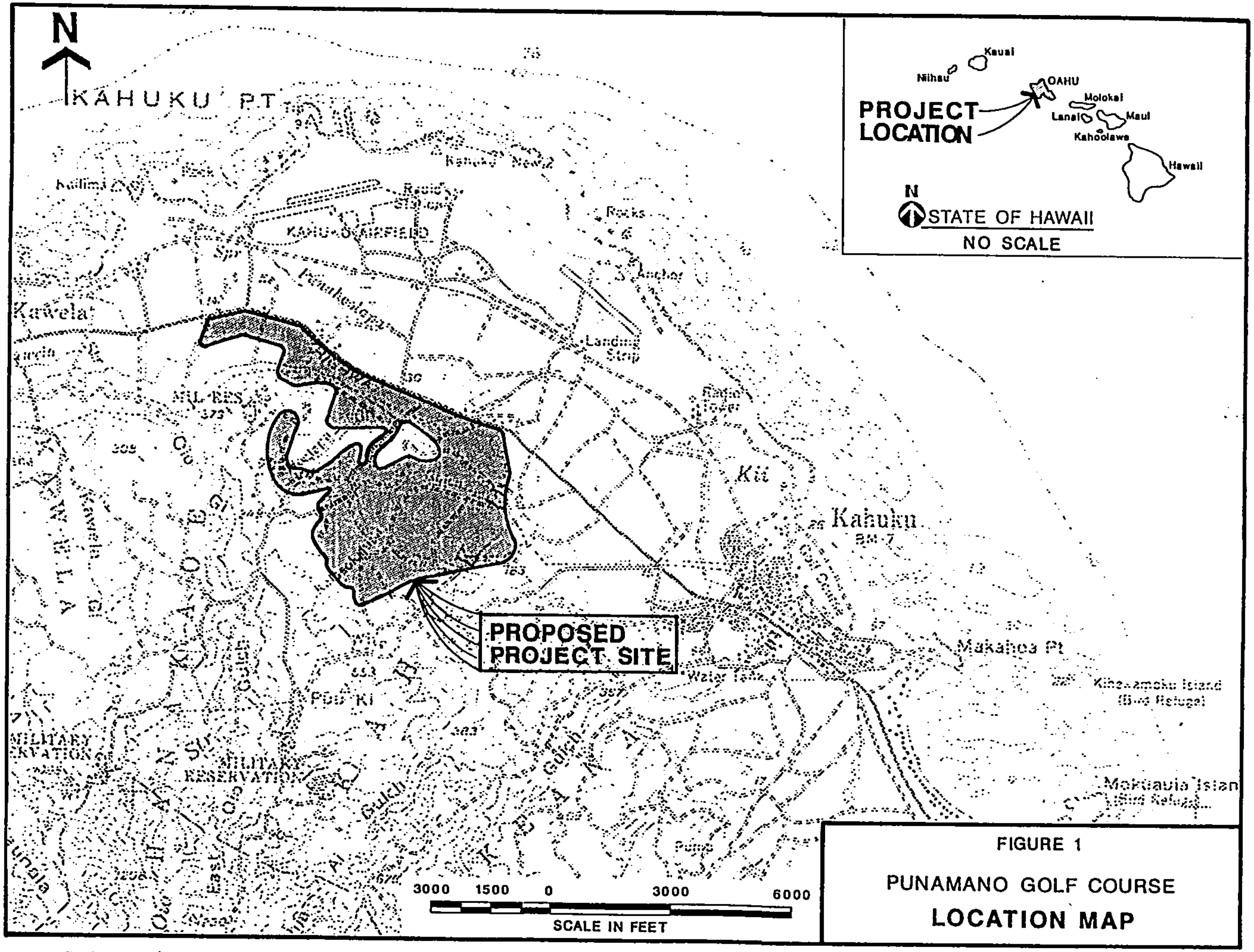

FIGURE 1

PUNAMANO GOLF COURSE

LOCATION MAP

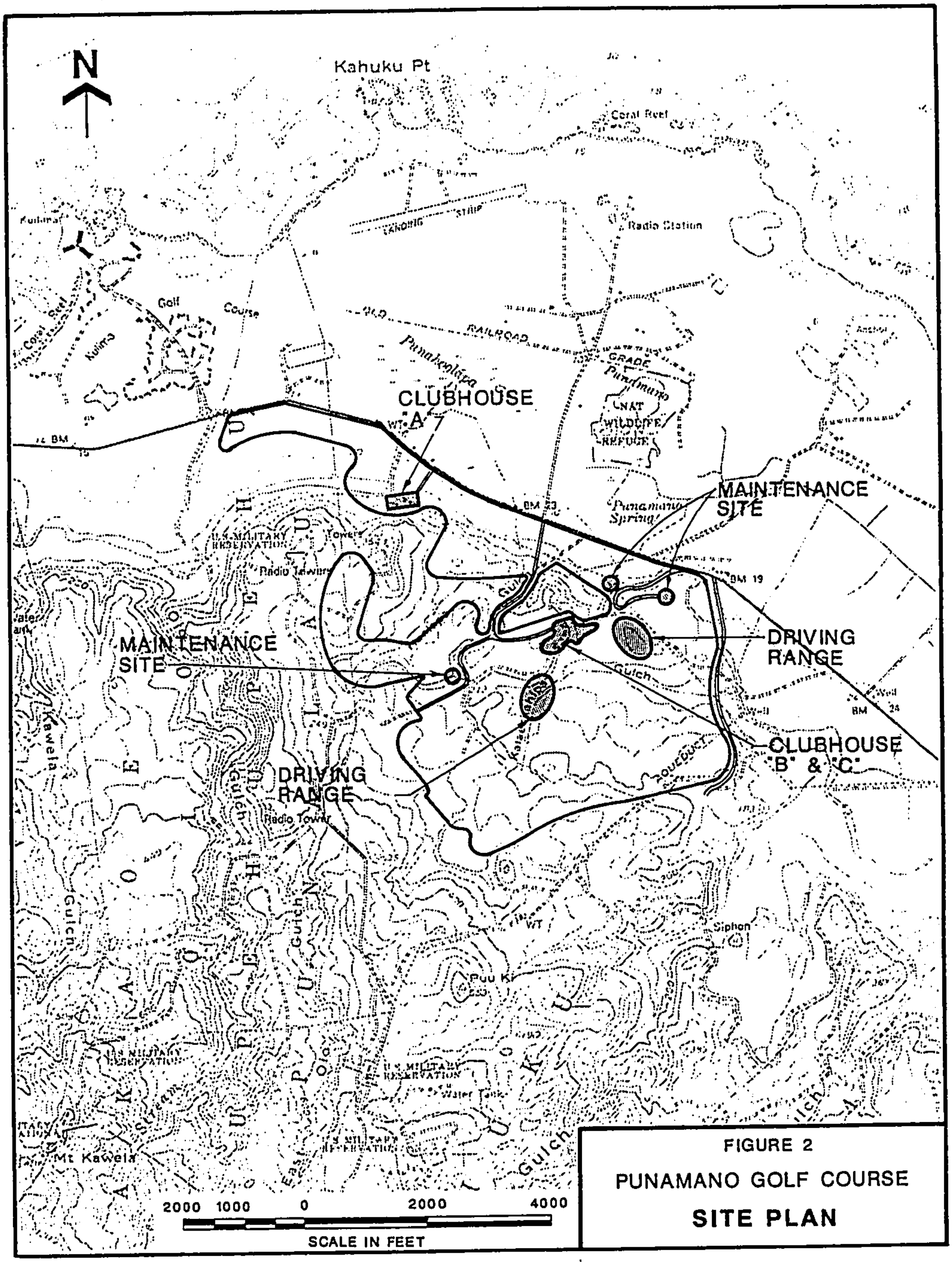

FIGURE 2

PUNAMANO GOLF COURSE

SITE PLAN

Golf Course "A" is located along Kamehameha Highway, while Golf Courses "B" and "C" are located in the mauka portion of the project site. Clubhouse "A" is situated at elevation ± 40 feet, while Clubhouses "B" and "C" are situated next to each other at elevation ± 223 feet.

A golf driving range will be constructed at the two upper (mauka) golf courses. Each driving range will have 20 to 26 tee positions. Parking for this facility will be accommodated at the clubhouse area for each course.

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-05: Por. 1, Por. 2, 5, 6, and Por. 7, and TMK: 5-7-01: Por. 21. The 605-acre project site at Punamano has been owned by The Estate of James Campbell since the 1890s.

The irregularly-shaped boundary of the Punamano site consists primarily of vacant grass and shrub meadows, rolling hillsides, intermittent stream gulches, and some steep slopes and cliffs. Portions of the site contain remnants of previous agricultural activities, including overgrown cultivated fields and an abandoned Christmas tree farm. Four abandoned windmill structures are located within the site near Kamehameha Highway. A road bisects the site, providing access from Kamehameha Highway to the U.S. Army Kahuku Training Area, located mauka of the site.

Land uses of property adjoining the Punamano site include military, agricultural, commercial, and resort activities. A U.S. Air Force telecommunications facility is also located adjacent to the property, along its western boundary. Also along the western boundary of the lower portion of the property is a small agricultural operation currently producing bananas and papayas. The Kuilima Resort is located across Kamehameha Highway from this site. Tanaka Store, a well-known local landmark, is a small grocery store and gas station located across Kamehameha Highway from the site at its Kahuku-side boundary. Vacant agricultural land adjoins the Kahuku-side boundary of the site. A major aquaculture operation exists just east of the Punamano site and makai of Kamehameha Highway.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall for Station No. 907.00, located at the Kuilima Resort, over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 280 feet at the western boundary. Slopes of 1 to 5 percent are found over most of the makai portion of the site, with moderate to steep slopes ranging from 5 to 20 percent over much of the mauka area. Steepest slopes occur around isolated peaks and along gulches, where slopes in excess of 30 percent occur. The southwest area is dominated by the steep hillsides and isolated peaks that border either side of Hoolapa Gulch. The southeast region has an undulating topography of minor gulches and ridges that intersect at Kalaeokahipa Gulch. Slopes are predominantly moderate in this region, except for the steep slopes along Kalaeokahipa Gulch.

The offsite watershed area mauka of the project site is characterized by moderate slopes near the project's southwest and southeast borders, with progressively steeper slopes at higher elevations. Typical slopes in the upper region are more than 20 percent. Elevations vary from 10 feet near the project's southwest border to 653 feet at the upper boundary of the watershed. The offsite area between the northeast side of the project boundary and Kamehameha Highway consists of uniformly sloping lands of 2 to 5 percent and is bisected by an existing drainageway. Elevations vary from 15 to 65 feet.

The vegetative cover is variable, ranging from open areas of short grasses to heavily vegetated areas consisting of tall grasses, scrub brushes, and trees. Uncovered areas in the form of dirt roads and pockets of erosion are also present.

WATER RESOURCES

Groundwater bodies underlying the island of Oahu are illustrated on Figure 3. Two groundwater resources of significance to the proposed golf course development are the Waialee Dike Aquifer and the Koolauloa basal waters (see Figure 4).

Waialee Dike Aquifer

The Waialee Dike Aquifer is approximately 10 miles long and 2 miles wide, bordered on the east and west by basal water. It is a marginal dike zone extending from Kawela Bay to the southeast, parallel to the crest of the Koolau mountain range. The dikes are variably spaced and hydraulically connected. Salt water underlies fresh water in the Waialee aquifer--a condition known as dike basal--which limits well depths and pumping rates. The sustainable yield of the aquifer has been estimated to be 7.5[1], 15[2],

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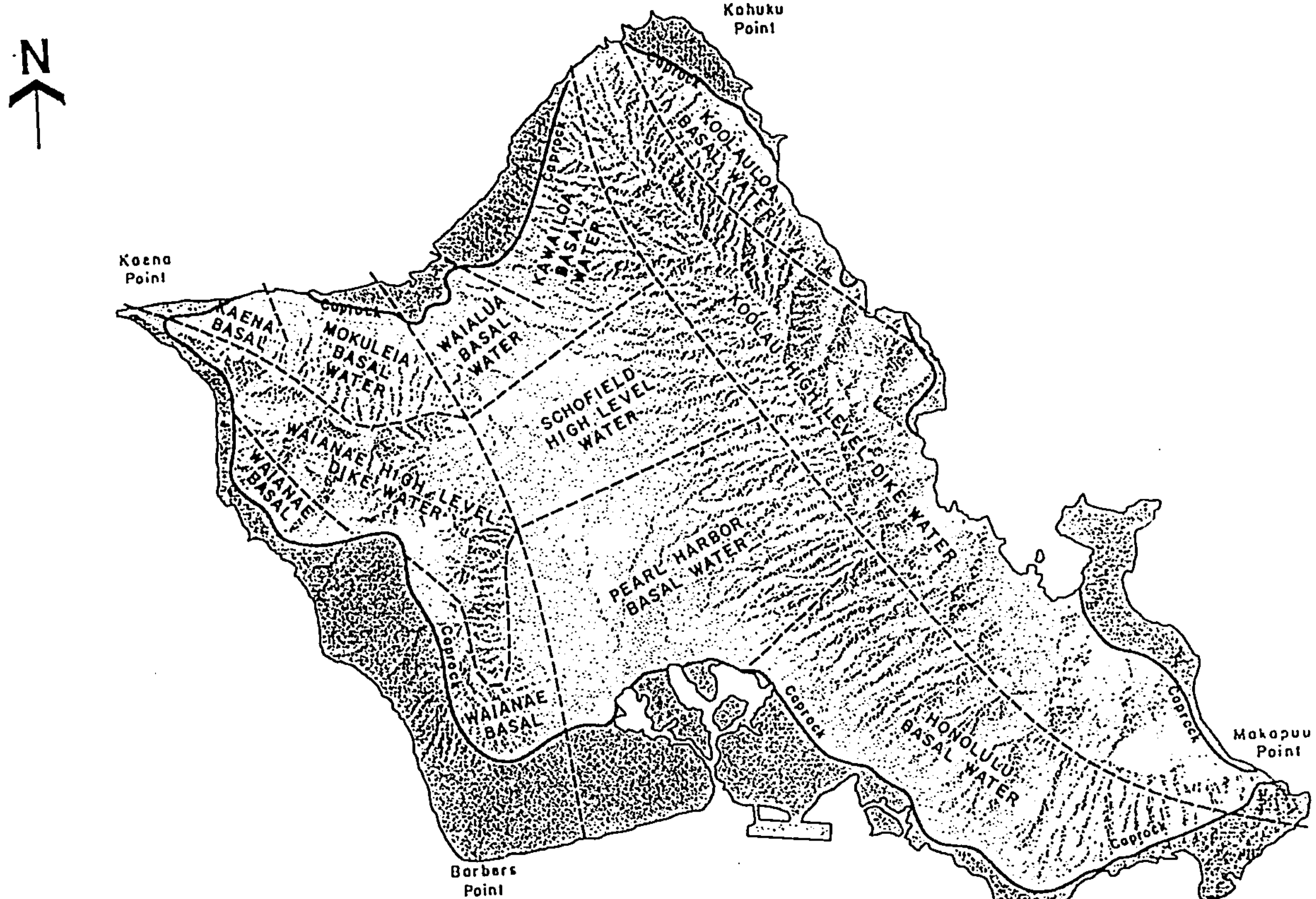
[1]John Mink, "Groundwater Resources and Availability--Kahuku Region," 1982.

[2]State of Hawaii, Department of Land and Natural Resources, March 1982.



SOURCE: BWS, OAHU WATER PLAN,
4th EDITION, JULY 1982, PG. 10

FIGURE 3

GROUND WATER BODIES
ISLAND OF OAHU

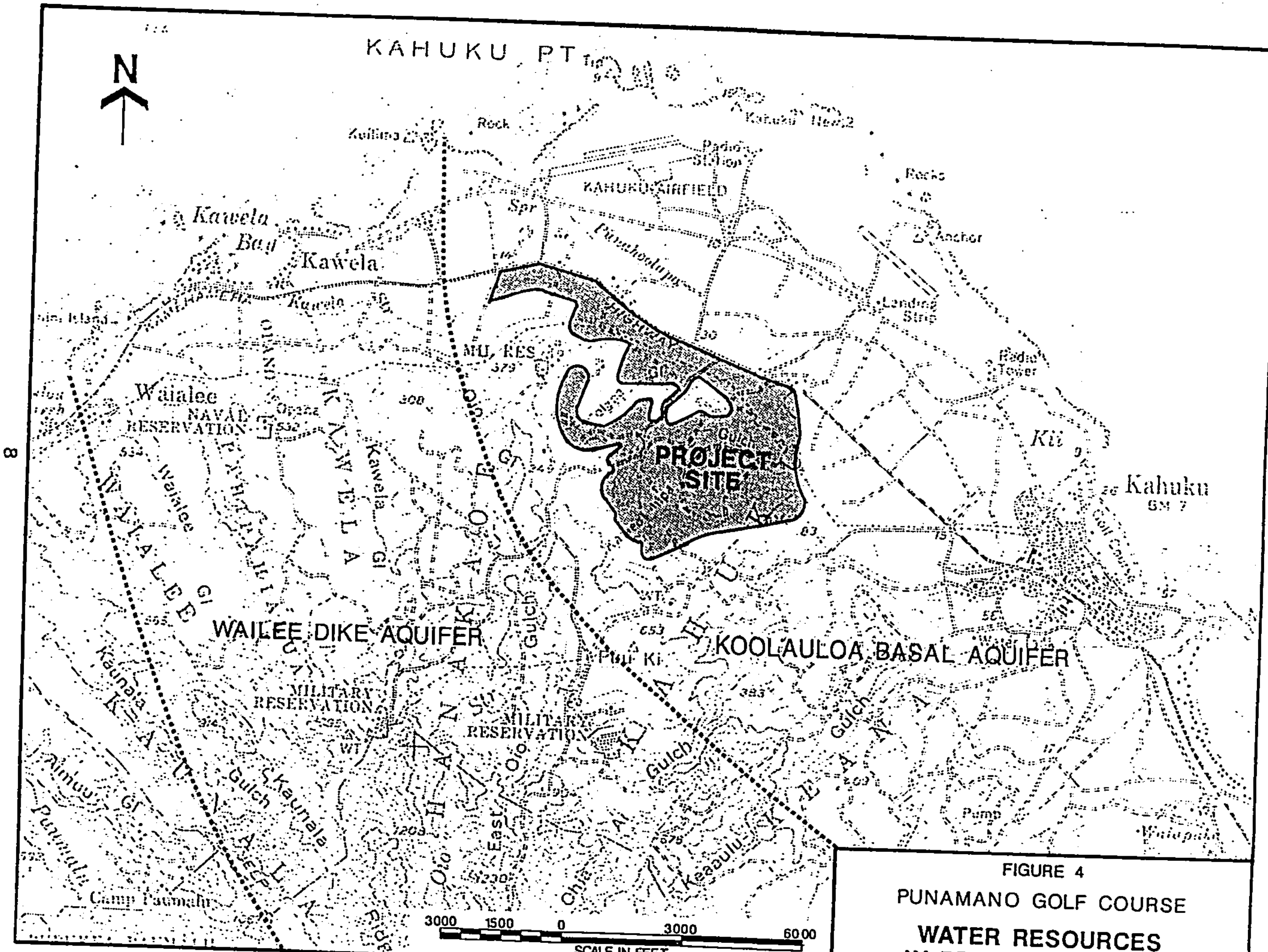


FIGURE 4
PUNAMANO GOLF COURSE
WATER RESOURCES IN PROJECT VICINITY

and 20[3] MGD. Currently, the only drafts from the aquifer are by the Waialee wells at a rate of 0.5 MGD.

Koolauloa Basal Aquifer

The Koolauloa basal aquifer extends east from the Waialee Dike Aquifer toward Kahuku. This aquifer is of less significance than the Waialee dike waters due to increased salinity as distance from the dikes increases.

EXISTING INFRASTRUCTURE

The existing water system servicing the Kuilima area is illustrated on Figure 5. The water system is part of the Board of Water Supply's (BWS) Kawela-Sunset Beach subsystem, encompassing the region from Sunset Beach to the Kuilima Resort. Wells at Sunset Beach and Waialee service this system. Storage capacity is provided by reservoirs at Sunset Beach and Kawela.

Sustained capacity of the Waialee wells is 0.7 MGD. Currently, the wells provide a maximum day supply of 0.5 MGD to the Kuilima Resort. The Kuilima Resort Water Master Plan (1984) states that the BWS will continue to supply 0.5 MGD to the Kuilima Resort in the future.

Presently, a 16-inch main along Kamehameha Highway transports water from the wells to the east toward Kahuku. The 16-inch main ends at the intersection of Kamehameha Highway and Kuilima Drive, where a 12-inch main transports water along Kuilima Drive to the Turtle Bay Hilton Hotel and existing resort condominiums.

A 20-inch influent/effluent transmission main connects the Kawela 228 reservoir to the 16-inch main along Kamehameha Highway. With a capacity of 2.0 MG, this reservoir is able to meet storage capacity requirements at present. The service zone for the reservoir is up to an elevation of 128 feet.

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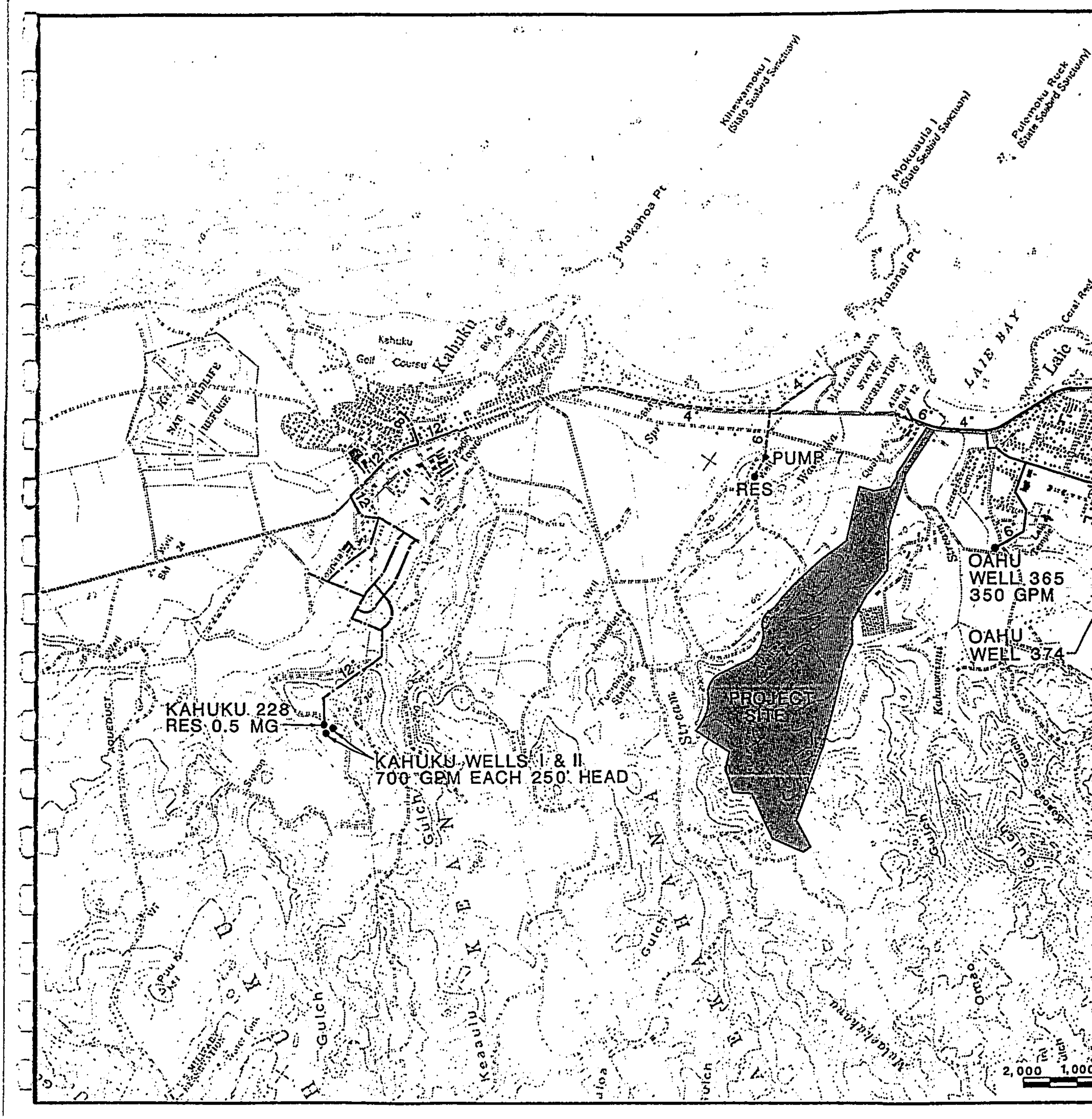
[3] State of Hawaii, Department of Land and Natural Resources, Memo, "State Water Commission Report," March 3, 1982.


Kihewamoku I (State Seabird Sanctuary)
Mokuauala I (State Seabird Sanctuary)
Pulemoku Rock (State Seabird Sanctuary)
Makahoa Pt
Kalanai Pt
LAIE BAY
Kahuku
Kahuku Golf Course
Laie
PUMP 7
RES
OAHU WELL 365 350 GPM
OAHU WELL 374
PROJECT SITE
KAHUKU 228 RES 0.5 MG
KAHUKU WELLS I & II 700 GPM EACH 250' HEAD
Gulch
Stream
2,000 1,000

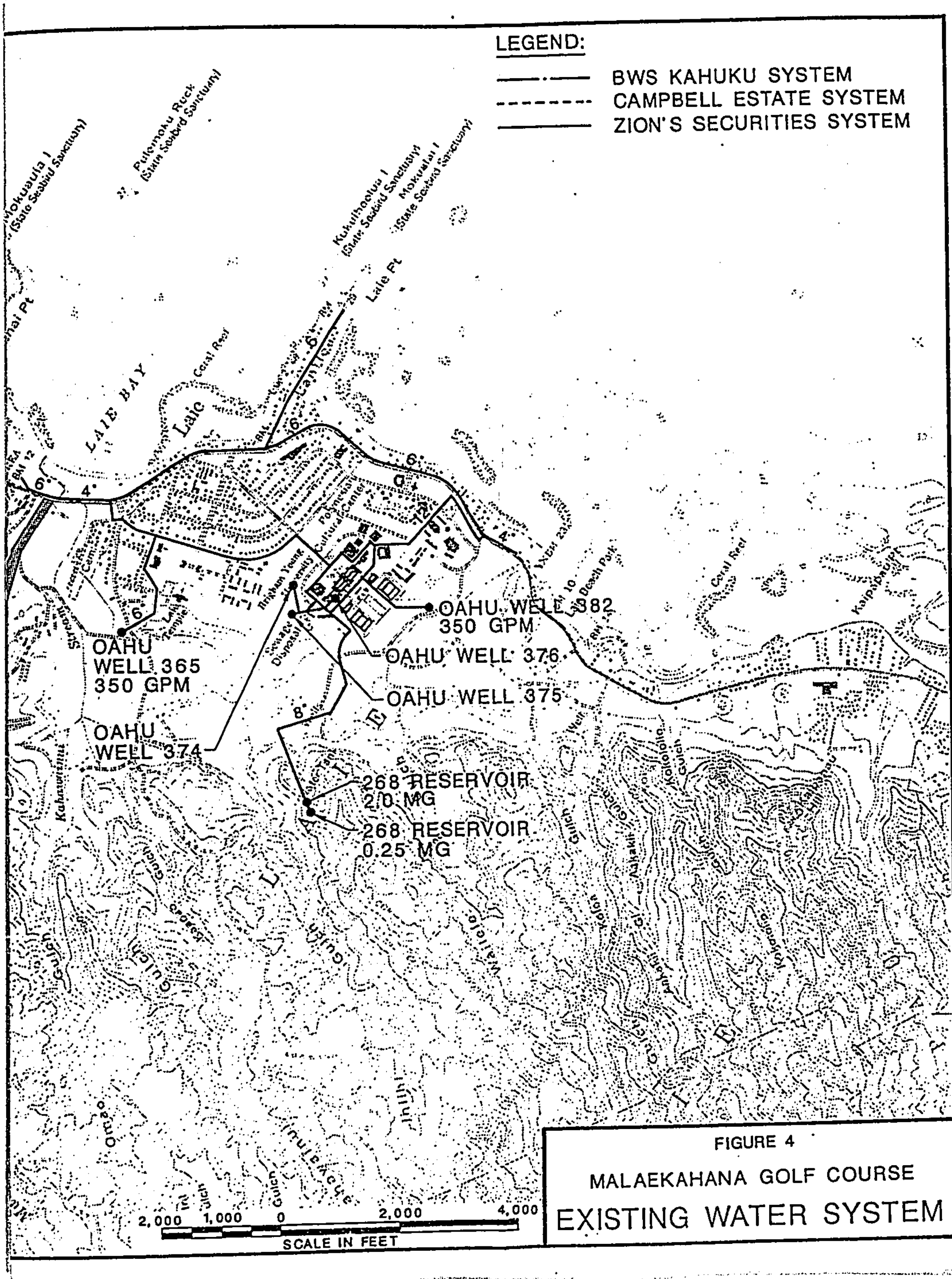


FIGURE 4
MALAEKAHANA GOLF COURSE
EXISTING WATER SYSTEM

CORRECTION

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

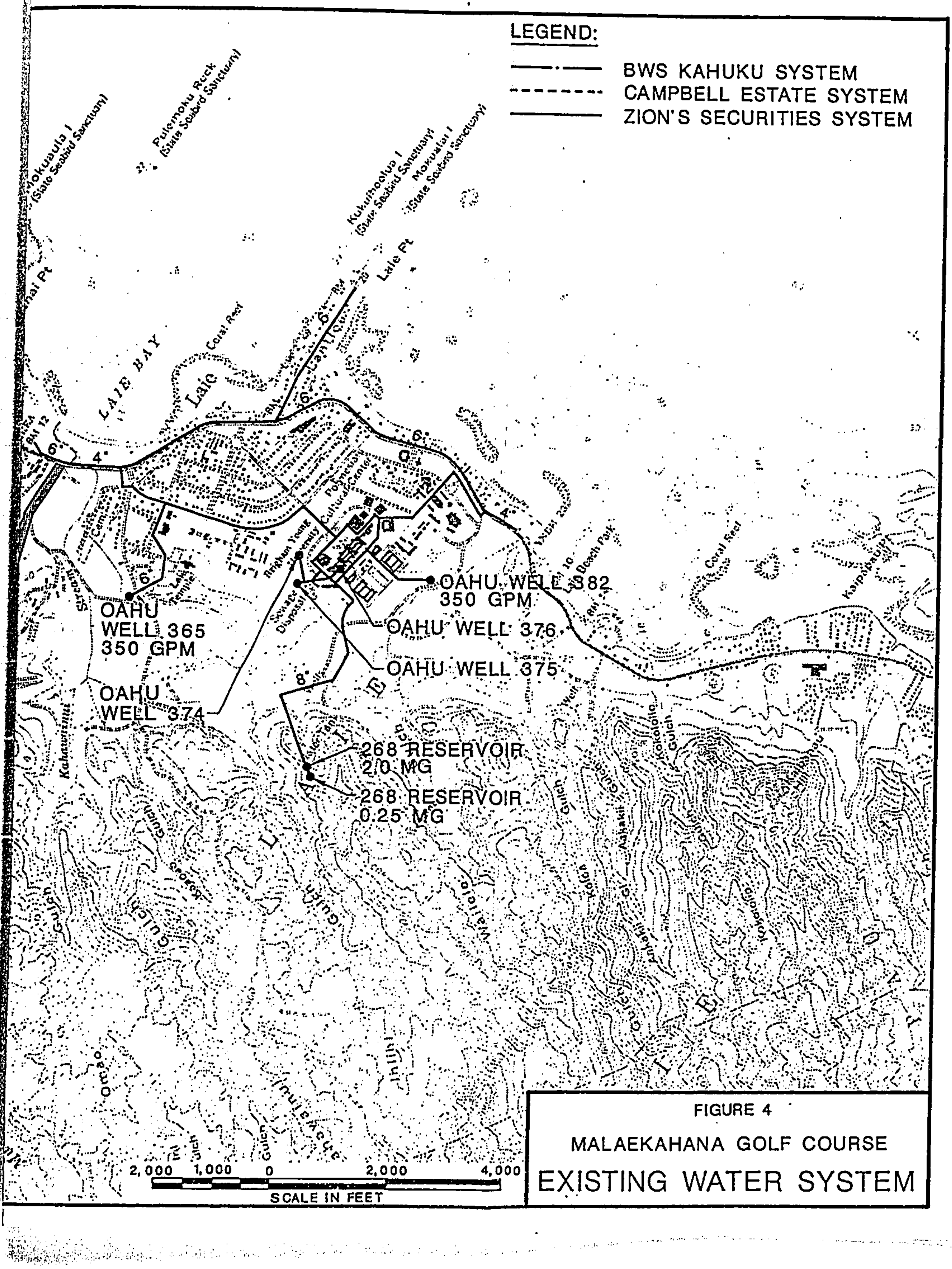


FIGURE 4

MALAEKAHANA GOLF COURSE

EXISTING WATER SYSTEM

PROJECTED WATER DEMAND

Water demand projections are based on the BWS Water System Standards (1985) and demands from similar developments.

Domestic Demand

Domestic water demand of the proposed development is estimated to be 60,000 to 75,000 gpd. This demand represents estimated domestic usage primarily from the clubhouses and maintenance facilities of the three proposed Punamano golf courses. The estimate is based on the BWS water demand rate of 4,000 gallons per acre per day for resort areas and a total of 15 to 18 acres planned for clubhouse development for the three proposed golf courses.

Irrigation Demand

An annual irrigation rate of 0.35 MGD is estimated for each of the proposed golf courses, based on experience at the Kuilima Resort. Thus, the anticipated total irrigation demand from the three proposed golf courses is 1.05 MGD. Irrigation typically encompasses the tees, greens, and fairways of the golf course and a limited portion of the "rough" area around the course.

Fire Protection

Fire protection is required for the clubhouses and maintenance facilities of the three proposed golf courses. The BWS has established fire protection criteria for different land uses. Based on the BWS standard for schools, small shopping centers, neighborhood businesses, and hotels, the water demand for fire protection is 2,000 gpm for a two-hour duration. Fire hydrants spaced at 250-foot intervals are required, with the last hydrant located at one-half the spacing distance (125 feet) from the last structure.

PROPOSED WATER SYSTEM

Recommendations for meeting the estimated domestic, irrigation, and fire protection water demands for the proposed project are presented in this section. In general, connection to the BWS water system is the recommended method of meeting the domestic and fire protection requirements for Golf Course "A". The BWS system is also the recommended source for potable water to Golf Courses "B" and "C". However, fire protection for Golf Courses "B" and "C" is proposed to be provided by an onsite source and reservoir. This onsite source is also proposed to provide irrigation water for the three golf courses. Refer to Figure 6 for the proposed water systems.

Proposed Potable Water System

The proposed method of providing potable water to the three golf courses is by connection to the BWS Sunset Beach-Kawela subsystem. Although the existing water service currently ends at the intersection of Kamehameha Highway and Kuilima Drive, there are plans to extend the system along Kamehameha Highway toward the project site. A 12-inch water line is proposed along Kamehameha Highway from the existing terminus of the 16-inch main to Marconi Road. This water line extension is proposed in the Kuilima Resort Water Master Plan to provide water for future development within the Kuilima Resort Complex. Extension of the BWS system would allow for connection by the proposed project at Kamehameha Highway.

Golf Course "A"

Elevations at the proposed site for Clubhouse "A" range from 45 to 80 feet--within the service zone of the Kawela 228 reservoir. Thus, plans for the proposed potable water system for Golf Course "A" call for tapping off the future BWS 12-inch main in Kamehameha Highway at the intersection with the Clubhouse "A" access road and running a potable water line along the access road to the clubhouse. A meter on this potable water line will be located near the highway.

Golf Courses "B" and "C"

Golf Courses "B" and "C" will share a single access road at the intersection of Kamehameha Highway and Marconi Road. Plans for the proposed potable water system for these golf courses call for tapping off the future 12-inch main at the intersection with Kamehameha Highway, with a domestic water meter located near the highway. Clubhouses "B" and "C" share a single site, ranging in elevation from 160 to 235 feet. Due to the site elevation exceeding the service zone of the Kawela 228 reservoir, a hydro-pneumatic system will be required to boost the water pressure in the proposed line. The hydropneumatic system will be located within the project site, along the clubhouse access

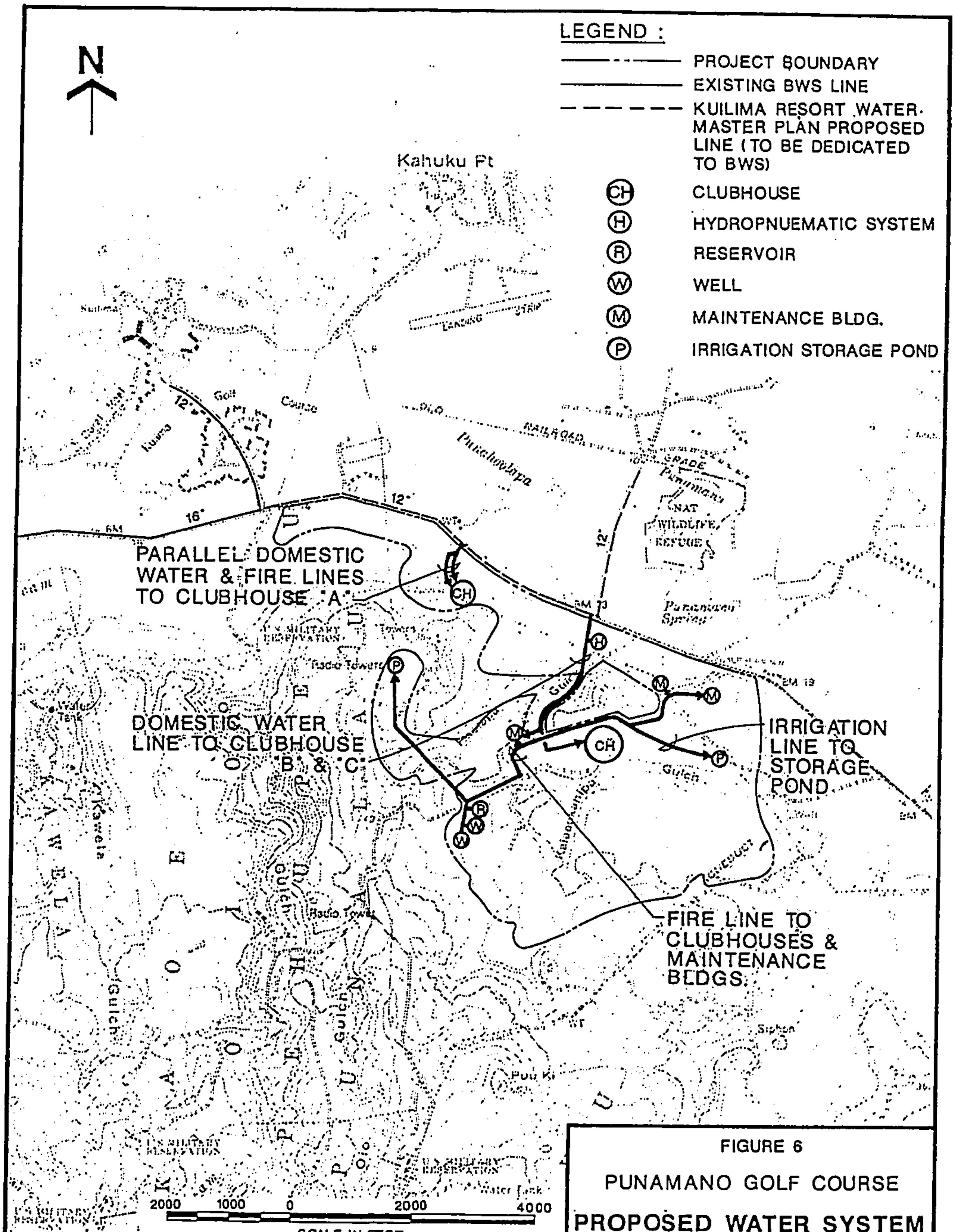


FIGURE 6

PUNAMANO GOLF COURSE

PROPOSED WATER SYSTEM

road, downstream of the BWS water meter. The hydropneumatic system will be maintained by the developer.

Proposed Irrigation Water System

Development of an onsite source and reservoir is proposed to supply irrigation water to the three golf courses. It is estimated that two onsite wells will be able to meet the total irrigation demand of 1.05 MGD. Irrigation water will be stored in ponds within the golf course and the onsite reservoir.

Proposed Fire Protection

Fire hydrants will be located near the clubhouses and maintenance facilities of the three proposed golf courses. Two sources will supply water for fire protection, as described below.

Golf Course "A"

Fire protection requirements for Golf Course "A" will be met by the BWS Sunset Beach-Kawela subsystem. A fire line will parallel the proposed domestic line from Kamehameha Highway to the Clubhouse "A" site. Two separate water lines are expected due to the low domestic demand in relation to the fire demand. A detector check meter will be located on the fire line near Kamehameha Highway.

Golf Courses "B" and "C"

Fire protection requirements for Golf Courses "B" and "C" can be met by the proposed onsite irrigation system. The onsite reservoir will be designed to provide adequate storage to meet fire code requirements.

IMPACTS AND MITIGATION

Impacts due to the proposed water systems can be classified as short-term and long-term.

Short-Term Impacts and Mitigation

Short-term impacts are construction related and may include dust, noise, and traffic disturbances in the vicinity of the project site and Kamehameha Highway. Mitigation of these nuisances can be accomplished by limiting construction to off-peak traffic house, the use of wind breaks or watering to reduce dust, and the observance of approved traffic control plans.

Long-Term Impacts

The water requirements of the proposed golf courses will have a long-term impact on the BWS Sunset Beach-Kawela subsystem, the Waialee Dike Aquifer, and the Koolauloa Basal Aquifer. The impact is that development will require a commitment of available water.

According to the Kuilima Resort Water Master Plan, additional source, storage, and transmission lines will be developed in the future and will be dedicated to the BWS. The proposed golf course requirements for domestic water and fire protection contribute an additional 4 percent to the storage and maximum daily demand of the ultimate Kuilima Resort addressed in the water master plan.

Currently, both the Waialee Dike Aquifer and the Koolauloa Basal Aquifer have surplus water supplies. A conservative estimate of the surplus capacity of the Waialee Dike Aquifer is 7.0 MGD. Based on an estimated average domestic water requirement for the proposed project of 60,000 to 75,000 gpd, the potential impact on the Waialee Dike Aquifer is a 1 percent reduction in surplus. The potential impact on the Koolauloa Basal Aquifer due to irrigation water requirements of the project is a 1.05 MGD reduction of surplus.

APPENDIX D

WATER SUPPLY REPORT

FOR THE

PROPOSED MALAEKAHANA GOLF COURSE

Prepared for:

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Prepared by:

Engineering Concepts, Inc.
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Honolulu, Hawaii 96814

February 1989

CONTENTS

CONTENTS (Cont.)

FIGURES

INTRODUCTION

Kuilima Resort Company is proposing the development of an 18-hole golf course in the vicinity of Kahuku-Laie on the North Shore of Oahu. This site, called Malaekahana, is located between Kahuku Town and Laie. The site, containing approximately 228 acres, is located mauka of Kamehameha Highway across Malaekahana State Park (see Figures 1 and 2).

The objective of this report is to present the necessary planning and preliminary engineering documentation for the water system at the proposed Malaekahana Golf Course. The domestic, fire protection, and irrigation water needs of the project will be addressed. Specifically, this report includes the following:

1. Background information on the proposed project
2. Water resources in the area
3. Existing infrastructure
4. Projected water demand and proposed water system
5. Impacts and mitigation of the proposed water system

BACKGROUND

Proposed Project

An 18-hole golf course is planned for the site. Of the 228-acre site, approximately 90 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

The clubhouse (approximately 20,000 square feet) will include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, small meeting rooms, and administrative offices. A parking area will be provided, with approximately 160 to 200 spaces.

A golf driving range will be constructed at the upper portion of the golf course near the clubhouse. The driving range will have 24 to 30 tee positions. Parking for this facility will be accommodated at the clubhouse parking area.

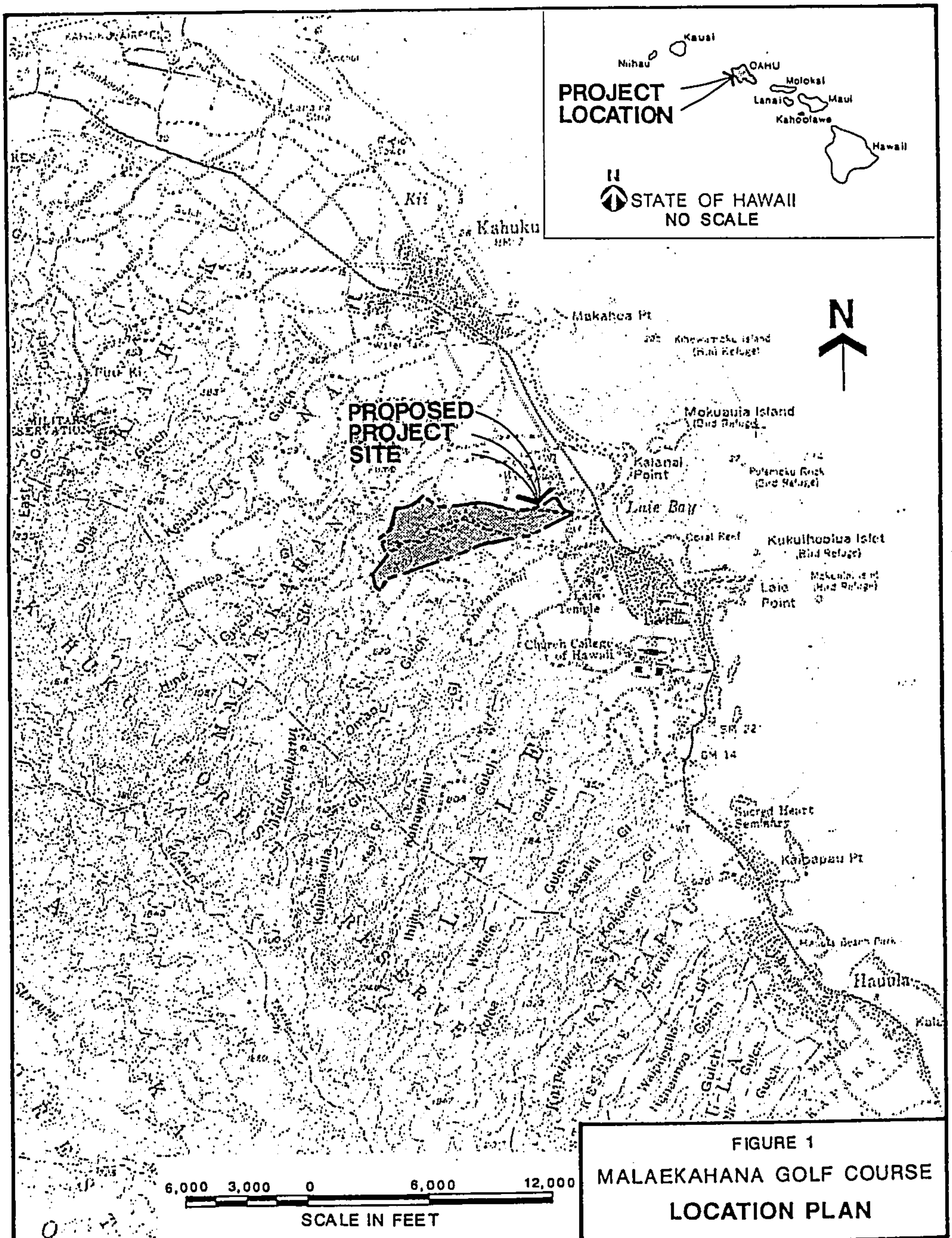


FIGURE 1
MALAEKAHANA GOLF COURSE
LOCATION PLAN

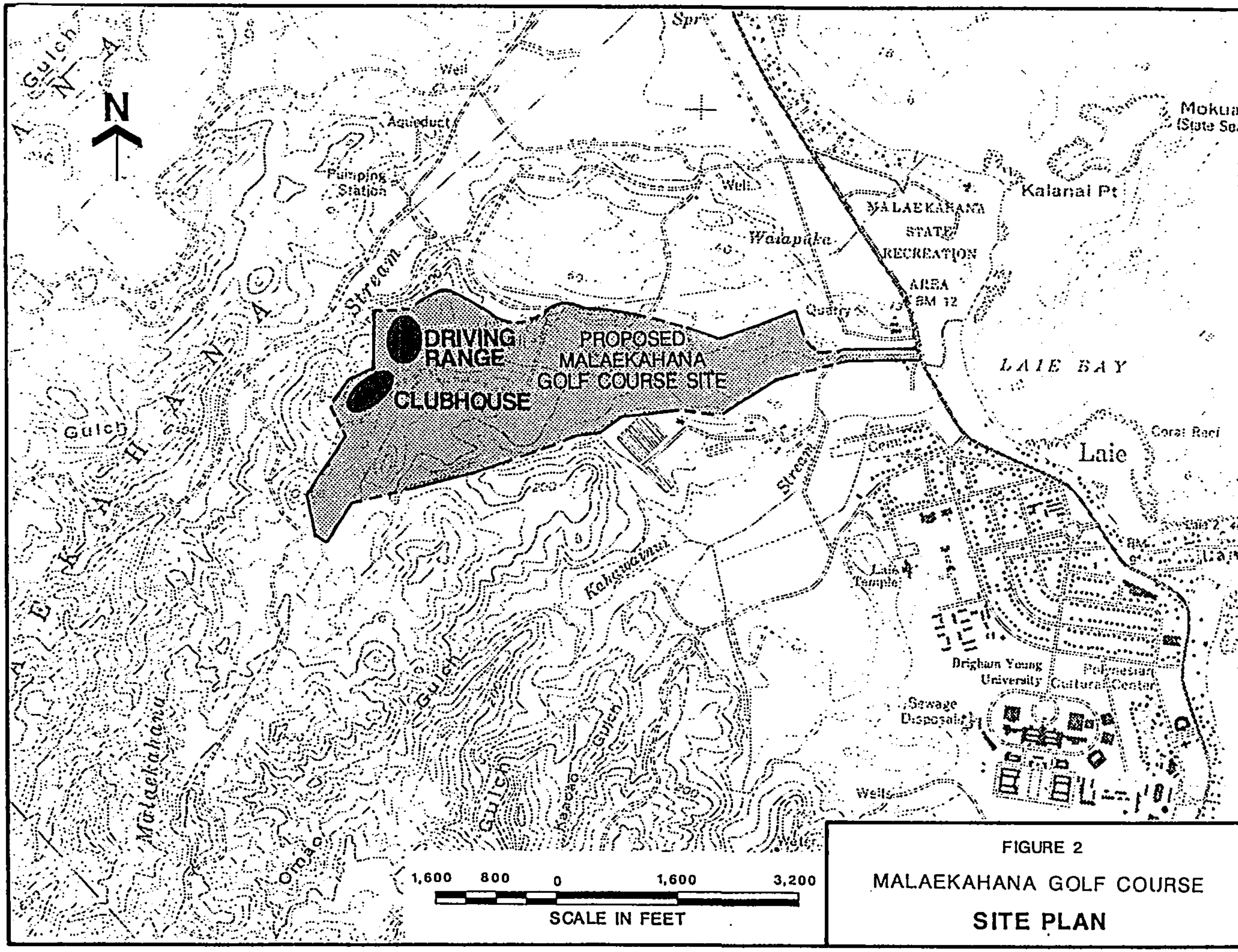


FIGURE 2
MALAEKAHANA GOLF COURSE
SITE PLAN

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-06: Por. 6 and TMK: 5-6-07: Por. 1. The 228-acre project site at Malaekahana has been owned by The Estate of James Campbell since the 1890s.

This site consists of many small hills that rise to elevations of 450 feet above mean sea level (MSL). The site is connected to Kamehameha Highway by a narrow strip of land extending mauka to the main portion of the property. The site is currently vacant, with the exception of some grazing uses. Formerly used extensively for grazing and some sugar cane production, the open pastures have become overgrown, reflecting the low-level activities of the site. No stream gulches cross the site; instead, concrete-lined water ditches cross parts of the lowlands, once performing an irrigation purpose, but now also overgrown and generally disintegrated. Barbed wire fences extend through much of the site and are maintained by the ranch tenants.

Land uses of adjoining properties are generally agricultural, military, recreational, and vacant. Makai of the site lies agricultural lands used for grazing that extend to Kamehameha Highway. Across the highway is Malaekahana State park. Along the southern boundary of the site is Cackle Fresh Egg Farm. The mauka boundary of the site adjoins other grazing lands and military use lands of the Kahuku Training Area. At the northern boundary of the site, agriculture and aquaculture operations are currently active, utilizing lowlands for their culture ponds.

The nearby communities of Kahuku and Laie are primarily low density residential areas with small village commercial shopping centers, churches, schools, and similar institutions. Malaekahana State Park is a large ocean-front park with picnic and camping facilities. Further south from this site in Laie Village are located Brigham Young University (Hawaii campus), the Mormon Temple, and the Polynesian Cultural Center.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

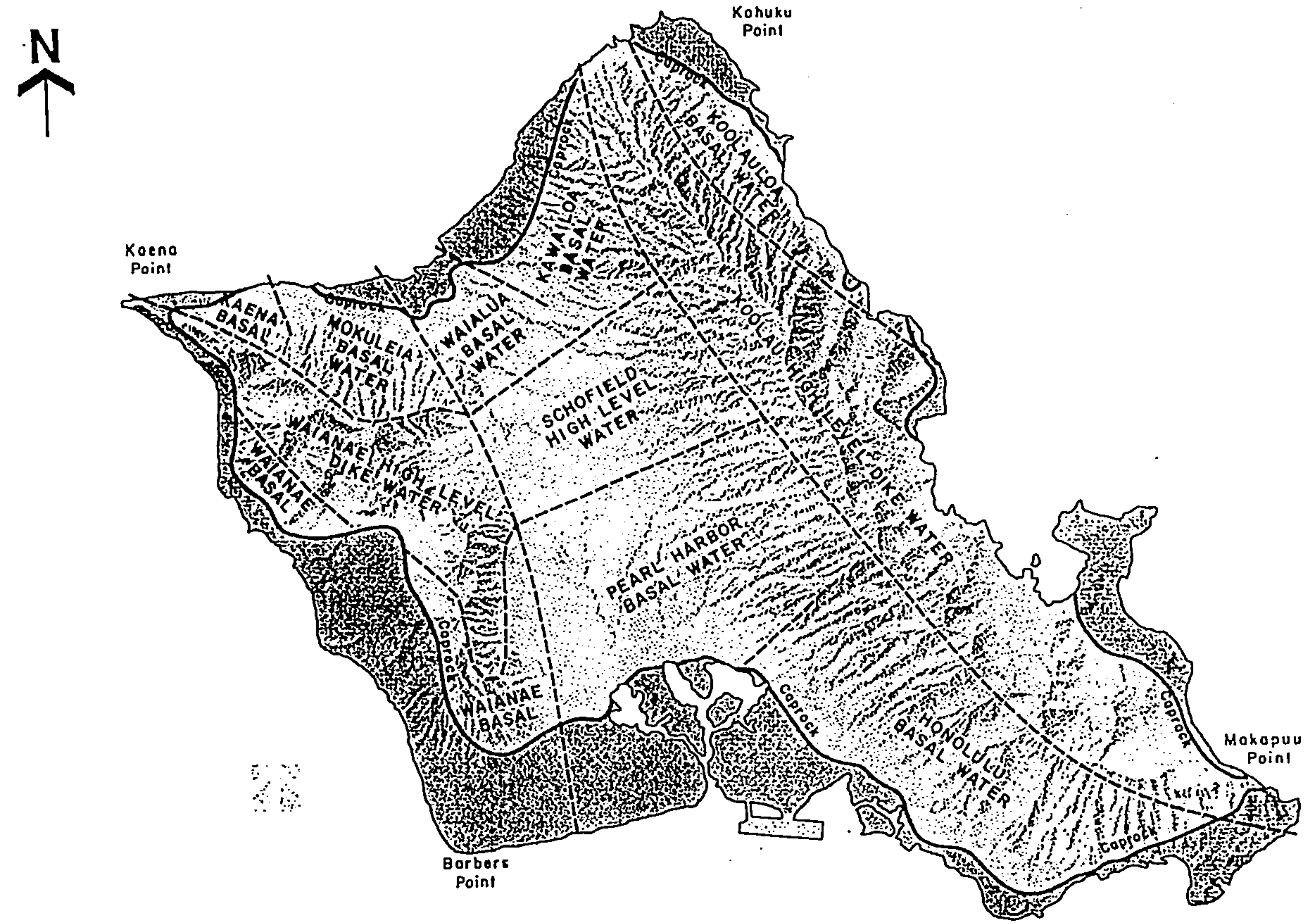
The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 375 feet at the mauka boundary. Slopes of 3 to 10 percent are found over most of the central-mauka portions of the site. Steeper slopes of 20 to 30 percent occur around isolated peaks and along gulches. The central area is dominated by a wide, shallow gulch that begins near the mauka boundary and traverses 75 percent of the project site's length before exiting along the southeast boundary.

WATER RESOURCES

Groundwater bodies underlying the island of Oahu are illustrated on Figure 3. The project site is situated over a basal lens known as the Koolauloa basal aquifer. In the Kahuku area, the basal lens extends in a northwest direction, parallel to the high level dike



SOURCE: BWS, OAHU WATER PLAN,
4th EDITION, JULY 1982, PG. 10

FIGURE 3

GROUND WATER BODIES ISLAND OF OAHU

zone and the crest of the Koolau Mountain Range. Rainfall is responsible for groundwater recharge in the area. A thin caprock layer allows offshore leakage, which accounts for groundwater flow in the lens.

In general, water quality in the basal lens improves toward the dike zone. This is a result of seepage of dike water that reduces salinity. It is thought that the basal lens in the region mauka of Kamehameha Highway is of high quality. Wells drilled in this portion of the aquifer may produce a potable water source.

EXISTING INFRASTRUCTURE

There are three water systems in the vicinity of the project site (see Figure 4). All three have a limited service zone at present and will require significant extension of transmission mains and/or additional source development before water can be delivered to the project site.

BWS Water system

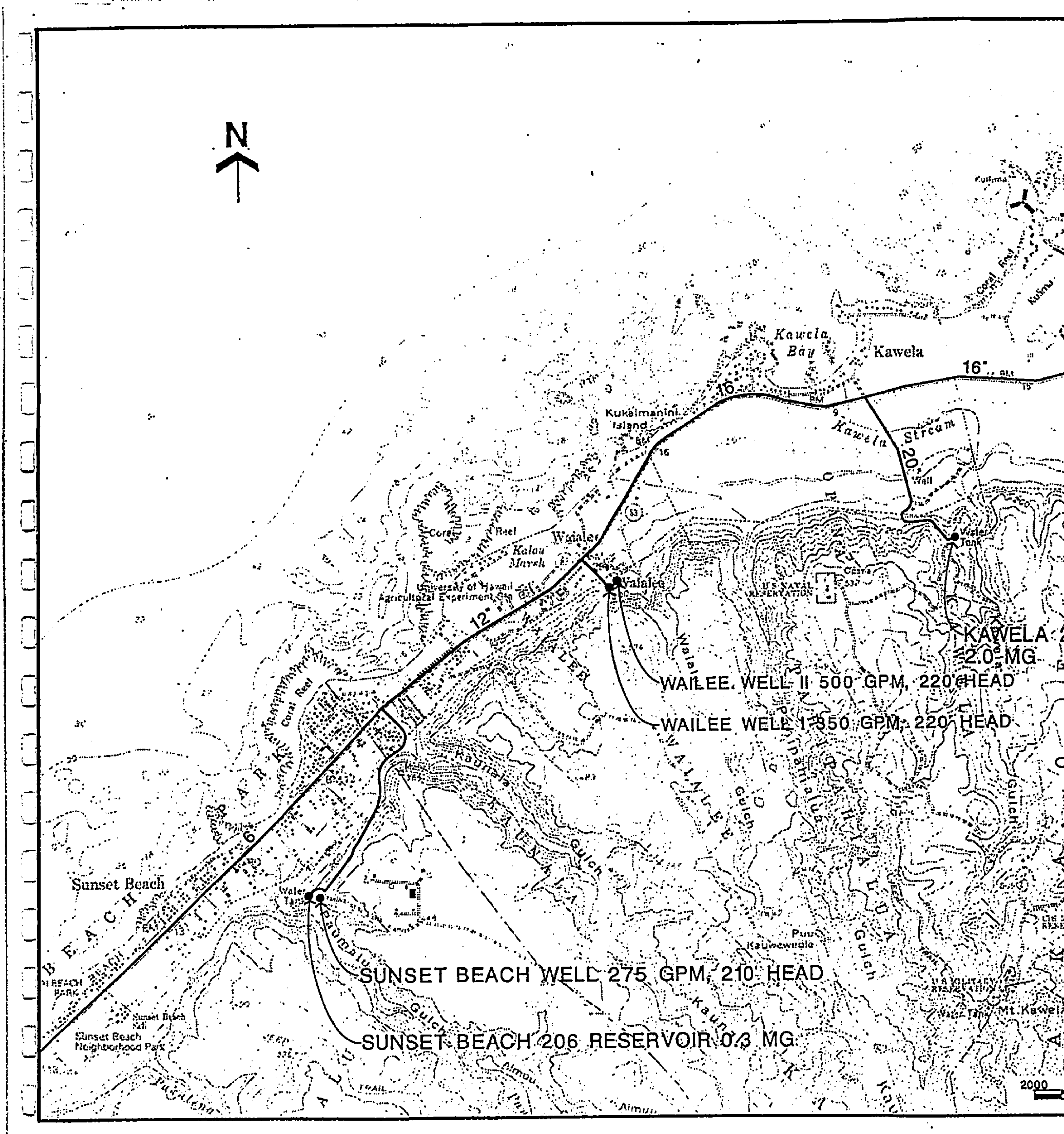
The BWS operates an independent water system serving the town of Kahuku. Two wells with 700 gpm capacity and 250-foot head tap the basal aquifer source. The wells have a total capacity of 2.0 mgd and an average daily draft of 0.3 mgd. Storage for the Kahuku system is provided by the Kahuku 228 reservoir, which has a capacity of 0.5 MG. The zone of service of this water system extends along Kamehameha Highway to the Kahuku fire station.

Campbell Estate Water System

The Campbell Estate water system services homes makai of Kamehameha Highway located between Malaekahana State Recreation Area and Kahuku Town. The water source is a well field known as Pump 7, located about 750 feet mauka of Kamehameha Highway. A reservoir, located about 250 feet mauka of Pump 7, provides storage for the system.

Zions Securities Corp. Water System

Zions Securities supplies water to the town of Laie, including the Mormon Temple, BYU Hawaii Campus, and the Polynesian Cultural Center. Its zone of service ends in the vicinity of the project access road on Kamehameha Highway. The City and County



N
Kawela Bay
Kawela
16"
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Coral Reef
University of Hawaii Agricultural Experiment Sta
12"
Waialee
KAWELA
2.0 MG
WAILEE WELL II 500 GPM, 220 HEAD
WAILEE WELL I 350 GPM, 220 HEAD
Kaunala Gulch
Sunset Beach
SUNSET BEACH WELL 275 GPM, 210 HEAD
SUNSET BEACH 206 RESERVOIR 0.3 MG
Sunset Beach Neighborhood Park
Puu Kauwewnole
Mt Kawela
2000

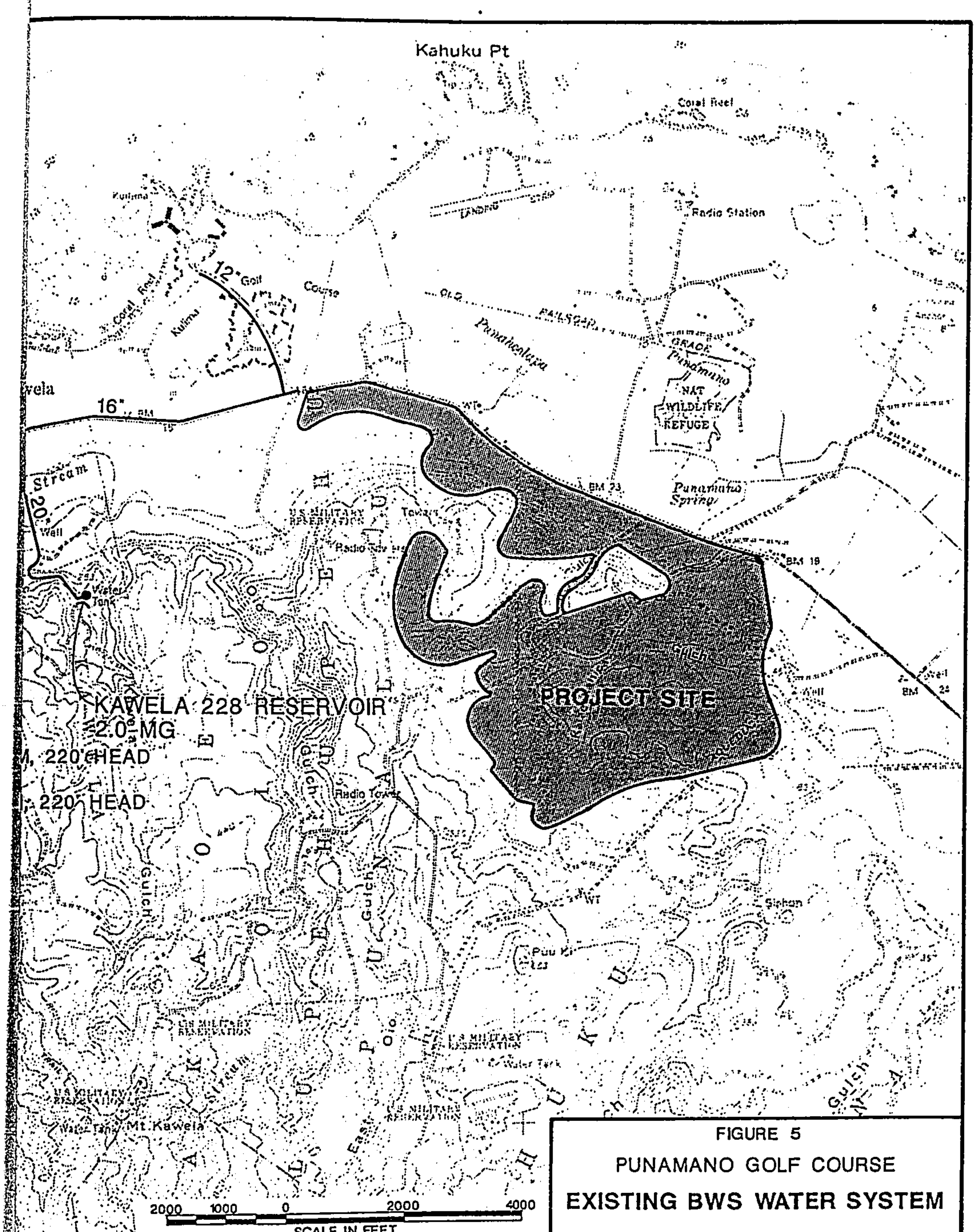

FIGURE 5
PUNAMANO GOLF COURSE
EXISTING BWS WATER SYSTEM

baseyard and Malaekahana State Recreation Area are among the water users at the extreme end of the service zone. A number of wells in the Laie area supply water for the system. Storage is provided by two reservoirs with total capacity of 2.25 MG and spillway at 268 feet.

PROJECTED WATER DEMAND

Water demand projections are based on the BWS Water System Standards (1985) and demands from similar developments.

Domestic Demand

An estimate of domestic water demand can be calculated using the BWS water demand rate for resort areas of 4,000 gallons per acre per day. Based on a 10-acre clubhouse site, the calculated demand is 40,000 gpd. The BWS factor considers both potable water and irrigation water. The potable water demand is estimated to be 20,000 gpd on the average.

Irrigation Demand

An annual irrigation rate of 0.35 MGD is estimated for the proposed golf course, based on the Kuilima Resort requirement. Irrigation typically encompasses the tees, greens, and fairways of the golf course and a limited portion of the "rough" area around the course.

Fire Protection

Fire protection is required for the clubhouse and maintenance facility of the proposed golf course. The BWS has established fire protection criteria for different land uses. Based on the BWS standard for schools, small shopping centers, neighborhood businesses, and hotels, the water demand for fire protection is 2,000 gpm for a two-hour duration. The resulting storage requirement for fire protection is 240,000 gallons. Fire hydrants spaced at 250-foot intervals are required, with the last hydrant located at one-half the spacing distance (125 feet) from the last structure.

PROPOSED WATER SYSTEM

Evaluation of Alternatives

In evaluating the most feasible means of meeting the domestic, irrigation, and fire protection requirements for the site, the following alternatives were considered:

1. Connection to the BWS Kahuku water system
2. Connection to the Campbell Estate water system
3. Connection to the Zions Securities water system
4. Development of an onsite water system

Source

Of the three existing water systems, only the Zions Securities system has adequate source to meet the project water requirements. The other three alternatives would require the golf course to develop an additional water source. The BWS generally does not allow connection to its water system for golf course irrigation or large-scale agricultural irrigation.

Storage

The proposed clubhouse is above the service zones of the three existing water systems. Therefore, all four alternatives require construction of an onsite reservoir to meet the pressure requirements. A hydropneumatic system will be required if connection to one of the three existing water systems is selected in order to boost the water pressure to the onsite reservoir.

Transmission

Connection to the BWS Kahuku system will require construction of approximately 9,000 feet of transmission main along Kamehameha Highway to the project site.

Construction of approximately 3,000 feet of transmission main along Kamehameha Highway will be necessary to connect to the Campbell Estate system.

There are two options for connection to the Zions Securities system. A 6-inch water main is located on the makai side of Kamehameha Highway at the intersection with the project site. However, this portion of the system is a lateral to Malaekahana State Recreation Area. Another option is connection before the park meter, which would require either crossing Kamehameha Highway or crossing Laiewai Stream.

Selected Alternative

Due to the inadequacies of the existing water systems, the recommended alternative is development of an onsite water system (see Figure 5).

Two wells will be required (one standby) to meet the project water demands (fire protection, domestic, and irrigation). The wells will pump to a reservoir located mauka of the clubhouse site for irrigation and fire protection storage. Elevation of the reservoir will be sufficient to provide 20 psi to fire hydrants at the clubhouse. An extension of the transmission main to the clubhouse fire hydrants will transport water from the reservoir to golf course ponds for irrigation.

The wells will also supply potable water to the clubhouse and maintenance facility via a separate potable water system. A hydropneumatic system will be necessary to deliver adequate water pressure (40 psi) to the clubhouse. A chlorination system will also be required to protect against bacterial contamination.

IMPACTS AND MITIGATION

Impacts due to the proposed water systems can be classified as short-term and long-term.

Short-Term Impacts and Mitigation

Short-term impacts are construction related and may include dust, noise, and traffic disturbances in the vicinity of the project site and Kamehameha Highway. Mitigation of these nuisances can be accomplished by limiting construction to off-peak traffic house, the use of wind breaks or watering to reduce dust, and the observance of approved traffic control plans.

Long-Term Impacts

The water requirements of the proposed golf course will have a long-term impact on the Koolauloa Basal Aquifer because development will require a commitment of available water.

Careful site selection of the proposed onsite wells will minimize impact on existing sources.

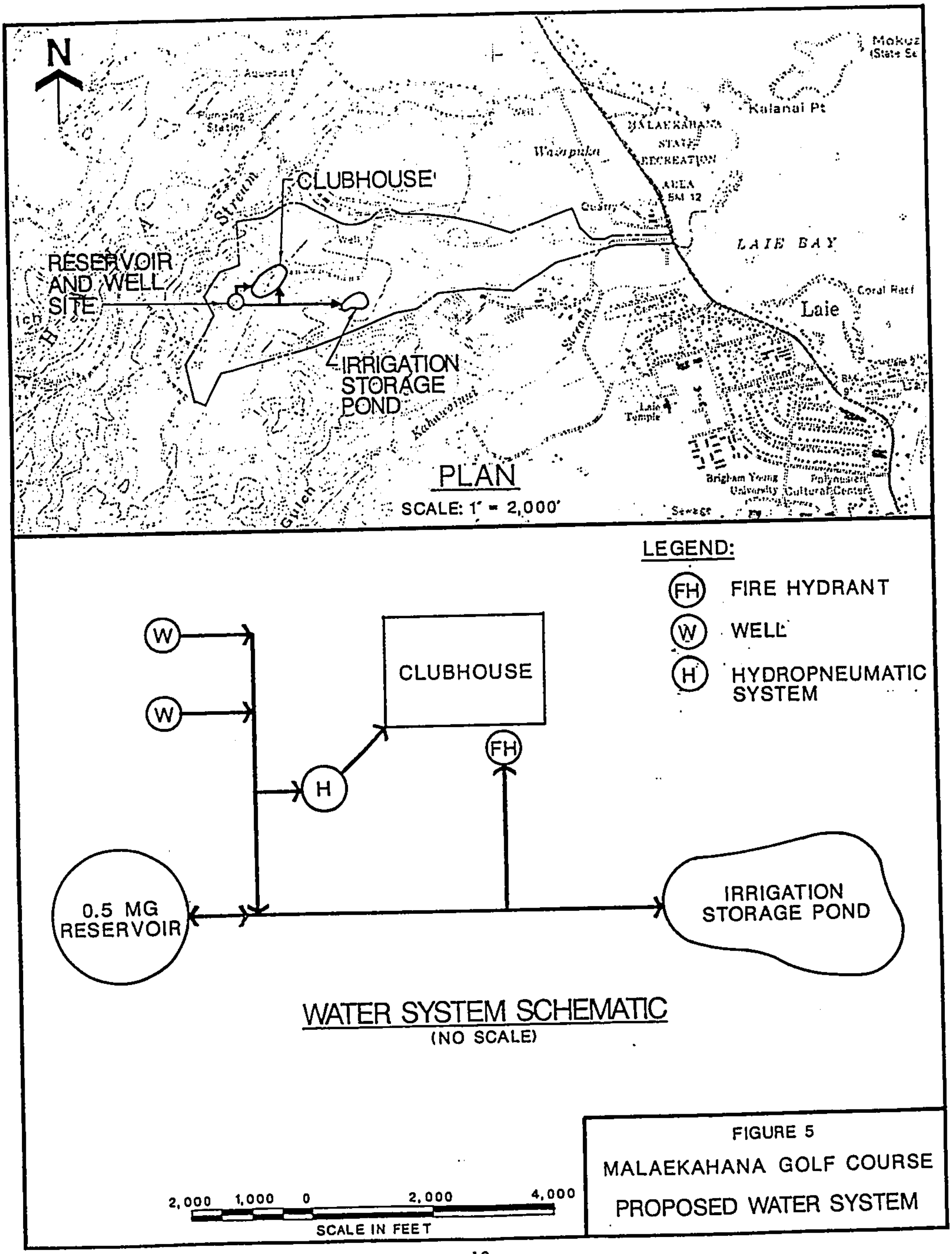

FIGURE 5
MALAEKAHANA GOLF COURSE
PROPOSED WATER SYSTEM

APPENDIX E

DRAINAGE REPORT

FOR THE

PROPOSED PUNAMANO GOLF COURSES

Prepared for:

Kuilima Resort Company

Prepared by:

Engineering Concepts, Inc.
250 Ward Avenue, Suite 206
Honolulu, Hawaii 96814

February 1989

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TABLES

FIGURES

INTRODUCTION

Kuilima Resort Company is proposing the development of three 18-hole golf courses in the vicinity of Kahuku on the North Shore of Oahu. A location map is provided on Figure 1. This site, called Punamano, is located approximately 1.5 miles west of Kahuku Town. The site, containing approximately 605 acres, is located mauka of Kamehameha Highway across Kuilima Resort.

The objective of this report is to present the necessary planning and preliminary engineering documentation for drainage at the proposed Punamano Golf Courses. Specifically, this report addresses the following:

1. Background information on the proposed project
2. Existing site and watershed conditions
3. Proposed development and resulting drainage
4. Impacts and mitigation of the proposed development affecting the site and the watershed

BACKGROUND

Proposed Project

Three 18-hole golf courses are planned for the site covering approximately 605 acres. The proposed site is shown on Figure 2. Each course will be designed for a different level of playing difficulty. Of the 605-acre site, approximately 270 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

At each of the three golf courses, a small clubhouse (12,000 to 14,000 square foot area) will be constructed. Each clubhouse would include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, and administrative offices. Small clubhouses are planned due to the proximity of extensive support facilities at the Kuilima Resort. A parking area will be provided at each clubhouse with approximately 130 to 160 spaces.

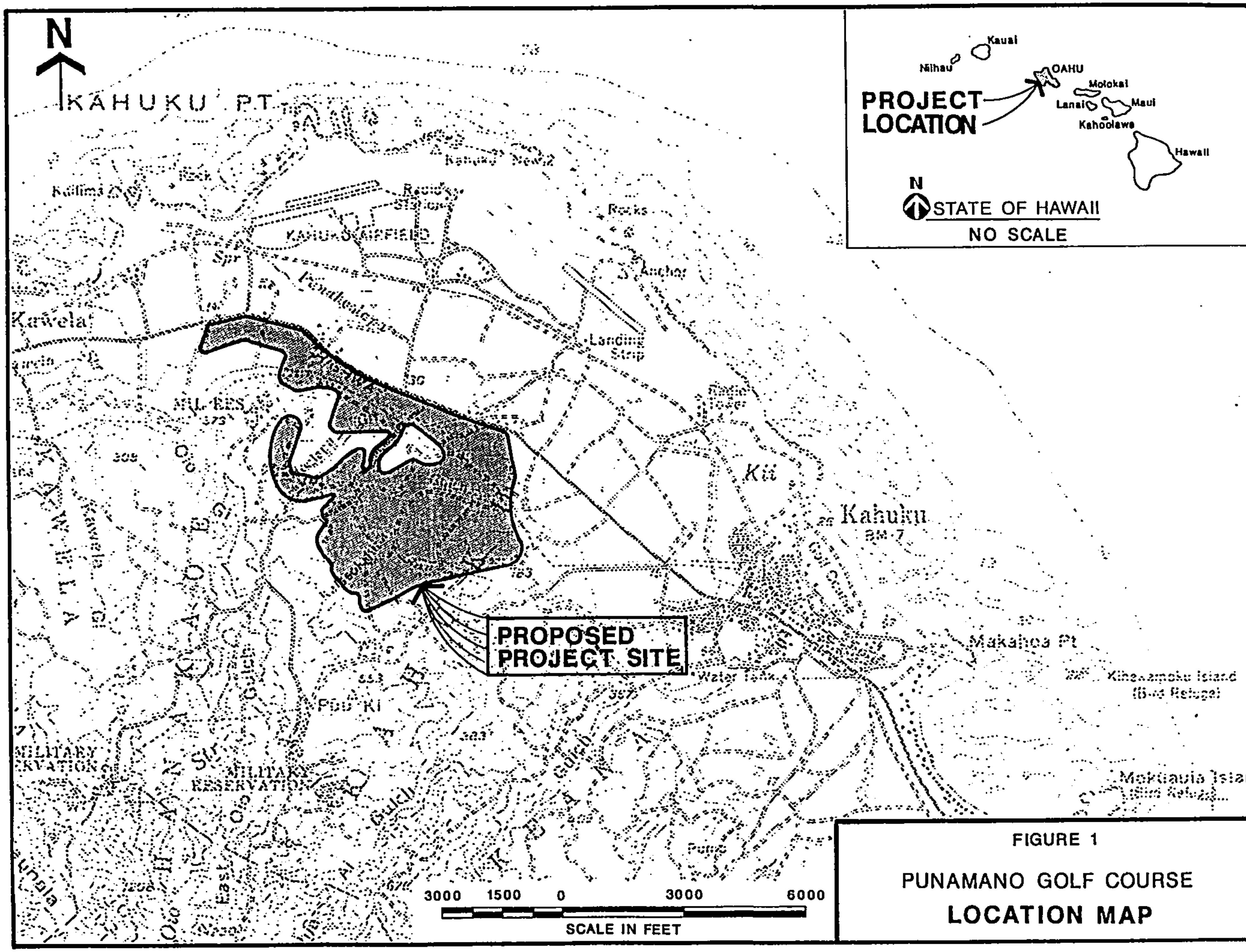

FIGURE 1

PUNAMANO GOLF COURSE

LOCATION MAP

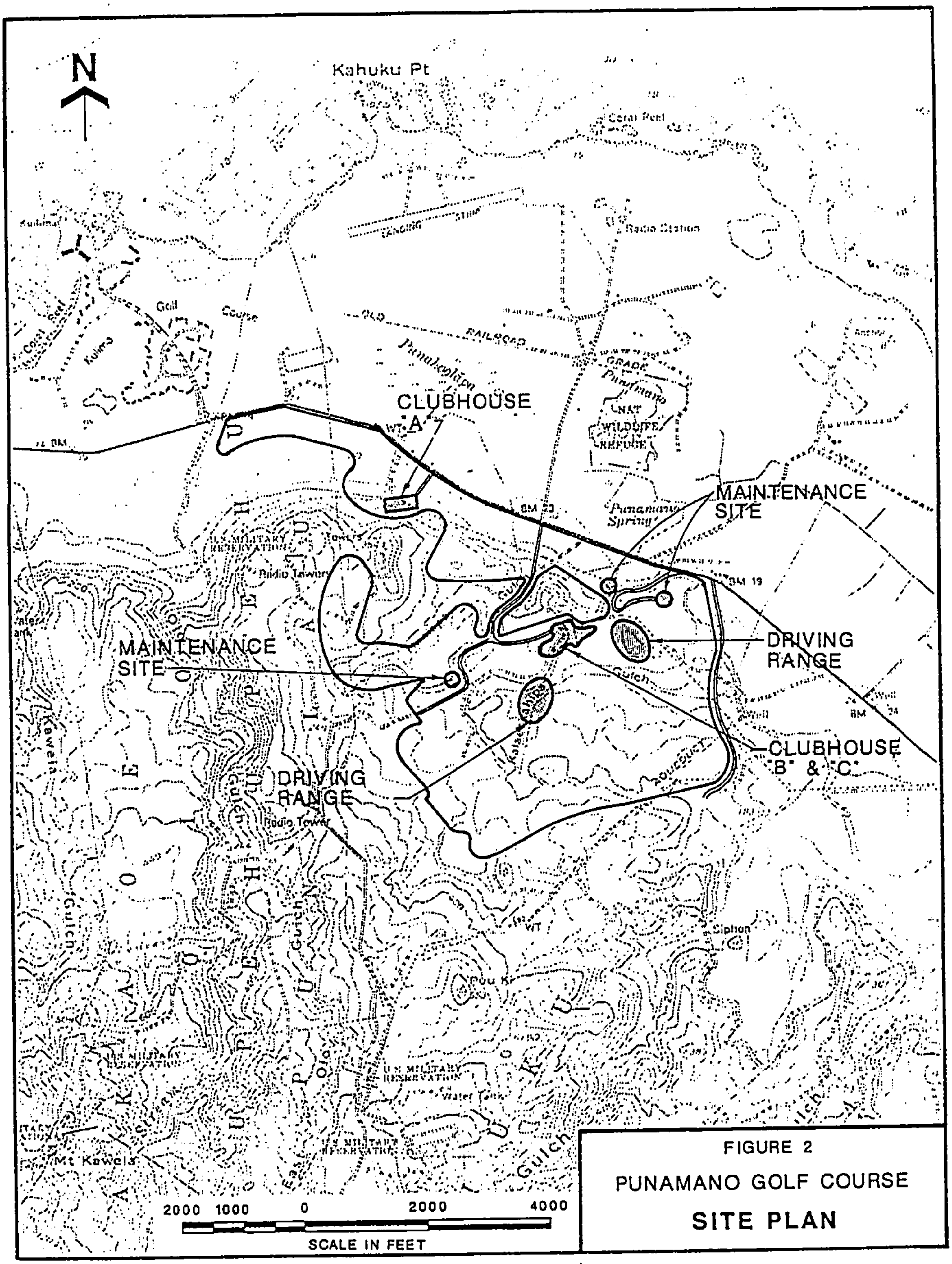

FIGURE 2
PUNAMANO GOLF COURSE
SITE PLAN

A golf driving range will be constructed at the two upper (mauka) golf courses. Each driving range will have 20 to 26 tee positions. Parking for this facility will be accommodated at the clubhouse area for each course.

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-05: Por. 1, Por. 2, 5, 6, and Por. 7, and TMK: 5-7-01: Por. 21. The 605-acre project site at Punamano has been owned by The Estate of James Campbell since the 1890s.

The irregularly-shaped boundary of the Punamano site consists primarily of vacant grass and shrub meadows, rolling hillsides, intermittent stream gulches, and some steep slopes and cliffs. Portions of the site contain remnants of previous agricultural activities, including overgrown cultivated fields and an abandoned Christmas tree farm. Four abandoned windmill structures are located within the site near Kamehameha Highway. A road bisects the site, providing access from Kamehameha Highway to the U.S. Army Kahuku Training Area, located mauka of the site.

Land uses of property adjoining the Punamano site include military, agricultural, commercial, and resort activities. A U.S. Air Force telecommunications facility is also located adjacent to the property, along its western boundary. Also along the western boundary of the lower portion of the property is a small agricultural operation currently producing bananas and papayas. The Kuilima Resort is located across Kamehameha Highway from this site. Tanaka Store, a well-known local landmark, is a small grocery store and gas station located across Kamehameha Highway from the site at its Kahuku-side boundary. Vacant agricultural land adjoins the Kahuku-side boundary of the site. A major aquaculture operation exists just east of the Punamano site and makai of Kamehameha Highway.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall for Station No. 907.00, located at the Kuilima Resort, over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

EXISTING CONDITIONS

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 280 feet at the western boundary. Slopes of 1 to 5 percent are found over most of the makai portion of the site, with moderate to steep slopes ranging from 5 to 20 percent over much of the mauka area. Steepest slopes occur around isolated peaks and along gulches, where slopes in excess of 30 percent occur. The southwest area is dominated by the steep hillsides and isolated peaks that border either side of Hoolapa Gulch. The southeast region has an undulating topography of minor gulches and ridges that intersect at Kalaeokahipa Gulch. Slopes are

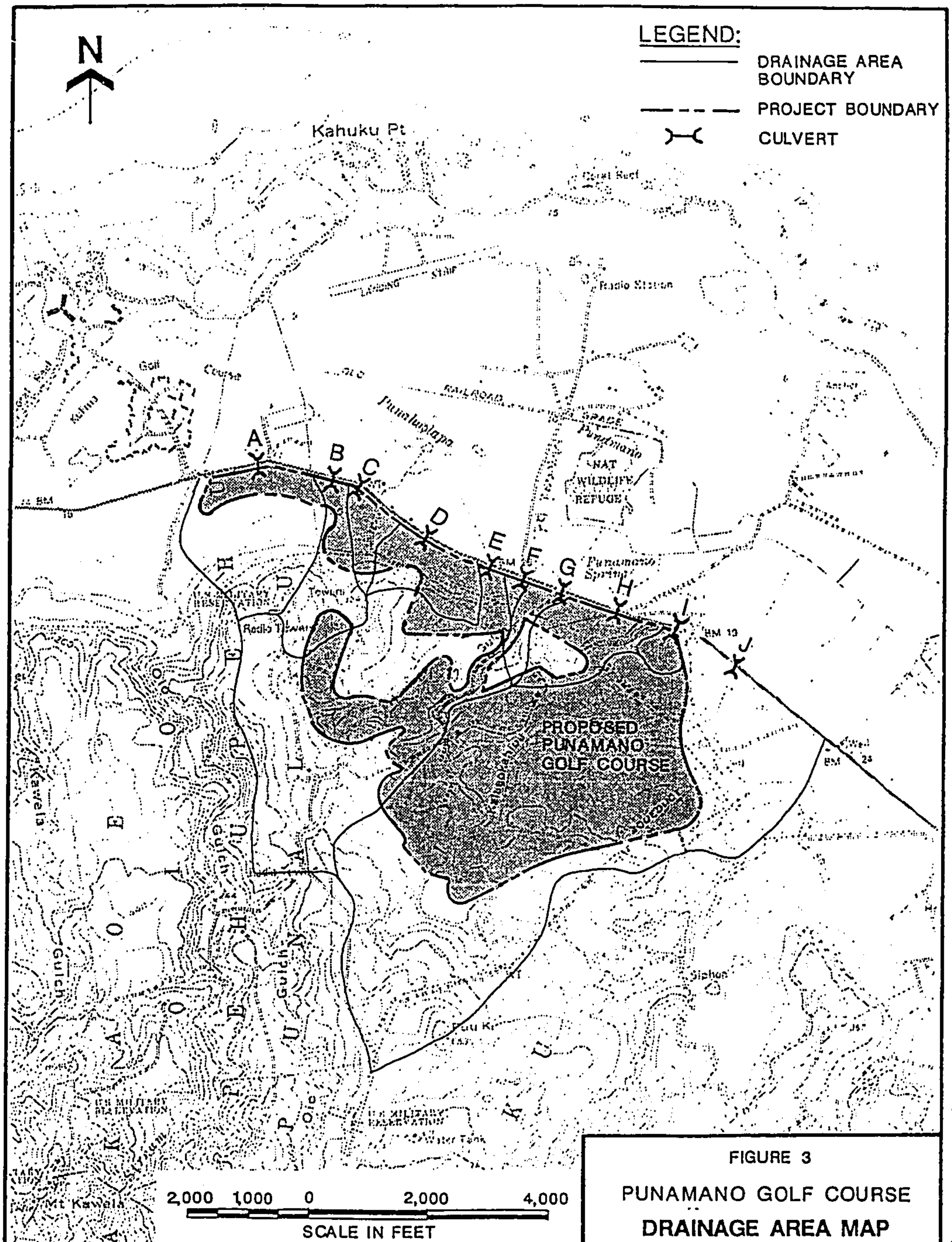

FIGURE 3

PUNAMANO GOLF COURSE

DRAINAGE AREA MAP

predominantly moderate in this region, except for the steep slopes along Kalaeokahipa Gulch.

The offsite watershed area mauka of the project site is characterized by moderate slopes near the project's southwest and southeast borders, with progressively steeper slopes at higher elevations. Typical slopes in the upper region are more than 20 percent. Elevations vary from 10 feet near the project's southwest border to 653 feet at the upper boundary of the watershed. The offsite area between the northeast side of the project boundary and Kamehameha Highway consists of uniformly sloping lands of 2 to 5 percent and is bisected by an existing drainageway. Elevations vary from 15 to 65 feet.

The vegetative cover is variable, ranging from open areas of short grasses to heavily vegetated areas consisting of tall grasses, scrub brushes, and trees. Uncovered areas in the form of dirt roads and pockets of erosion are also present.

Runoff

Figure 3 shows the existing onsite and offsite drainage areas. Runoff from the offsite areas crosses the southern boundary of the project site, combines with onsite runoff, and exits the northern boundary along Kamehameha Highway. A series of ten drainage culverts along Kamehameha Highway between road stations 496+60 and 583+32[1] convey the existing runoff quantities, as calculated for 10- and 50-year storms in Table 1, to the open area on the makai side of the highway. (The tributary drainage area for each culvert is identified on Figure 3.) Calculations were based on rainfall intensities of 2.3 inches per hour for 10-year storms and 3.4 inches per hour for 50-year storms. The ten drainage culverts along Kamehameha Highway are indicated by letters "a" through "j" on Figure 3; the corresponding station number for each culvert is listed in Table 1.

The majority of all onsite and offsite runoff is collected either in Kalaeokahipa Gulch, located in the eastern portion of the project site, or in Hoolapa Gulch, situated in the central region. The former gulch crosses Kamehameha Highway at station 583+32 and the latter at 532+70. Approximately 168 acres of offsite area (24.4 percent of all offsite areas) and 121 acres of onsite area (19.7 percent of total onsite area) drain into Hoolapa

[1]"Plans of Kamehameha Highway," Federal Aid Project No. 3C and 3E.

TABLE 1

STORM WATER RUNOFF - PUNAMANO GOLF COURSE

TOTAL RUNOFF

Map Index	Station Number	Existing 10-Year (cfs)	Existing 50-Year (cfs)	Developed 10-Year (cfs)	Developed 50-Year (cfs)	% Increase 10-Year	% Increase 50-Year
A	496+60	208	312	226	338	8.7	8.3
B	509+00	121	179	142	209	17.4	16.8
C	513+50	39	57	57	84	46.2	47.4
D	527+35	97	143	117	174	20.6	21.7
E	538+70	678	1004	719	1062	6.0	5.8
F	543+65	9	14	12	18	30.4	28.6
G	551+40	35	52	38	56	8.6	7.7
H	560+90	105	155	127	189	21.0	21.9
I	572+15	28	42	31	45	10.7	7.1
J	583+32	1221	1761	1353	1955	11.2	11.0
		2541	3719	2822	4130	11.1	11.1

Gulch. Kalaeokahipa Gulch accepts runoff from 348 acres of offsite area (50.5 percent) and 278 acres of onsite area (45.2 percent). The other eight culverts each drain relatively small areas ranging from 5.11 acres to 105.5 acres.

Flood Hazard

A small portion of the project site may be subject to inundation by a 100-year flood, as indicated on the Flood Insurance Rate Map (Figure 4). This 7.5-acre area is confined to an 800-foot wide band around Hoolapa Gulch that extends 400 feet into the project site from Kamehameha Highway. Under the present golf course layout, the 100-year flood will inundate half of three fairways, including one green and two tees.

MODIFICATIONS AFTER DEVELOPMENT

The proposed golf course development would change the character of the 616-acre project site. The vegetative cover currently found on the site would be replaced by a more open, close-cropped landscaping typically associated with golf course developments. Roadways, parking lots, buildings, ponds, and other features normally supporting a golf course would further add to the modification of the project site.

As a result of the proposed improvements, peak runoff generated onsite is expected to increase. Estimated peak runoff for 10- and 50-year storms at each of the ten culverts along Kamehameha Highway and the percent increase from existing conditions are shown in Table 1.

Drainage patterns are expected to remain similar to existing conditions, although diversion of some onsite runoff to the golf course ponds is proposed. It is anticipated that the natural slopes and vegetation of most of the areas unaffected by golf course construction would be maintained.

IMPACT AND MITIGATION

Development of the proposed golf course improvements may result in a potential increase in the offsite discharge of peak runoff generated onsite. Without mitigation, the downstream discharge of the total onsite runoff has the potential to increase an average of 27 percent for the 10- and 50-year storm. However, runoff entering the Kamehameha

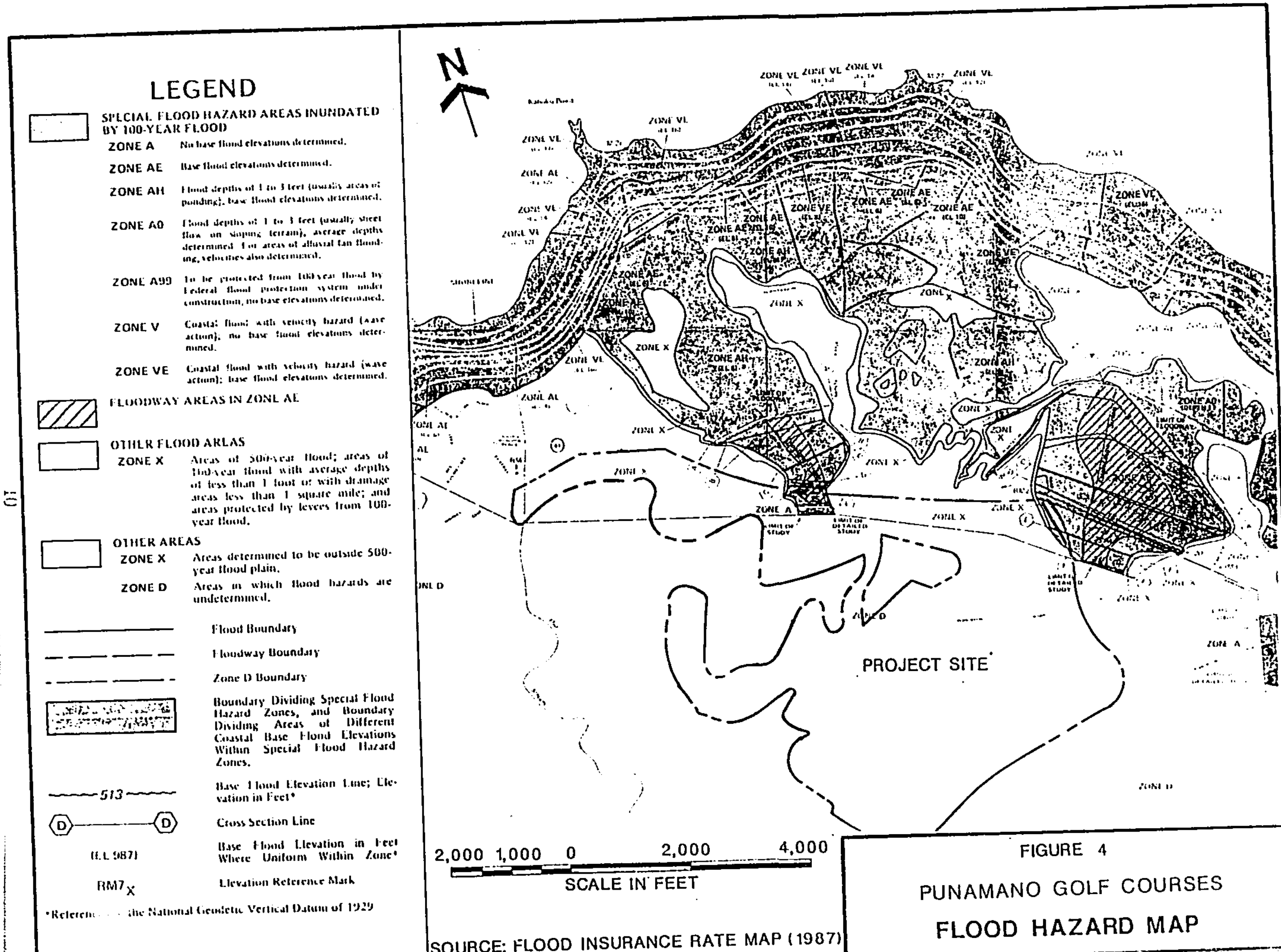

FIGURE 4
PUNAMANO GOLF COURSES
FLOOD HAZARD MAP

Highway culverts can remain near levels experienced for existing conditions when mitigating measures are employed. These measures include routing runoff to ponds and detention basins within the golf course layout.

It is intended that the ponds serve as detention basins, dampening the peak runoff generated onsite. Additional detention basins can be created to dampen major storm runoff by selective sizing of drain culverts under cart paths crossing gullies and depressed areas between fairways. By incorporating these detention basins into the golf course design, the discharge of peak storm runoff from the project site is not expected to increase from existing conditions.

The impacts of the increased onsite peak runoff are greatly reduced when compared to the impact of peak runoff generated over the entire drainage basin. The increase in onsite peak runoff represents 11 percent of the total peak runoff from the drainage basin.

A positive impact of the proposed development is the probable reduction of erosion and sediment transport to open areas on the makai side of Kamehameha Highway. Bare areas currently found would be planted, with the project site as a whole having better control and maintenance of its landscaping.

APPENDIX F

DRAINAGE REPORT

FOR THE

PROPOSED MALAEKAHANA GOLF COURSE

Prepared for:

Kuilima Resort Company

Prepared by:

Engineering Concepts, Inc.
250 Ward Avenue, Suite 206
Honolulu, Hawaii 96814

February 1989

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The objective of this report is to present the necessary planning and preliminary engineering documentation for drainage at the proposed Malaekahana Golf Course. Specifically, this report addresses the following:

1. Background information on the proposed project
2. Existing site and watershed conditions
3. Proposed development and resulting drainage
4. Impacts and mitigation of the proposed development affecting the site and the watershed

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Proposed Project

An 18-hole golf course is planned for the site, which is shown on Figure 2. Of the 228-acre site, approximately 90 acres will be used to develop greens, tees, fairways, and roughs. Detention and retention ponds will be constructed as water hazards and will serve additional purposes, such as aesthetic features, storm water runoff control, and irrigation water storage.

The clubhouse (approximately 20,000 square feet) would include men's and women's locker rooms, pro shop/starter's station, a lounge/snack bar/kitchen, small meeting rooms, and administrative offices. A parking area will be provided, with approximately 160 to 200 spaces. A driving range with 24 to 30 tee positions will be part of the golf course complex.

Land Use and Property Ownership

The property is located in the Koolauloa Judicial District, with the following Tax Map Key designations: TMK: 5-6-05: Por. 6 and TMK: 5-6-07: Por. 1. The 228-acre

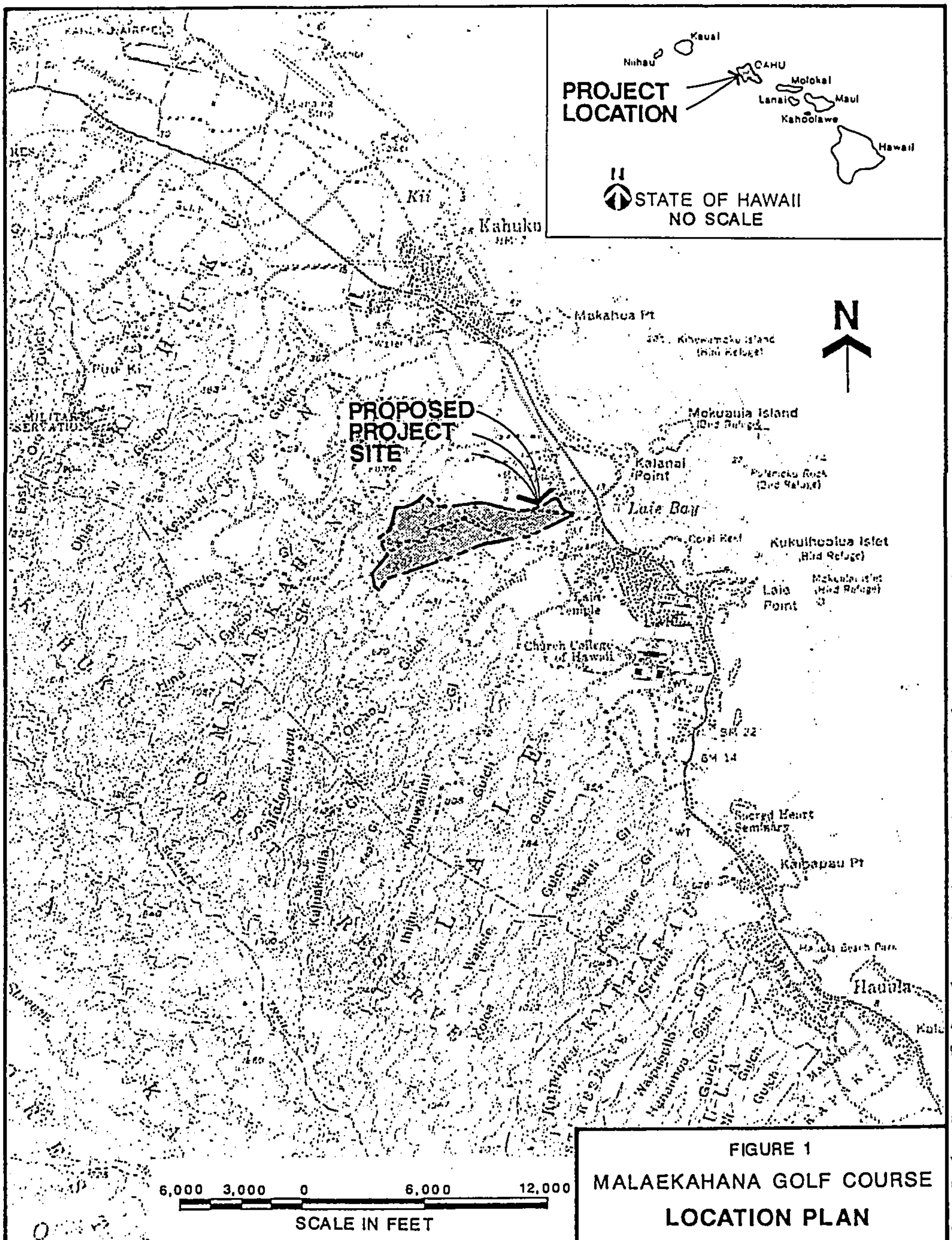


FIGURE 1
MALAEKAHANA GOLF COURSE
LOCATION PLAN

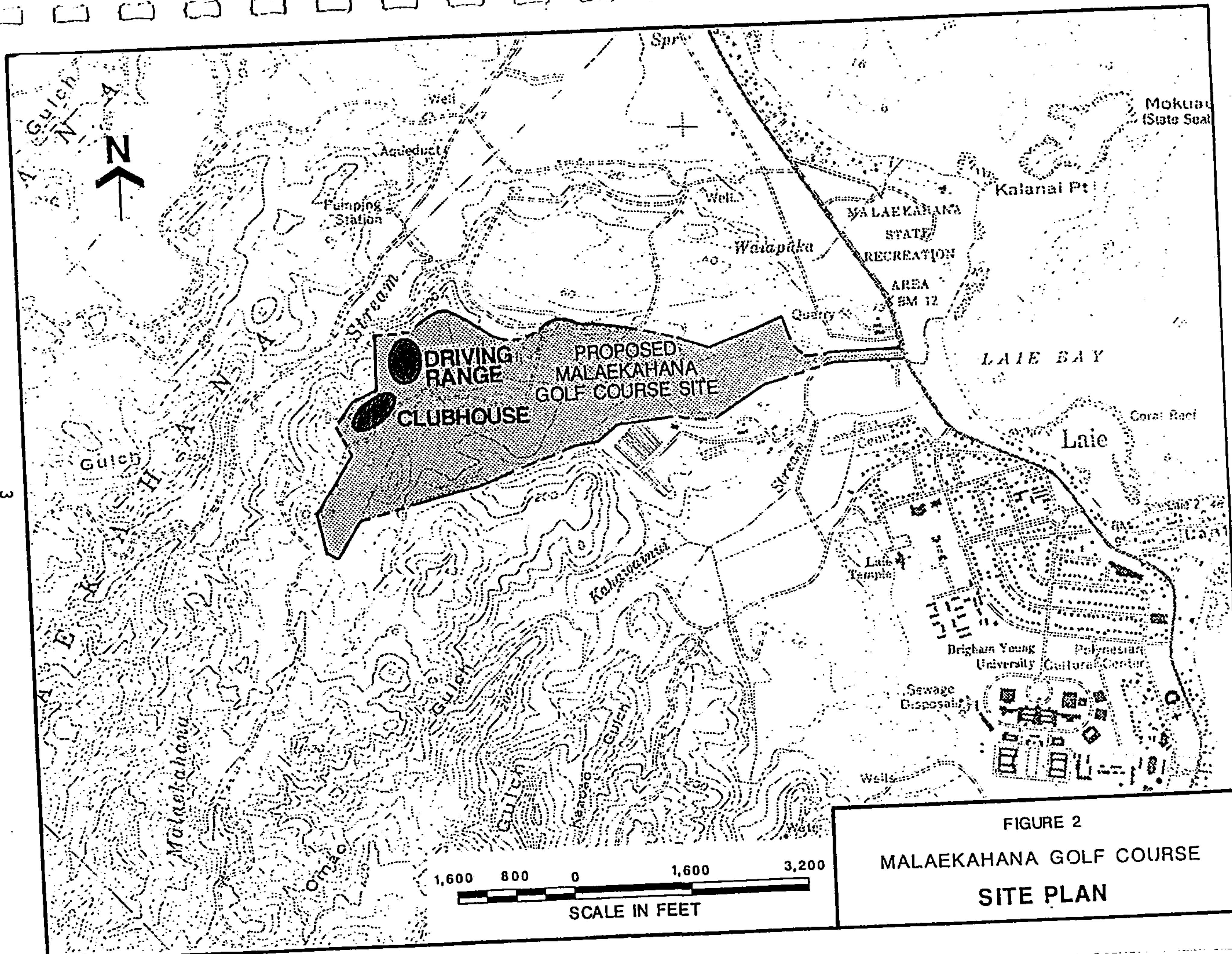


FIGURE 2
MALAEKAHANA GOLF COURSE
SITE PLAN

project site at Malaekahana has been owned by The Estate of James Campbell since the 1890s.

The site is connected to Kamehameha Highway by a narrow strip of land extending mauka to the main portion of the property. The site is currently vacant, with the exception of some grazing uses. The site has been formerly used extensively for grazing and some sugar cane production. The open pasture areas have become overgrown, reflecting the low-level activities of the site. No stream gulches cross the site. Concrete-lined water ditches cross parts of the lowlands on the site, which once performed an irrigation purpose but are now overgrown and generally disintegrated. Barbed wire fences extend through much of the site and are maintained by the ranch tenants.

Land uses of adjoining properties are generally agricultural, military, recreational, and vacant. Makai of the site lies agricultural lands used for grazing that extend to Kamehameha Highway. Across the highway is Malaekahana State park. Along the southern boundary of the site is Cackle Fresh Egg Farm. The mauka boundary of the site adjoins other grazing lands and military use lands of the Kahuku Training Area. At the northern boundary of the site agriculture and aquaculture operations are currently active, utilizing lowlands for their culture ponds.

The nearby communities of Kahuku and Laie are primarily low density residential areas with small village commercial shopping centers, churches, schools, and similar institutions. Malaekahana State Park is a large ocean-front park with picnic and camping facilities. Further south from this site in Laie Village are located Brigham Young University (Hawaii campus), the Mormon Temple, and the Polynesian Cultural Center.

The site is presently designated an agricultural district by the State Land Use Commission. The Koolauloa Development Plan Land Use Map designates the site Agriculture, while the City and County of Honolulu's Zoning District classifies the site as Agriculture (AG-1/AG-2).

Climate

Temperatures range from the low 60's (degrees Fahrenheit) to the mid 80's, depending on the time of day and the season. Daily temperatures vary by about seven degrees between winter and summer and about fifteen to eighteen degrees between day and night. Cooler temperatures are experienced at higher elevations in this area.

Median annual rainfall over a 60-year period amounted to 39.4 inches. The distribution is uneven and varies from month to month, heavy at some times and nonexistent at others. Winter months typically have the most rainfall.

The Kahuku area is subject to both trade winds and Kona storms. Kahuku has average wind velocities of ten to twelve miles per hour, with the prevailing wind directions being northeasterly and easterly. Winds at Kahuku are generally of greater velocity than experienced in most parts of Oahu.

In this particular area of Oahu, slightly less than one-third of the days per month are clear, about one-third are partly cloudy, and a little more than one-third of the days are cloudy.

The average relative humidity approximates 74.6 percent on the northern coast of Oahu, slightly lower in the summer and higher in the winter.

EXISTING CONDITIONS

Topographic Features

The project site exhibits varying terrain, with elevations ranging from 10 feet above mean sea level (MSL) along Kamehameha Highway to 375 feet at the mauka boundary. Slopes of 3 to 10 percent are found over most of the central-mauka portions of the site. Steeper slopes of 20 to 30 percent occur around isolated peaks and along gulches. The central area is dominated by a wide, shallow gulch that begins near the mauka boundary and traverses 75 percent of the project site's length before exiting along the southeast boundary.

Runoff

The project site is situated in both the Malaekahana and Kahawainui stream drainage basins (see Figure 3). Inclusive of the project site, these drainage basins consist of approximately 3,400 and 3,200 acres respectively. About 204 acres, or 90 percent, of the project site lies within the Kahawainui drainage basin, while the remaining 24 acres are situated within the Malaekahana basin. The project site represents only 3 percent of the

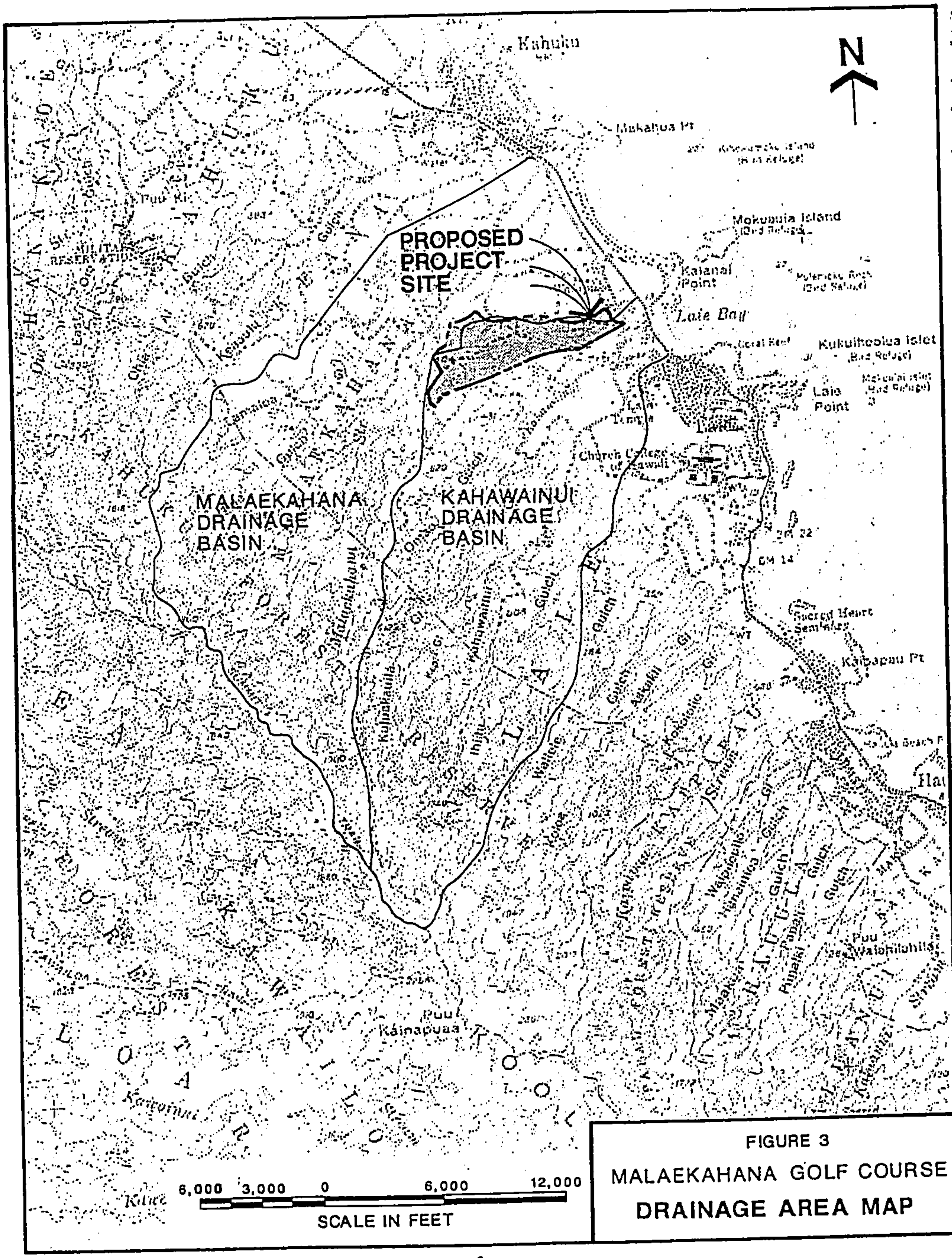


FIGURE 3
MALAEKAHANA GOLF COURSE
DRAINAGE AREA MAP

total drainage areas. Runoff from the drainage basins is transported across Kamehameha Highway via the Malaekahana Stream Bridge and the Laiewai Stream Bridge.

Calculations for runoff were based on rainfall intensities of 2.3 inches per hour for 10-year storms and 3.2 inches per hour for 50-year storms. Table 1 summarizes runoff quantities for the project site under existing conditions and after development of the golf course. Table 2 shows total onsite and offsite runoff under existing and developed conditions.

Flood Hazard

As indicated on the Flood Insurance Rate Map (Figure 4), the Malaekahana Golf Course site is outside the areas subject to inundation by a 100-year flood.

MODIFICATIONS AFTER DEVELOPMENT

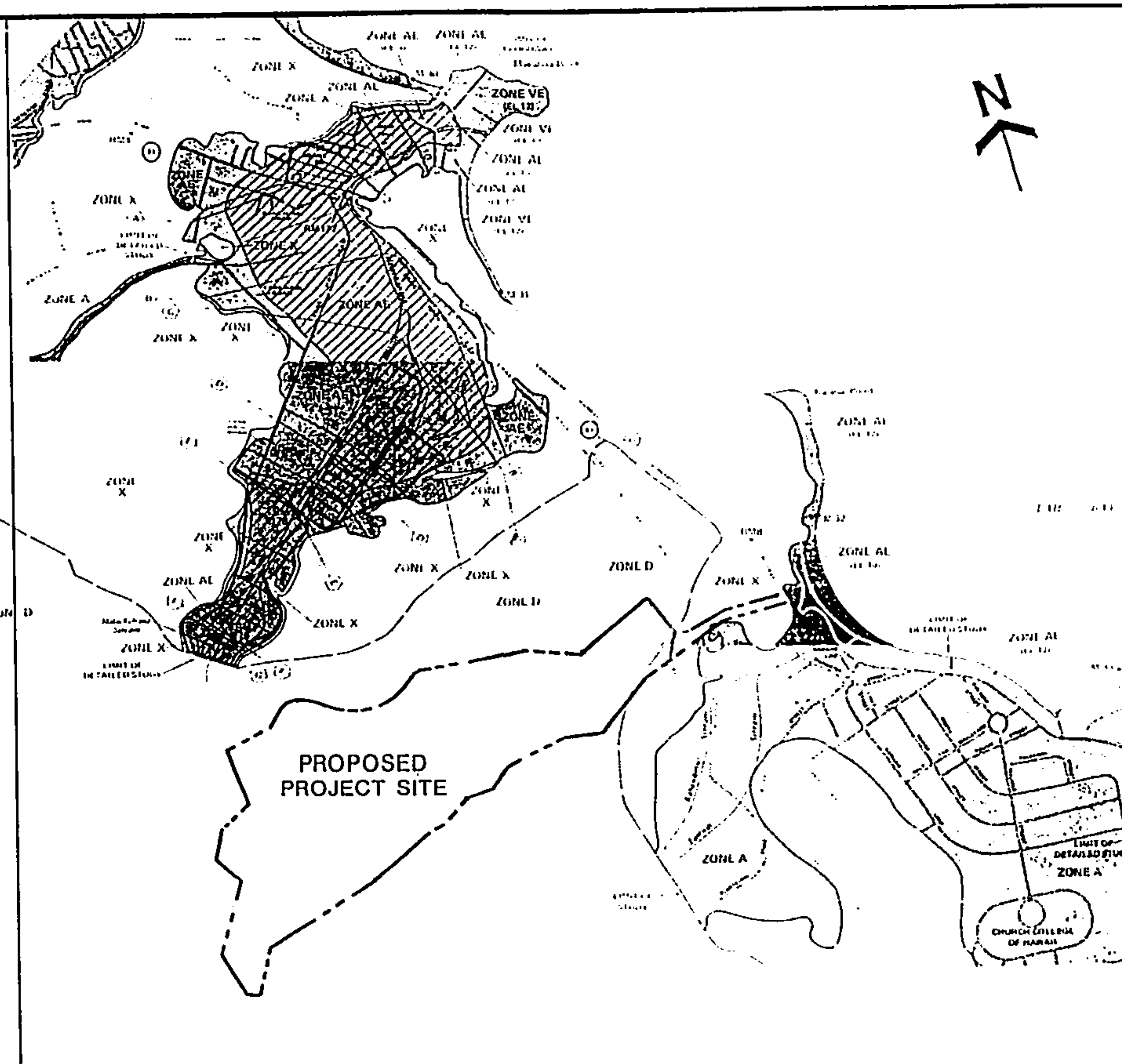
The proposed golf course development would change the character of the 228-acre project site. The vegetative cover currently found on the site would be replaced by a more open, close-cropped landscaping typically associated with golf course developments. Roadways, parking lots, buildings, ponds, and other features normally supporting a golf course would further add to the modification of the project site.

As a result of the proposed improvements, peak runoff generated onsite is expected to increase. Estimated peak runoff for 10- and 50-year storms and the percent increase from existing conditions are shown in Tables 1 and 2.

Drainage patterns are expected to remain similar to existing conditions, although diversion of some onsite runoff to the golf course ponds is proposed. It is anticipated that the natural slopes and vegetation of most of the areas unaffected by golf course construction would be maintained.

IMPACT AND MITIGATION

Development of the proposed golf course improvements may result in a potential increase in the offsite discharge of peak runoff generated onsite. Without mitigation, the downstream discharge of the total onsite runoff has the potential to increase an average of 26 percent for the 10- and 50-year storm. However, runoff leaving the project site can



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 AO	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*

Cross Section Line

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

$RM7_X$ — Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

2,000 1,000 0 2,000 4,000

SCALE IN FEET

SOURCE: FLOOD INSURANCE RATE MAP (1987)

FIGURE 4

MALAEKAHANA GOLF COURSE

FLOOD HAZARD MAP

TABLE 1

STORM WATER RUNOFF - MALAEKAHANA GOLF COURSE SITE

Storm Interval	Existing Conditions (cfs)	Developed Conditions (cfs)	Percent Increase
10 Years	336	425	26.5
50 Years	468	591	26.3

TABLE 2

STORM WATER RUNOFF - COMBINED ONSITE AND OFFSITE

(Malaekahana and Kahawainui Drainage Basins)

Storm Interval	Existing Conditions (cfs)	Developed Conditions (cfs)	Percent Increase
10 Years	6,570	6,660	1.4
50 Years	9,140	9,260	1.3

remain near levels experienced for existing conditions when mitigating measures are employed. These measures include routing runoff to ponds and detention basins within the golf course layout.

It is intended that the ponds serve as detention basins, dampening the peak runoff generated onsite. Additional detention basins can be created to dampen major storm runoff by selective sizing of drain culverts under cart paths crossing gullies and depressed areas between fairways. By incorporating these detention basins into the golf course design, the discharge of peak storm runoff from the project site is not expected to increase from existing conditions.

The impacts of the increased onsite peak runoff are greatly reduced when compared to the impact of peak runoff generated over the entire drainage basin. The increase in onsite peak runoff represents 1.4 percent of the total peak runoff from the drainage basin for the 10- and 50-year storm.

A positive impact of the proposed development is the probable reduction of erosion and sediment transport to open areas on the makai side of Kamehameha Highway. Bare areas currently found would be planted, with the project site as a whole having better control and maintenance of its landscaping.

APPENDIX G

KPMG Peat Marwick

Market Assessment for the Proposed Country Courses at Kahuku

Kahuku, Oahu, Hawaii

Prepared for
KUILIMA RESORT COMPANY

February 1989

KUILIMA RESORT COMPANY

Table of Contents

Table of Contents, Continued

I - INTRODUCTION AND EXECUTIVE SUMMARY

In December of 1988, Kuilima Resort Company engaged Peat Marwick Main & Co. (KPMG Peat Marwick) to conduct a market analysis for four proposed golf courses, referred to as "The Country Courses at Kahuku" (Country Courses). This chapter reviews the background, objectives and scope of our assistance and provides a brief description of the project and presents an executive summary of the study findings and conclusions.

BACKGROUND

The Kuilima Resort Company is planning the development of a golfing complex at two sites near Kahuku on the North Shore of Oahu, as shown in Exhibit I-A. The complex is near the existing Kuilima Resort (Resort), which is owned by the Kuilima Resort Company. Development of the additional four golf courses is intended to augment the Resort by creating a golfer's "haven" on Oahu, superior to any currently existing in the islands.

Development of the golfing complex will require several approvals from government land use regulatory agencies. In this respect, the Kuilima Resort Company requested KPMG Peat Marwick to assess the market support for the proposed golf courses. This assessment will be included in documents prepared to support requests for necessary governmental approvals.

STUDY OBJECTIVES

The objectives of KPMG Peat Marwick's engagement are as follows:

- To assess the market potential of the four planned golf courses, assuming development of five new hotels, additional condominium development and other changes as planned at the Resort.
- To identify planned golf courses on Oahu for which disclosures have been made to the County Department of Land Utilization and to identify those that could be most competitive with the four planned courses.

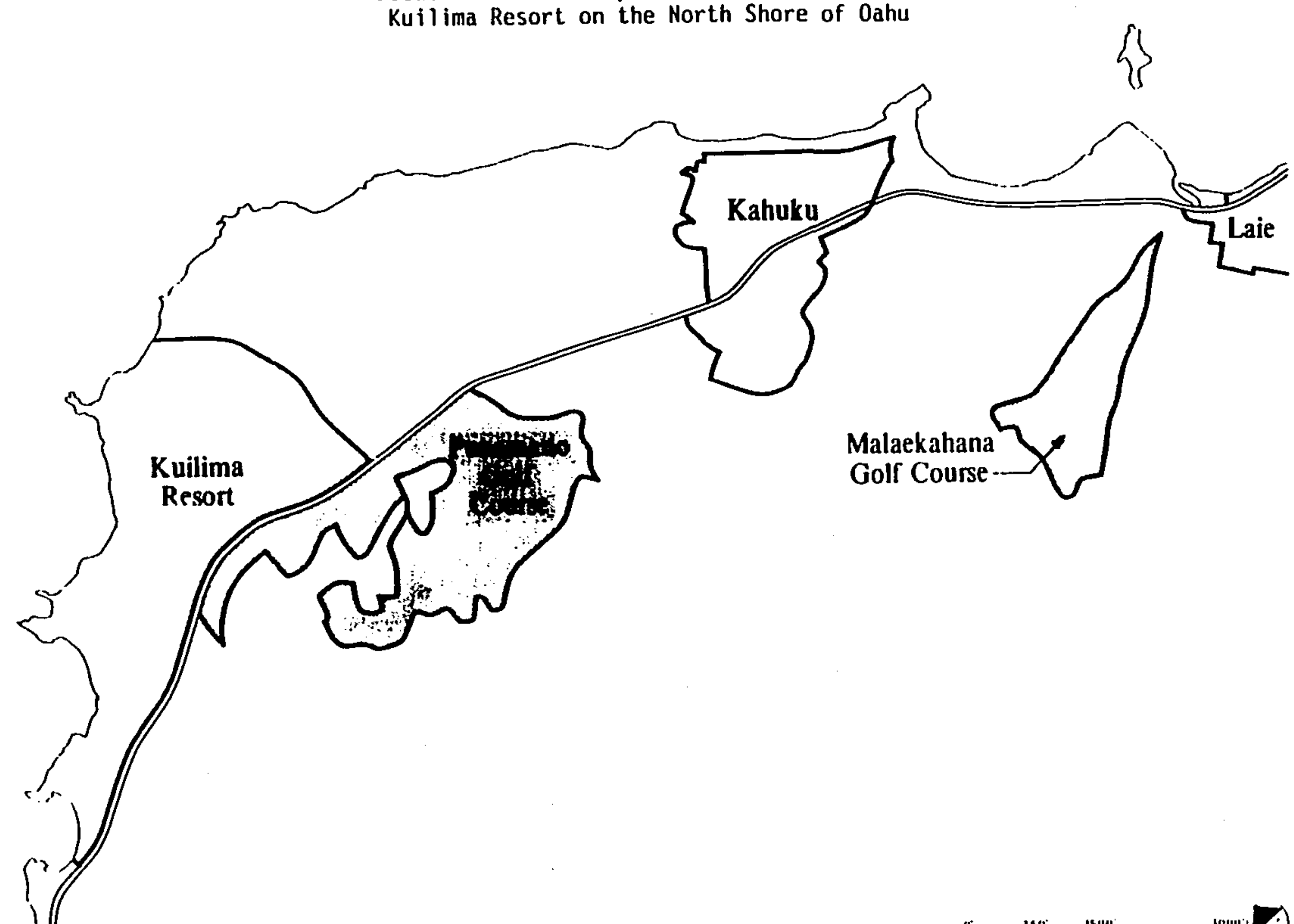
PROJECT AND SITE DESCRIPTION

The project would include four golf courses at two sites near Kahuku on the North Shore of Oahu. Three golf courses are planned for the Punamano site and one is planned for the Malaekahana site. The golf courses are briefly described below.

- Punamano site - Three 18-hole, daily-fee courses open for public play are planned for this site. The courses will provide varying levels of playing difficulty:
    - One course is planned to accommodate players seeking a low level of difficulty, similar to the higher quality municipal courses located on Oahu.

KUILIMA RESORT COMPANY

Location of the Proposed Country Courses and Kuilima Resort on the North Shore of Oahu



REGIONAL LOCATION MAP
THE COUNTRY COURSES AT KAHUKU

Source: Group 70.

- Another course is planned to be middle level in terms of difficulty, similar to the higher quality daily-fee golf courses located on Oahu.

- Another course is planned to be a championship golf course that will be challenging for the seasoned golfer.

- Malaekahana site - One 18-hole, daily-fee course that is open for public play is planned for this site. The course is envisioned as a tournament-level golf course that will be very challenging for even the experienced golfer. This course will contain the most spectacular ocean, mountain and valley views and will be the highest quality course of the four planned courses.

Each of the courses will include a clubhouse, and the Malaekahana course and two of the Punamano courses will include driving ranges. The Malaekahana course is planned to be either the first or second course completed and could be open for play as early as 1992. The construction of each golf course is estimated to require 18 to 24 months. The other three courses will be phased, with all three to be completed by 1997. Actual construction dates will depend on future market conditions and timing of government approvals.

VISITOR MARKET OVERVIEW

In 1988, Oahu attracted about 3 million westbound visitors and about 1.9 million eastbound visitors, based upon 11-month annualized data. This reflects relatively little growth from 1987 for westbound visitors, but a 20% increase in eastbound visitors. The overall trend of increasing tourism from the east is particularly good for Oahu because approximately 95% of all Hawaii eastbound visitors spend time on Oahu, whereas only about 73% of westbound visitors spend time on Oahu.

Differences between eastbound and westbound visitors that may affect the marketing of golf and the demand for golf at the Country Courses are summarized below.

- The westbound visitors are more likely to be free independent travelers rather than part of a group inclusive tour.

- The eastbound visitors are more likely to be traveling as part of a group inclusive tour.

- The average westbound visitor is 41 years old, whereas the average eastbound visitor is 34 years old.

- Average daily expenditures by westbound visitors is estimated at $99 per person versus $257 per person by eastbound visitors. The eastbound visitors tend to spend more on gifts and personal shopping.

HAWAII GOLF OVERVIEW

Nationally, the number of golfers is increasing and is projected to continue to increase in the future. This trend is even more evident in Hawaii, with its year-round outdoor weather and resort orientation. The golfer market in the state consists of two market segments: the local residents and visitors to the islands.

There are currently 62 golf courses in the state, 28 of which are located on Oahu. Those on Oahu include 2 resort, 4 municipal, 9 daily-fee, 4 private and 9 military courses. Approximately 29 new golf courses have been proposed for development on Oahu. However, only 11 of these, including a second course at the Resort, have obtained the permits necessary to begin construction in the near future. Only 3 of the courses are currently under construction.

There are 21 resort courses in the State of Hawaii and two of these are located on Oahu. Average daily rounds played on representative resort courses range from 85 to 225, with an average of 147 rounds per day. Oahu resort courses experience the highest average daily rounds at 185, reflecting the current island situation of very limited supply.

GOLF COURSE MARKET ASSESSMENT

The demand for golf at the Country Courses and at the Resort is based upon the projected daily overnight population at the Resort and upon the anticipated number of other visitors and residents on Oahu. The development of five new hotels and two additional golf courses at the Resort is assumed in the market assessment.

The Kuilima area is projected to continue to experience very tight golf market conditions, with insufficient supply, until the first Country Course at Malaekahana and both the Kuilima Resort courses are operational in 1992. With the opening of the last three Country Courses between 1994 and 1997, there could be more than ample supply to meet the projected demand for golf for the next several years. This would imply there could be fewer than the optimal number of rounds played per day at the courses, and competitive pricing. However, all six golf courses would be expected to be utilized near their optimum levels by 1999. With the opening of the final planned hotel at the Resort in 2000, demand is projected to slightly exceed supply. Thereafter, there could continue to be excess demand, implying further market support for other golf courses in the area and/or higher rates of play at the Country Courses and Resort courses.

At stabilization in the year 2005, the market mix is projected to be approximately 60% resort hotel guests and condominium guests and residents, 20% other Oahu visitors and 20% other Oahu residents. These categories would include a few complimentary rounds at about 4% of the total.

Green and cart fees for resort courses on Oahu range from $40 to $90. Based upon these rates and the design plans for the four courses, the published green and cart fees are estimated to range from $40 to $110 for nonguests in 1989 dollars. The large range is to allow for the varying qualities of the four courses.

II - OAHU ECONOMIC AND DEMOGRAPHIC OVERVIEW

This chapter presents a brief overview of key economic and demographic conditions on Oahu that affect the outlook for golf course development.

ECONOMIC TRENDS

Hawaii's economy has grown rapidly, exceeding national economic growth by 2.5% in 1987. The primary force behind this growth has been the rapid growth of tourism in Hawaii, specifically Asian (Japanese) visitor arrivals and their expenditures. The visitor industry's rapid growth has increased its importance to the economy and reduced the relative contribution of nontourist-related sectors such as federal defense expenditures and agriculture.

Tourism is also Oahu's major industry, as Waikiki continues to be Hawaii's top attraction for tourists. Military installations and the federal government's civilian establishments also provide substantial income to Oahu. Additionally, approximately one-fifth of the land is used for agriculture. Oahu produces approximately 14% of the state's total sugar crop.

RESIDENT POPULATION

The island of Oahu primarily includes the City and County of Honolulu, which is the center of business and government for the State of Hawaii. Oahu is the third largest island in Hawaii, but includes more than 75% of the state's resident population. This section describes the historical and projected resident population trends for the island.

Historical Resident Population

The resident population of Oahu as of July, 1987 was 830,600 according to the State of Hawaii Department of Business and Economic Development (DBED). This represents an 8.9% increase from 1980, or an average annual increase of approximately 1.3%, which is slightly below the average annual growth rate of 1.7% for the entire state for the same period.

Projected Resident Population

Resident population is projected to increase at slightly more than 1% per year until 1995, according to DBED's "Revised Long-Range Economic and Population Projections to 2010 (Series M-K)," dated November 1988. The growth rate is anticipated to decline after 1995, as shown in the following table.

Projected Population
Island of Oahu

1985 - 2005

Year	Projected population (in thousands)	Average annual growth since prior date
1985	811.1	-%
1990	861.6	1.2%
1995	910.4	1.1%
2000	932.8	0.5%
2005	961.1	0.6%

Source: State of Hawaii, Department of Business and Economic Development, 1988.

Average annual resident population growth for the state is projected to be slightly higher than for Oahu through 1995 and about double Oahu's rate of growth from 2000 to 2005.

VISITOR MARKET TRENDS

Oahu also has a sizable visitor population centered primarily in Waikiki. Oahu has been and continues to be the most visited island in the state. This section describes Oahu visitors including historical and projected visitor arrivals and visitor travel patterns and characteristics.

Historical Visitor Arrivals

Since 1970, Oahu has experienced the second highest growth rate in westbound visitors of all the islands with an average annual growth rate of 5.7%. More recent data has distinguished the westbound from the eastbound visitors because of the growth in eastbound visitors.

In 1987 Oahu attracted about 3.1 million westbound visitors and 1.5 million eastbound visitors as shown in Exhibit II-A. Based upon 11-month annualized data for 1988, westbound visitors to Oahu remained constant at 3 million, but eastbound visitors increased 20% to 1.9 million. The trend of increasing tourism from the east is particularly good for Oahu because approximately 95% of all Hawaii eastbound visitors spend time in Oahu, whereas, about 73% of westbound visitors spend time in Oahu.

The success of Oahu as a visitor destination area can be attributed to the following factors:

- Waikiki is internationally recognized as a major resort area.
- The only international airport in Hawaii, and the major airport for domestic interisland flights, is located in Oahu.
- The variety of restaurants, shops, visitor attractions and entertainment on Oahu is not found on the neighbor islands.

Exhibit II-A

KUILIMA RESORT COMPANY

Historical Visitor Arrivals to the Island of Oahu

1985 to 1988

	Historical						Estimated(1)	
	1985		1986		1987		1988	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Total Hawaii visitors:								
Westbound	3,708,610	76%	4,256,390	76%	4,204,010	72%	4,204,000	69%
Eastbound	1,175,500	24	1,350,590	24	1,595,820	28	1,915,000	31
Total	4,884,110	100%	5,606,980	100%	5,799,830	100%	6,119,000	100%
Total percent increase	-%		15%		3%		6%	
Oahu visitors:								
Westbound	2,835,800	72	3,146,030	71	3,078,500	67	3,037,865	63
Eastbound	1,116,725	28	1,283,061	29	1,516,029	33	1,819,250	37
Total	3,952,525	100%	4,429,091	100%	4,594,529	100%	4,857,115	100%
Total percent increase	-%		12%		4%		6%	
Percent of:								
Westbound visiting Oahu	76		74		73		72	
Eastbound visiting Oahu	95		95		95		95	
Total visiting Oahu	81		79		79		79	

(1) Estimated based upon eleven-month annualized data.

Source: Compiled by KPMG Peat Marwick based on information reported by the Hawaii Visitors Bureau and the State Department of Business and Economic Development.

Exhibit II-8

KUILIMA RESORT COMPANY

Projected Visitor Arrivals to the Island of Oahu

1989 to 1998

	1989		1990		1991		1992		1993	
	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent
Total Hawaii visitors (1):										
Westbound	4,372,000	69%	4,547,000	69%	4,706,000	69%	4,871,000	69%	5,041,000	69%
Eastbound	1,992,000	31	2,072,000	31	2,145,000	31	2,220,000	31	2,298,000	31
Total	6,364,000	100%	6,619,000	100%	6,851,000	100%	7,091,000	100%	7,339,000	100%
Oahu visitors:										
Westbound (2)	3,159,000	63	3,285,000	63	3,341,000	62	3,398,000	62	3,456,000	61
Eastbound (3)	1,892,400	37	1,968,000	37	2,037,750	38	2,109,000	38	2,183,100	39
Total	5,051,400	100%	5,253,000	100%	5,378,750	100%	5,507,000	100%	5,639,100	100%
Percent of:										
Westbound visiting Oahu	72%		72%		71%		70%		69%	
Eastbound visiting Oahu	95		95		95		95		95	
Total visiting Oahu	79		79		79		78		77	

	1994		1995		1996		1997		1998	
	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent	Amount	Per-cent
Total Hawaii visitors (1):										
Westbound	5,217,000	69%	5,400,000	69%	5,562,000	69%	5,729,000	69%	5,901,000	69%
Eastbound	2,378,000	31	2,461,000	31	2,535,000	31	2,611,000	31	2,689,000	31
Total	7,595,000	100%	7,861,000	100%	8,097,000	100%	8,340,000	100%	8,590,000	100%
Oahu visitors:										
Westbound (2)	3,515,000	61	3,575,000	60	3,629,000	60	3,683,000	60	3,738,000	60
Eastbound (3)	2,259,100	39	2,337,950	40	2,408,250	40	2,480,450	40	2,554,550	40
Total	5,774,100	100%	5,912,950	100%	6,037,250	100%	6,163,450	100%	6,292,550	100%
Percent of:										
Westbound visiting Oahu	67%		66%		65%		64%		63%	
Eastbound visiting Oahu	95%		95		95		95		95	
Total visiting Oahu	76%		75		75		74		73	

(1) Based on Department of Business and Economic Development's "Updated Tourism Projections 1985-2010," January 1988. The projections are based on an average annual growth rate of 4.0% for 1989 to 1990, 3.5% for 1990 to 1995 and 3.0% for 1995 to 1998.

(2) Based on Department of Business and Economic Development's "Updated Tourism Projections 1985-2010," January 1988. The projections are based on an average annual growth rate of 4.0% for 1989 to 1990, 1.7% for 1990 to 1995 and 1.5% for 1995 to 1998.

(3) Estimated to represent 95% of all eastbound visitors to the state.

Source: Compiled by KPMG Peat Marwick based on information reported by the Hawaii Visitors Bureau and the State Department of Business and Economic Development.

- Oahu offers diverse entertainment and visitor attractions including Waikiki, Pearl Harbor, Sea Life Park, Polynesian Cultural Center, National Cemetery at Punchbowl and an abundance of white sand beaches.

- More budget tours are offered to visitors of Oahu than the other islands.

PROJECTED VISITOR ARRIVALS

Visitor arrivals to Oahu are projected based on DBED's and Hawaii Visitors Bureau's (HVB) updated tourism projections, as shown in Exhibit II-B. A decreasing proportion (from 79% to 76%) of the state's visitors are projected to visit Oahu due to:

- The increase in the number of repeat visitors to the state who seek new and different attractions and experiences.

- Greater development of new and expanded resort areas on the neighbor islands in comparison to Oahu.

The projections point out the following trends regarding Oahu visitors:

- Visitors to Oahu are expected to increase by about 3% annually , from 5 million in 1989 to about 6.3 million by 1998.

- Westbound visitors to Oahu are projected to increase by about 2% annually, from 3.2 million in 1989 to about 3.7 million in 1998.

- Eastbound visitors to Oahu are projected to increase by about 4% annually, from 1.9 million in 1989 to about 2.6 million by 1998.

- Eastbound visitors are expected to represent an increasing proportion of Oahu visitors, accounting for about 37% of Oahu visitors in 1989 and about 40% by 1998.

VISITOR TRAVEL PATTERNS AND CHARACTERISTICS

Travel patterns of visitors to the State of Hawaii are summarized in Exhibit II-C and include the following:

- Place of origin - In 1987, about 68% of all visitors to the state resided in the continental United States and Canada. About 20% of Hawaii visitors were from Japan and 6% were from the Pacific.

Exhibit II-C

KUILIMA RESORT COMPANY

Visitor Travel Patterns
to Oahu and the State of Hawaii

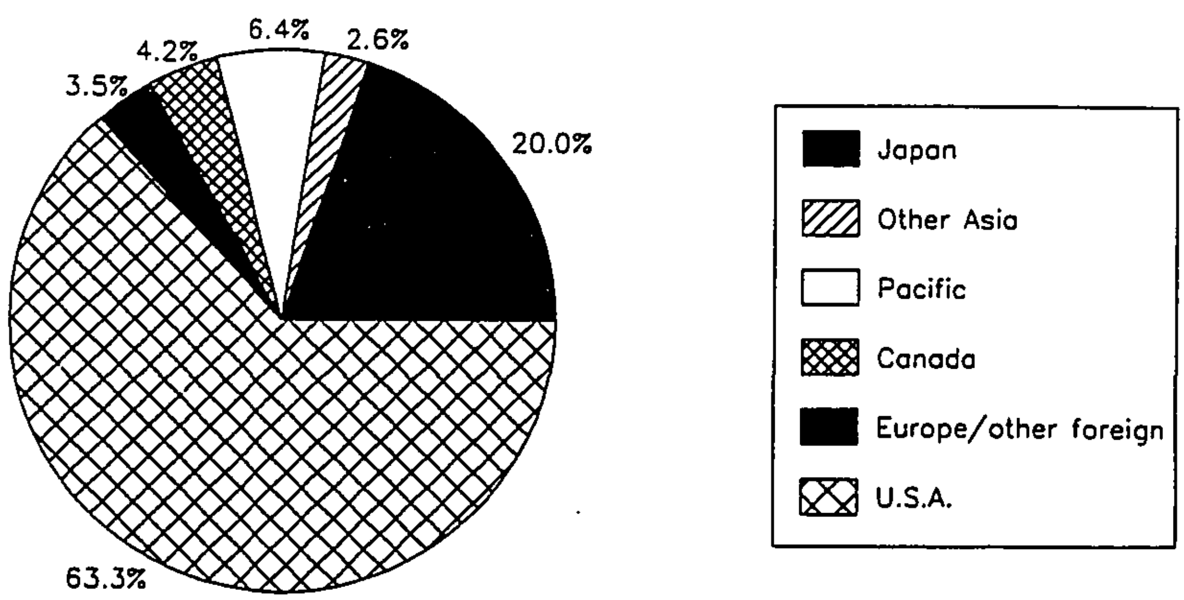
1987

	Island of Oahu westbound visitors	Visitors to the State of Hawaii Westbound	Visitors to the State of Hawaii Japanese
Pleasure trip (percent of total)	81%	82%	91%
Accomodation usage (percent of total):			
Hotel	67	80	94
Condominium	11	10	N/A
Other	22	10	N/A
Total	100%	100%	100%
Length of stay (days):			
State of Hawaii	10.1	10.1	5.8
Island of Oahu	7.2	N/A	4.8
Travel status (percentage distribution):			
Free independent travelers (FIT)	79%	80%	30%
Group inclusive tours (GIT)	14	13	70
Incentive group	4	5	-
Convention	3	2	-
Total	100%	100%	100%

N/A Not Available

Source: Hawaii Visitors Bureau, "Study of Japanese Visitors to Hawaii, 1987"; ibid., "Westbound Visitors to Hawaii by Island: Oahu, Maui, Kauai, the Big Island and Molokai," 1987.

Visitor Arrivals by Country of Origin
1987



Source: Hawaii Visitors Bureau, 1987.

- Purpose of trip - Visitors to Hawaii tend to be primarily vacationers. About 82% of westbound travel to the state and to Oahu is for pleasure, while 91% of Japanese travel to Hawaii is likewise for pleasure.

- Accommodation usage - Hotels serve the majority of visitors. About 80% of westbound visitors to the state and about 67% of westbound visitors to Oahu use hotels during their stay. Japanese use of hotels is higher than westbound visitors, at 94%.

- Average length of stay - The average length of stay in the state is ten days for westbound travelers and six days for Japanese visitors. The average length of stay on Oahu, however, is less, with seven days for westbound travelers and five days for Japanese visitors.

- Travel status - Two major travel market segments represent more than 90% of visitors to the state: free independent travelers and visitors who are part of group inclusive tours. About 80% of the westbound visitors and 30% of the Japanese visitors are free independent travelers. About 13% of the westbound visitors and 70% of the Japanese visitors are part of group inclusive tours.

Characteristics of the visitors are described below and are shown in Exhibit II-D.

- Average party size - The average party size for westbound travel is 1.8 persons, while the average party size for Japanese travel is 2.5 persons.

- Age - The average age for westbound travel is 41 years, while the average Japanese traveler is 34 years.

- Occupation - Professional/technical visitors comprise 38% and business/managerial occupations represent 25% of all westbound visitors to the state and 36% and 23%, respectively, of all westbound visitors to Oahu. Clerical/office/sales occupations represent the largest Japanese visitor occupation at 28%, followed by others at 25% and professional/technical at 24%.

- Number of visits - Half of Hawaii's westbound visitors are first-time visitors to the state. However, the percentage of first-time visitors to Oahu is higher, at 66%. First-time Japanese visitors to the state is slightly higher, representing 68% of all Japanese visitors.

- Westbound visitor expenditures - Oahu westbound visitor expenditures for 1987 are estimated by the HVB at $99 per person per day, as shown in Exhibit II-E. The bulk of these expenditures are for lodging, at $38 per day, and food and beverages, at $22 per day.

- Eastbound visitor expenditures - HVB estimates that the average Japanese visitor spends $257 per day, or almost two-and-a-half times that of the typical Oahu westbound visitor. The bulk of these expenditures is also for lodging, at $90 per day, and food and beverage, at $64 per day. Japanese tend to spend more on gifts and personal shopping than their westbound counterparts.

WINDWARD TO NORTH SHORE REGIONS

The Koolau and Waianae mountain ranges and the areas from Kahuku to Kaena Point form the main boundaries for the traditionally rural communities of the North Shore. The primary land uses in this region have traditionally been agricultural. Coastal residential areas are concentrated at Mokuleia, Waialua, Haleiwa, Waimea, Pupukea, Sunset Beach and Kawailoa.

The Windward region is defined as the Koolauloa census district, and includes the northern half of Oahu's windward coast, bounded by the north end of the Koolau mountains and extending to the south near Kauloa Point and Kaaawa Stream. Kamehameha Highway is the main roadway linking this area with the adjacent North Shore region. Residential communities bordering the highway include Kaaawa. Punaluu, Hauula, Laie and Kahuku. This section reviews the economic and population trends of the North Shore and Windward regions along with their current image and marketability as a destination.

Exhibit II-D

KUILIMA RESORT COMPANY

Visitor Characteristics

1987

	Westbound visitors to island of Oahu	Visitors to the State of Hawaii	
		Westbound	Japanese
Average party size	1.8	1.8	2.5
Median age	41	41	34
Occupation (percent distribution):			
Professional and technical	36%	38%	24%
Business, managerial, official	23	25	20
Clerical, office, sales	10	9	28
Retired	15	14	4
Other	16	14	25
Total	100%	100%	100%
First-time visitors (percent of total)	66%	50%	68%

Source: Hawaii Visitors Bureau, "Study of Japanese Visitors to Hawaii, 1987"; ibid., "Westbound Visitors to Hawaii by Island: Oahu, Maui, Kauai, the Big Island and Molokai," 1987.

Exhibit II-E

KUILIMA RESORT COMPANY

Average Daily Expenditures Per Visitor (1)

1987

	Oahu westbound visitors	Japanese visitors(2)
Food and beverage	$ 22.31	64.25
Entertainment	6.96	15.42
Transportation	8.20	28.27
Clothing	8.95	23.13
Gifts and souvenirs	8.70	23.13
Lodging	37.62	89.95
All other	3.96	12.85
Adjustment factor(3)	2.35	-
Total	$ 99.05	257.00

(1) Does not include cost of tranportation to Hawaii.

(2) Delineation of daily expenditures based on "Hawaii Visitors Bureau Visitor Expenditure Survey," 1987.

(3) A per day estimate made by each visitor concerning the dollar amount that may have been neglected in the listed categories.

Source: "Hawaii Visitors Bureau Visitor Expenditure Survey," Hawaii Visitors Bureau, 1983 and 1987; Study of Japanese Visitors to Hawaii, 1987.

Economic

The two regions are evolving from a primarily rural and residential area to an area that includes one of Oahu's major resorts, world-famous beaches and surfing areas, and residential suburbs.

The opening of the Kuilima Resort in 1972 has had the most significant economic impact on the area with an estimated 500 jobs created since the resort's inception.

The North Shore and Windward regions should experience increased tourism in the years ahead as the Resort expands and as attractions such as professional surfing events continue to attract visitors. In addition, the Polynesian Cultural Center (PCC), located in Laie, is Hawaii's largest paid tourist attraction according to state tourism statistics. PCC could draw even more visitors in the future, with the completion of its planned 800-seat theater featuring the state's largest movie screen, a new evening show and other attractions highlighting the cultures of Polynesia and possibly Asia.

The regions could also become a major attraction to visiting golfers with the anticipated development of the proposed project. This area could become known as the premiere place to golf on Oahu with its variety of courses, availability of tee-times and uncrowded neighbor island resort-like atmosphere.

Resident Population

The 1988 resident populations of the North Shore and Windward regions were 13,400 and 12,000, respectively, as shown in Exhibit II-F. This represents an annual compounded growth rate of 0.3% and 1.9% since 1980 for the North Shore and Windward regions, respectively.

The City of Honolulu recently ammended general plan population ceilings. The new ceilings allow for more growth in the North Shore and Windward areas. Ceilings for 2010 are 18,000 for the North Shore and 14,500 for the Windward area. These ceilings represent a 34% and 21% increase over 1988 population estimates for the North Shore and the Windward areas, respectively.

Exhibit II-F

KUILIMA RESORT COMPANY

Resident Population of the
North Shore and Windward Regions of Oahu

1970 to 2010

	North Shore	Windward	Total
Historical:			
1970	9,200	10,600	19,800
1980	13,100	11,000	24,100
1988	13,400	12,000	25,400
Approved population ceilings:			
1990	13,700	12,400	26,100
1995	14,000	12,800	26,800
2000	14,300	13,200	27,500
2005	16,150	13,850	30,000
2010	18,000	14,500	32,500
Compounded annual percentage increase:			
1970 to 1980	3.6%	0.4%	2.0%
1980 to 1990	0.4	1.2	0.8
1990 to 2000	0.2	0.3	0.3
2000 to 2010	0.2	0.3	0.3

Source: U. S. Bureau of the Census, 1980 Census of Population, Number of Inhabitants, Hawaii, 1981: City and County of Honolulu, Residential Development Implications of the General Plan, 1985. Historical 1988 and 2010 data is based upon conversation with personnel in the Department of General Planning. Interim numbers are calculated based upon estimated growth rates.

III - GOLF COURSE MARKET OVERVIEW

This chapter reviews national and Hawaii golf market trends pertinent to the market assessment for golf course development on the North Shore of Oahu. In addition, Oahu's golf courses and golf markets are reviewed.

NATIONAL GOLF MARKET TRENDS

According to the National Golf Foundation, 21.7 million U. S. golfers played 434 million rounds of golf in 1987. This represented a 7.4% increase in golfers over the previous year and a 3.1% increase in the number of rounds played. Nationally, two major demographic trends are projected to favor the golf market:

- Rapid increases in the 60+ year-old age group which has the highest golf participation rates, as shown in Exhibit III-A.
- Rapid growth of the female golfer market. In 1983 only 21% of all new golfers were estimated to be women. In 1987 this figure increased to 41%.

HAWAII GOLF MARKET OVERVIEW

This section focuses on the Hawaii golf market, reviewing market segments, tour operators, and existing and proposed golf courses on Oahu.

Golf Market Segments

Golfers in Hawaii represent two major markets; local residents and visitors to the islands. Local resident golfers can be segmented into two sub-markets:

- Local recreational players use daily fee and municipal courses, usually as small social golfing clubs or foursomes. These players tend to be flexible in time of play, often utilizing early morning tee-times, and tend to be more price sensitive than other golfer segments.
- Country club players have memberships at a private club and are willing to pay a premium for private club play with its various amenities and associated prestige. These players represent the high end of the local market.

The visitor golf market in Hawaii is viewed as four sub-markets:

- Resort guest golfers stay at visitor accommodations in resorts with one or more on-property golf courses. Access to courses is typically associated with resort accommodations, and green and cart fees are charged according to usage. Although golf resorts are becoming an important component of the visitor industry statewide, currently, the only such resorts on Oahu are the Makaha and Kuilima Resorts.

Exhibit III-A

KUILIMA RESORT COMPANY

Age Profile of the U. S. Golf Market

1987

Age	Golfers (millions)	Percent of golfers	Golf participation rate(1)
5 - 19	2.43	11.2%	11.1%
20 - 29	5.92	27.3	14.0
30 - 39	4.82	22.2	12.1
40 - 49	3.06	14.1	11.0
50 - 59	2.21	10.2	10.2
60+	3.25	15.0	17.9
Total	21.69	100.0%	N/A

N/A Not applicable.
(1) Golfers as a percent of total U. S. population.

Source: National Golf Foundation, August 1988.

- Resort resident golfers are generally part-time residents of the state who own a single- or multifamily home in a golf resort. Such property owners are generally repeat visitors to the vicinity of the resort, and priority access to a particular golf course is often an important motivation in their purchasing of resort real estate.

- Free and independent travel (FIT) golfers are those not staying at a golf resort, who independently arrange their own recreational itinerary. FIT golfers generally reserve tee-times through guest services at their hotel or through a local golf tour operator.

  - The U. S. mainland FIT segment tends to be price sensitive and generally seeks green, cart, equipment and transportation expenses of less than $100 for a single round of play.

  - The Japanese FIT segment is much less price sensitive than its U. S. mainland counterpart, and frequently purchases golf tour packages priced up to $120 for one round of play.

- Group travel golfers make their recreational as well as travel and tour arrangements at the point of origin. Most are Japanese who book their golf tee-times in Japan with one of several golf tour operators. This Japanese market is also less price sensitive than other U. S. markets.

Visitor Golf Market Segments

The outlook for Oahu visitor golf market is assessed based on interviews with representatives of selected Waikiki hotels and the Kahala Hilton, as summarized in Exhibit III-B.

Approximately 10% to 30% of the guests at these hotels request golf, except for those at the Halekulani, where about 50% inquire about making golf arrangements. The Halekulani's high figure could be due to the hotel's orientation towards the upscale FIT market and its minimal number of group travel guests. Thus, relatively fewer guests would be expected to have made arrangements through golf wholesalers prior to arriving at the hotel.

Popular courses vary by hotel. The Hawaii Kai golf course is the most popular in the survey, due to the availability of tee-times and its fairly short driving distance from Waikiki. The Ala Wai and Waialae Country Club golf courses are also frequently requested, although the nonavailability of tee-times generally precludes visitor play at these courses.

The Kuilima and Makaha Resort courses are also frequently requested by visiting players. Hotel representatives indicate that golfers are willing to play on courses that are farther from the Waikiki resort area, especially if tee-times are readily available.

The hotels may also reserve individual tee-times at the request of guests. However, the hotel concierge or guest service personnel generally suggest the use of a golf tour for convenience.

With the increasing numbers of Japanese visitors to Oahu, there appears to be strong demand for visitor golf in the future.

KUILIMA RESORT COMPANY

Golfer Characteristics at Selected Oahu Hotels

1987

Hotel name	Guests requesting golf(1)	Most popular courses(2)	Method of transport(2)	Origins of resort golfers(2)	Golf tours available	Additional comments
Hawaiian Regent	Over 15%	Ala Wai Hawaii Kai Turtle Bay	Car rental Taxi Golf tour	Japan U. S. mainland	Tachibana Kato's golf AKK Tours	Japanese consider Hawaii inexpensive; many request Waialae golf course but cannot be accommodated.
Hyatt Regency Waikiki	10% to 30%	Hawaii Kai Turtle Bay Makaha	Car rental Golf tour	Japan U. S. mainland	Tachibana American Express	Tachibana golf tours are reserved in Japan; many request Waialae golf course but cannot be accommodated.
Royal Hawaiian Hotel	10%	Waialae Makaha Hawaii Kai Pearl C.C. Mililani	Car rental Taxi	U. S. mainland	-	Waialae available for guests; Sheraton owns key parcels within Waialae golf course.
Kahala Hilton	10% to 20%	Hawaii Kai	Car rental Golf tour	U. S. mainland Japan	American Express	Waialae usually requested but cannot be accommodated; all golf arrangements are made through the American Express desk at Kahala Hilton.
Halekulani	50%	Hawaii Kai Makaha	Car rental Golf tour	U. S. mainland Japan	AKK Tours	Current high rate of requests may be due to predominantly FIT mix of hotel guests.

(1) Percent of guests inquiring about golfing through the hotel concierge or guest services personnel. Others may have made prior arrangements at place of origin, or may independently arrange tee-times with friends or at courses that they are familiar with.

(2) Rank ordered by observed incidence.

Source: Compiled by KPMG Peat Marwick based on interviews with hotel concierges and guest services personnel.

Exhibit III-3

Golf Tour Operators

The relative lack of golf courses in the Waikiki resort area supports several golf tour companies that package day-trip tours including transportation to and from hotels, green and cart fees, golf clubs and shoes. Tour package prices at popular courses and other characteristics are listed in Exhibit III-C.

Tachibana is the largest golf tour operator active in Hawaii and the best example of a company that serves group markets and makes most reservations at the point of visitor origin. Kato's and American Express more typically serve the FIT market after their arrival in Hawaii, with Kato catering to the Japanese segment and American Express to the U. S. mainland segment.

The most common factors in selecting courses are said to be convenience in terms of time, proximity and tee-time availability. Price is not a factor with the group of FIT golfers from Japan, but is a concern for U. S. mainland FIT golfers.

State of Hawaii Golf Course Inventory

The State of Hawaii has 62 resort, municipal, daily fee, private and military golf courses as shown in the table below. A majority of the courses have been developed at resorts and/or developed as daily fee courses. Approximately one third of the courses are located on Oahu, which also has the most restricted use courses. There are four private and nine military golf courses on Oahu.

Island	Resort	Municipal	Daily fee	Private	Military	Total
Oahu	2	4	9	4	9	28
Maui	7	1	2	1	-	11
Hawaii	7	1	2	2	-	12
Kauai	5	1	1	1	-	8
Molokai	1	-	1	-	-	2
Lanai	-	-	1	-	-	1
Total	22	7	16	8	9	62

Oahu's golf courses are described in Exhibit III-D. Public access is available on 15 of these courses, representing two resort, four municipal and nine daily fee golf courses. Characteristics of municipal, daily fee and private courses are described below. Resort courses are discussed in a subsequent section.

Characteristics of Municipal Golf Courses

Municipal golf courses are owned and operated by a local municipality. On Oahu, the City and County of Honolulu operates three 18-hole golf courses and one 9-hole course. Municipal course characteristics include:

- Tee-times are usually offered on a first-come, first-serve basis for the general public.
- They are generally designed to accommodate volume rather than challenging or exciting play.

Exhibit III-C

KUILIMA RESORT COMPANY

Selected Golf Tour Operator Characteristics

1987

	Tachibana	Kato	American Express(3)
Clientele profile:			
Business travellers	10%	10%	20%
Vacationers	90	90	80
Peak season	December to April and "Golden week"	Winter/summer	Winter/summer
Number of golf packages	160/day	N/A	N/A
Favorite courses:	Mililani 40% Makaha West 30% Turtle Bay 25% Makaha East 5%	Hawaii Kai 35% Turtle Bay 35% Makaha East 20% Makaha West 10%	Hawaii Kai 50% Pearl C.C. 40% Makaha West 10%
Tour package prices by golf course:	Mililani $ 75 Makaha West 120 Turtle Bay 85 Makaha East 70	Hawaii Kai $ 60 Turtle Bay 75 Makaha East 60 Makaha West 115	Hawaii Kai $ 70 Pearl C.C. 65 Makaha West 120
Average tour time (hours)	5 to 7	5 to 6	5 to 6
Factors in client selection of course:			
Prestige	- (1)	- (1)	- (1)
Convenience (time/proximity)	Yes	Yes	Yes
Tee-time availability	Yes	Yes	Yes
Name designer	- (1)	- (1)	- (1)
Price sensitivity	No	No	Yes
Aesthetics of play	- (1)	- (1)	- (1)
Ancillary services	- (1)	- (1)	- (1)
Reservations characteristics:			
At visitor origin	98%	-	10%
Reservations from hotel/FIT	2%	100%	90%
Discount on green and cart fees	No	No	No
Tee-times reserved in blocks	Yes(2)	No	No

N/A Not Available.
(1) More important to the better golfers.
(2) Tee-times reserved three to four months ahead.
(3) American Express utilizes Tachibana golf tours.

Source: KPMG Peat Marwick, based upon interviews with tour company representatives.

Exhibit III-D

KUILIMA RESORT COMPANY

Oahu Golf Course Inventory

1989

	Holes	Location
Resort:		
Sheraton Makaha Resort and Country Club	18	Makaha Valley
Turtle Bay Golf Course	18	Kahuku
Private:		
Waialae Country Club	18	Waialae/Kahala
Oahu Country Club	18	Nuuanu
Mid-Pacific Country Club	18	Lanikai/Kailua
Honolulu International Country Club	18	Salt Lake
Municipal:		
Ala Wai Golf Course	18	Honolulu
Kahuku Golf Course	9	Kahuku
Ted Makalena Golf Course	18	Waipio/Waipahu
Pali Golf Course	18	Kaneohe
Daily fee:		
Bay View Golf Center (Par 3)	18	Kaneohe
Hawaii Country Club	18	Kunia
Hawaii Kai Championship Golf Course	18	Hawaii Kai
Hawaii Kai Executive Golf Course (Par 3)	18	Hawaii Kai
Makaha Valley Country Club	18	Makaha Valley
Mililani Golf Course	18	Mililani
Moanalua Golf Club (1)	9	Moanalua
Olomana Golf Links	18	Olomana/Kailua
Pearl Country Club	18	Pearl City/Aiea
Military:		
Barbers Point Golf Course	18	Barbers Point NAS
Hickam Golf Course	18	Hickam AFB
Kalakaua Golf Course	18	Schofield Barracks
Kaneohe Marine Golf Course	18	Kaneohe MCAS
Leilehua Golf Course	18	Schofield East Range
Navy Marine Golf Course	18	Aliamanu
Fort Shafter Golf Course	9	Fort Shafter
Hickam (Par 3)	9	Hickam AFB
Ford Island Golf Course	9	Ford Island NAS

(1) Course is open for public play Mondays through Fridays only.

Source: Based on published information.

- Rounds of play are typically fast due to the familiarity of the course by local golfers.
- Volume of play is high due to shorter intervals between starting times and greater skill of golfers at the particular courses.
- Green and cart fees range from $2 to $23, with an average of $15 to $23 as shown in Exhibit III-E.

Characteristics of Daily Fee Courses

The most common type of golf course operation is the daily fee course, nine of which are located on Oahu. These facilities are typically owned by individuals, partnerships or corporations on a "for-profit" basis. Daily fee course characteristics include:

- Tee times are offered on a first-come, first-serve or telephone reservation basis.
- They are generally designed for more challenging play than are municipal courses.
- Landscaping and maintenance are more extensive than municipals and often offer better natural viewpoints.
- Average rounds played and number of golfers accommodated are similar to municipal courses.
- Overall appearance of the golf course, clubhouse and facilities allow for higher green fees. Green and cart fees range from $17 to $45 on weekdays and $22 and $45 on weekends, as previously shown in Exhibit III-E.

Characteristics of Private Golf Courses

There are currently four private golf courses on Oahu. Private golf courses and country clubs are generally member-owned, nonprofit entities. Usage is generally restricted to members and their guests. Several types of memberships are generally available ranging from a regular membership with unrestricted privileges to a social membership with limited or no golfing privileges. Characteristics of these courses include:

- Designed to promote challenging and exciting play.
- Emphasis on natural viewpoints and extensive landscaping.
- Restricted membership, with club acceptance determined by existing members.
- Members are charged initiation fees and monthly dues rather than green fees. Initiation fees range from $15,000 to $135,000 and monthly dues range from $125 to $175 for full membership privileges.

Exhibit III-E

KUILIMA RESORT COMPANY

Fees at Selected Oahu Golf Courses

1988

	Total green and cart fees	
	Weekdays	Weekends
Resort courses:		
Sheraton Makaha Resort and Country Club:		
Resort guests	$ 43	$ 43
Others	85	85
Kuilima Resort:		
Turtle Bay Golf Course(1):		
Hotel guests	65	65
Island residents	40	45
Others	80	90
Range	40 - 85	40 - 90
Private club (guest fee):		
Waialae Country Club	40	40
Oahu Country Club	25 - 50	50
Mid-Pacific Country Club(2)	26 - 120	26 - 120
Honolulu International Country Club	30 - 70	30 - 70
Range	25 - 120	26 - 120
Daily fee courses:		
Hawaii Country Club	17	23
Hawaii Kai Championship Golf Course	40	33 - 40
Mililani Golf Course	22 - 45	22 - 45
Olomana Golf Links	18	24
Pearl Country Club	28	32
Range	17 - 45	22 - 45
Municipal courses:		
Ala Wai	15 - 19	17 - 23
Pali	15 - 19	17 - 23
Ted Makalena	15 - 19	17 - 23
Kahuku (9 holes)	2 - 3	2 - 7
Range	2 - 19	2 - 23
Total Oahu range	$ 2 - 120	$ 2 - 120

(1) 1989 rates.
(2) $120 green and cart fee for unaccompanied nonmember.

Source: Compiled by KPMG Peat Marwick based upon discussions with club representatives and other published information.

- Reasons for membership in a private golf club include the following:

  - Access to a well-designed, high quality golf course.
  - Presence of outstanding facilities and amenities.
  - Prestige associated with membership.
  - Social and business aspects of membership.

Proposed Golf Courses on Oahu

Approximately 29 additional golf courses have been proposed for Oahu, as shown in Exhibit III-F. However, only 11 (10 new courses and 1 expansion) have obtained the permits necessary to begin construction in the near future. These 11 new courses and/or expansions include the following:

Project	Type of courses
Ewa Golf Course	Daily fee
Kahuku Golf Course (expansion)	Municipal
Kapolei Golf Course	Municipal
Ko Olina Golf Course #1	Resort
Minami Golf Course	Private
Puuloa Golf Course(1)	Not available
Royal Hawaiian Country Club(2)	Daily fee and private
Kuilima resort second course	Resort
Waikele Golf Course	Daily fee
West Loch Golf Course	Municipal

(1) Only nine holes have been approved. Developers are currently seeking rezoning for the final nine holes.

(2) Two courses planned.

Only three of the approved courses are currently under construction: Ko Olina Golf Course #1, Minami Golf Course, and West Loch Golf Course.

HAWAII RESORT COURSE OVERVIEW

This section reviews the inventory, characteristics, usage, fee structure, player market mix and planned future development of resort courses in Hawaii.

Inventory of Resort Golf Courses

The State of Hawaii has 21 courses located in master-planned resort areas, distributed by island as shown in Exhibit III-G. All have 18 holes, except for the courses at Mirage Princeville (Kauai) and Keauhou Resort (Hawaii island), which have 27 holes each and the Prince Golf course with 9 holes.

Exhibit III-F

KUILIMA RESORT COMPANY

Proposed Golf Course Developments on Oahu

1989

Region/ project/developer	Type of course	Number of holes	Location	Course designer	Approval status(1)	Comments
North Shore:						
Turtle Bay expansion, Kuilima Resort Company	Resort	18	Kuilima Resort	Arnold Palmer	Zoning approved August 14, 1986.	Proposed to be completed by 1991. Second course at resort.
Lihi-Lani Recreational Community, Obayashi Hawaii Corp.	Daily fee Private	18 18	Pupukea Pupukea	N/A Jack Nicklaus	Pending SLUC application. Pending SLUC application.	Proposed to be completed by 1993. Proposed to be completed by 1991.
Mokuleia Golf Course, Mokuleia Land Co.	Daily fee	18	Mokuleia	BCA Golf Design	CUP application rejected; archaeological study required. Application resubmitted.	-
Waialua Golf Course, Oceanic Properties, Inc.	Daily fee	18	Waialua	N/A	Development Plan amendment pending.	Construction cost estimated at $10.7 million.
Kahuku Golf Course, City and County of Honolulu	Municipal	9	Kahuku	N/A	N/A	To be developed near the Kuilima Resort. Proposed expansion from 9 to 18 holes to be completed by by 1992.
Punamano Golf Courses, Kuilima Resort Company Campbell Estate	Resort	18 18 18	Kuilima Resort	N/A	Development plan amendment pending.	-
Malaekahana Golf Course, Kuilima Resort Company Campbell Estate	Resort	18	Kuilima Resort	N/A	Development plan amendment pending.	-
Windward:						
Waikane Golf Course No. 1, Waikane Development Co.	Semiprivate	27	Waikane Valley	BCA Golf Design	Development plan amendment pending from agriculture to preservation.	Local and Japanese memberships to be offered. Open to outside play also. Shares to be sold on Tokyo Stock Exchange. Extensive course and clubhouse improvements.

Exhibit III-F, Cont.

KUILIMA RESORT COMPANY

Proposed Golf Course Developments on Oahu, Continued

Region/ project/developer	Type of course	Number of holes	Location	Course designer	Approval status(1)	Comments
Windward, Cont.:						
Waikane Golf Course #2,	N/A	27	Waikane Valley	N/A	Preliminary inquiry.	-
Royal Hawaiian Country Club, Inc., YY Valley Corp.	Daily fee Private	18 18	Maunawili	Pete Dye	CUP approved June 13, 1986.	State-owned road runs through the middle of the property. The Board of Land and Natural Resources is expected to discuss the state's options.
Minami Golf Course, Minami Corp.	Private	18	Kaneohe	Robert Trent Jones	CDUA approved March 13, 1987	Iolani School site; construction cost estimated at $60 million.
Central and West:						
Ko Olina Golf Course #1, West Beach Estates	Resort	18	Ko Olina Resort	Ted Robinson	Zoning approved 3/11/86.	Course expected to be ready for play by mid-1989. Construction to begin in 1988.
Ko Olina Golf Course #2, West Beach Estates	Resort	18	Ko Olina Resort	N/A	Preliminary inquiry.	Long-range plans for the resort. No completion date set.
Makakilo Golf Course, Finance Realty	Daily fee	18	Makakilo	N/A	CUP application rejected based on water issue.	Resubmitted and application was accepted.
Kapolei Golf Course, Hawaii Housing Authority	Municipal	18	Kapolei Village	N/A	Exempt from city permits.	Proposed for 1991.
Waikele Golf Course, Amfac Properties	Daily fee	18	Waikele	Ted Robinson	Zoning approved December 1, 1986.	Completion expected in 1991.
West Loch Golf Course, City and County of Honolulu	Municipal	18	West Loch	BCA Golf Design	SUP approved.	Proposed for 1990.
Ewa Golf Course Myers Corp.	Daily fee	27	Ewa Beach	Arnold Palmer	CUP approved 10/7/88.	Expected to be operational in 1991. To be designed to play as three different courses.
Royal Kunia Golf Course, Halekua Dev. Co.	Private	18	Kunia	N/A	Development plan amendment pending.	Members only course with construction cost of $18 million.

KUILIMA RESORT COMPANY

Proposed Golf Course Developments on Oahu, Continued

Region/ project/developer	Type of course	Number of holes	Location	Course designer	Approval status(1)	Comments
Central and west, Cont.: Ewa Gentry Golf Course, Gentry Pacific Corp.	Daily fee	18	Ewa	N/A	Pending SLUC boundary adjustment.	Course to be operational by 1990.
Puuloa Golf Course, H. Horita Realty/ Puuloa Homes, Inc.	N/A	18	Puuloa	N/A	Permit for 9 holes approved; rezoning for additional 56 acres being processed.	-
Waianae: Maili Kai Golf Course, Kaiser Cement	N/A	27	Maili Kai	N/A	CUP application withdrawn based on agricultural and water issues.	-
Waianae Kai Golf Course, H. Horita Investment/ Shinwa Golf Co.	N/A	18	Waianae	N/A	CUP application rejected based on water issue. Resubmitted and application accepted. 12/16/88.	-
Lualualei Golf Course, Sanjiro Nakode	N/A	18	Waianae	N/A	Preliminary inquiry.	-
Okukilolo Golf Course, Alpha Kai Corp.	N/A	18	Waianae	N/A	Preliminary inquiry.	-

(1) Abbreviations:
N/A - Not available
SLUC - State Land Use Commission
CUP - Conditional Use Permit
CDUA - Conservation District Use Application
SUP - Special Use Permit

Source: Compiled by KPMG Peat Marwick based upon discussions with developers and other published information.

Exhibit III-F, Cont.

Exhibit III-F, Cont.

Exhibit III-G

KUILIMA RESORT COMPANY

Resort Golf Courses in Hawaii

1989

Resort	Course	Number of holes
Oahu:		
Makaha	Makaha Resort and Country Club Course	18
Kuilima	Turtle Bay Hilton Country Club Course	18
Subtotal		36
Maui:		
Wailea	Blue Course	18
	Orange Course	18
Kaanapali Beach	North Course	18
	South Course	18
Kapalua	Bay Course	18
	Village Links	18
Makena	Makena Golf Course	18
Subtotal		126
Kauai:		
Mirage Princeville	Makai Golf Course	27
	Prince Golf Course	9
Kiahuna	Kiahuna Plantation Golf Course	18
Westin Kauai	Kiele Golf Course	18
	Kauai Lagoons	18
Subtotal		90
Hawaii:		
Mauna Kea	Mauna Kea Beach Golf Course	18
Mauna Lani	Francis I'i Brown Golf Course	18
Waikoloa Beach	Waikoloa Beach Resort Golf Course	18
Waikoloa Village	Waikoloa Village Golf Course	18
Keauhou	Keauhou Golf Course	27
Punalu'u	Seamountain Golf Course	18
Subtotal		117
Molokai - Kalua Koi	Kalua Koi Golf Course	18
Total holes		387

Source: Compiled by KPMG Peat Marwick based on published information.

Oahu has two resort courses, the Turtle Bay Golf Course at Kuilima Resort and the Sheraton Makaha Resort Golf Course.

- Turtle Bay Golf Course - Located on the north shore of Oahu in the Kuilima Resort, the Turtle Bay Golf Course is a 7,061 yard, 18-hole championship course designed by George Fazio. The course is managed by the Arnold Palmer Management Company and includes a putting green and driving range. A second course is being designed by Arnold Palmer for this resort. Additionally, renovation of the Turtle Bay Golf Course is planned.

- Sheraton Makaha Country Club - Located on the leeward side of Oahu in Makaha Valley, the 18-hole championship golf course designed by William Bell offers a long flat design with 7,091 yards. The Makaha Resort is operated by Sheraton Hotels and is owned by a subsidiary of All Nippon Airways.

Characteristics of Resort Golf Courses

Resort golf courses are primarily utilized by resort guests and residents, and secondly by the general public. Golf courses benefit the resort market in important ways:

- Enhance the image of the resort community.

- Preserve open space, tranquility and aesthetic values.

- Broaden visitor market appeal of the resort.

- Enhance the value of the surrounding developments for condominium or single-family use.

- May serve as ecological havens for small wildlife and provide an economic means of preserving historic sites.

Design characteristics of resort courses typically include:

- Well-known course architect for the design and layout.
- Natural ocean and mountain views are maximized.
- Extensive landscaping.
- Oceanfront holes are considered premiums.
- Easy play to accommodate a wide range of skills.

Resort golf courses are typically owned and managed by a subsidiary of the master landowner/developer of the entire resort. Major management and operational concerns include maintenance of the course and related facilities, and managing the rate of play. Tee-times are typically set eight to nine minutes apart compared to seven minutes at nonresort golf courses.

Resort green fees tend to be the most expensive among the daily fee courses due to their high quality and name recognition. Course fee structures are summarized in Exhibit III-H. Green fees for nonresort guests range from $55 to $125, including golf carts, with an average of about $82. Discounts for hotel and resort guests range from none to $50 under the nonguest rate or from $30 to $95 with an average of about $55.

Exhibit III-H

KUILIMA RESORT COMPANY

Fees at Selected Resort Golf Courses in Hawaii

1989

	Total cart and green fees: Resort guests	Nonresort guests
Oahu:		
Makaha	$ 45.00	$ 95.00
Turtle Bay Golf Course	65.00	85.00(1)
Oahu average	$ 55.00	$ 90.00
Maui:		
Wailea - Blue and Orange Courses(2):		
Peak season (December - April)	45.00	90.00
Low season (May - November)	30.00	60.00
Royal Kaanapali - North and South Courses	74.00	74.00
Kapalua Golf Club - Bay Course and Village Course	55.00	85.00(1)
Maui average	$ 51.00	$ 77.25
Kauai:		
Princeville Golf Club:		
Peak season (December - April)	53.00	68.00
Low season (May - November)	48.00	63.00
Kiahuna Golf Club	55.00	55.00
Kiele Golf Course(3)	95.00	125.00
Kauai average	$ 62.75	$ 77.75
Hawaii:		
Mauna Kea Beach Golf Course	55.00	90.00
Mauna Lani:		
Peak season (December - March)	50.00	100.00
Low season (April - November)	50.00	70.00
Waikoloa Beach Resort and Golf Club(4):		
Peak season (January - March)	55.00	90.00
Low season (April - December)	55.00	90.00
Kona Country Club(5):		
Peak season (January - March)	53.00	75.00
Low season (April - December)	47.00	70.00
Hawaii average	$ 52.10	$ 83.60
All islands:		
Range	30 - 95	55 - 125
Average	$ 54.70	$ 81.50

(1) Island residents - $40 green and cart fee on weekdays and $45 on weekends.
(2) Maui residents are entitled to Resort guest rates.
(3) Hawaii residents - $55 green and cart fee.
(4) Formerly Kona at Keauhou Golf Course.
(5) Island residents - $45 green and cart fee.

Source: Compiled by KPMG Peat Marwick based upon discussions with club representatives and other published information.

The strong demand for golf in the resort market can be measured in terms of achieved rounds of play, as shown in Exhibit III-I and discussed below:

- Average daily rounds on representative courses range from 85 to 225 with an average of 147 rounds per day.
- Oahu experiences the highest average daily rounds at 185. The island of Hawaii is second with 173 average daily rounds.
- Utilization of resort courses is seasonal:
    - Peak season is usually from December through April when affluent U. S. mainland and Japanese visitors arrive to escape cold winters.
    - Slow season is usually from June through August.
    - Difference in monthly rounds may vary by almost 100%.

Membership fees at resort golf courses are usually a small portion of the revenues generated by a resort golf operation. However, these memberships are utilized to encourage repeat visitors and attract potential residential unit buyers. Memberships are described as follows:

- The following resorts offer memberships to owners of condominiums or single-family lots within the resort:
    - Mauna Kea Beach Resort
    - Wailea Resort
    - Kapalua Resort
    - Keauhou Resort
    - Mirage Princeville Resort
- Memberships are nontransferable and the number of memberships is typically limited from 100 to 200 members.
- Membership fees range from $450 to $3,000 annually and are subject to annual price adjustments. Membership fees represent a prepayment of annual green fees.
- Earlier reservations for tee-times are allowed for members. For example, members may make reservations three days in advance as compared to two days for resort guests.

Characteristics of Resort Golfers

The demographic profile of resort golfers is directly influenced by the guest mix of the resort itself. At luxury resorts such as Mauna Kea, Mauna Lani and Kapalua, affluent and older hotel guests have a higher propensity to golf than at resorts which attract budget or group visitors such as the Keauhou and Kaanapali Beach resorts.

Exhibit III-I

KUILIMA RESORT COMPANY

Rounds of Golf at Resort Courses in Hawaii

1988

Course	Number of rounds Total annual	Average daily
Oahu:		
Makaha	69,350	190
Turtle Bay Golf Course	65,910	180
Average	67,630	185
Maui:		
Wailea:		
Blue Course	43,800	120
Orange Course	43,800	120
Royal Kaanapali:		
North Course	61,800	169
South Course	41,200	113
Kapalua Golf Club:		
Bay Course	71,175	195
Village Links	47,450	130
Average	51,525	141
Kauai:		
Kiahuna Golf Club	46,625	125
Princeville Makai and Prince Golf Courses(1)	62,000	85
Kiele Golf Course(2)	11,520	90
Average(3)	54,310	100
Hawaii:		
Mauna Lani - Francis I'i Brown Golf Course	49,275	135
Mauna Kea Beach Golf Course	78,475	215
Waikoloa Beach Golf Course	43,000	118
Keauhou Golf Course(4)	82,125	225
Average	63,220	173
All islands:		
Range		85 - 225
Average		147

(1) Total of 36-holes adjusted for daily rounds based on an 18-hole golf course.
(2) Opened August 26, 1988.
(3) Total annual average excludes Kiele Golf Course.
(4) 27-hole golf course adjusted for rounds based on an 18-hole golf course.

Source: Based on discussions with golf pros or representatives of the respective courses.

For example, The Westin Mauna Kea Beach Hotel, which caters to a very affluent clientele, estimates about 25% of the guests golf at least one round during their visit. Keauhou Golf Course attracts more budget-minded guests, so management supplements on-property guest play by offering discounts for group play and by selling memberships.

Resort golfers are comprised of three major market segments:

- Resort hotel and condominium/single-family guests:
  - Represent 20% to 90% of resort golf play. Resorts with a low percentage of play from this group usually accommodate convention visitors or group visitors who do not have as much leisure time to devote to all-day golf play or have lower vacation budgets.
  - Typically have higher median incomes and are usually middle-aged or older.
- Nonresort visitors:
  - Represent 10% to 55% of total golf play at resorts. They tend to represent a greater proportion of total play at golf courses that do not have a large "captured" visitor market such as the Makaha, Kuilima and Makena resorts.
  - Include "golf course-hopping" visitors from neighboring resort areas such as Kaanapali Resort guests who play at Kapalua.
- Island residents - Represent 10% to 45% of total resort play. The highest percentage is achieved at resort courses which offer special rates to island residents or groups.

The mix of these groups at a given resort is influenced by factors including:

- Degree of development of residential units at the resort.
- Accessibility of resort to the local community and other resorts.
- Existence of a priority reservation system.
- Availability of discounts offered to resort guests, island residents and group guests.
- Seasonality, because the type of golfer at each resort changes significantly throughout the year.
  - Resort guests play during the peak season.
  - Nonresort guests may not be able to obtain a starting time during the peak season.

- Non-resort guests, local golfers and groups are sought to offset the decline in visitor arrivals during the slow season.

Resort Golf Course Utilization

Resort hotel guests play an average of 85 rounds per day per 1,000 guests, as shown in Exhibit III-J. Eight resort golf courses were surveyed to approximate this average. The daily rounds range from 45 at Princeville in Kauai to 263 at Mauna Kea in Hawaii.

Planned Resort Course Developments

At least seven resort golf courses are proposed to be developed on Oahu, as previously shown in Exhibit III-F. In addition to the new resort course proposed at the Kuilima Resort and the four proposed Country Courses, two courses are planned for the Ko Olina Resort.

On the other islands 13 resorts have proposed to develop eleven 18-hole and four 9-hole additions or expansions:

- On the island of Hawaii:
  - An 18-hole Mauna Kea Golf Club second course, part of the proposed Hapuna Resort area, adjacent to The Westin Mauna Kea Resort.
  - An 18-hole Mauna Lani Resort second course.
  - An 18-hole Waikoloa Beach Resort second course.
- On Maui:
  - An 18-hole Kapalua Resort third golf course.
  - An 18-hole North Beach-Kaanapali Resort golf course.
  - An 18-hole Wailea Resort third golf course.
  - Two 9-hole additions at Makena Resort.
- On Kauai:
  - A second 9-hole at the Prince course, Mirage Princeville Resort.
  - A 9-hole Kiahuna Golf Club expansion at Kiahuna Resort.
  - A second 18-hole course at Kauai Lagoons in Nawiliwili.
  - A third 18-hole course at Kauai Lagoons in Nawiliwili.
  - An additional 18 holes at Westin Kauai.
  - An 18-hole course at Hyatt Regency Kauai.
- Lanai - An 18-hole course at Manele Bay.

Exhibit III-J

KUILIMA RESORT COMPANY

Rounds Played Per 1,000 Hotel Guests
at Selected Resort Golf Courses

	Estimated daily resort population(1)	Rounds per 1,000 guests per day
Oahu:		
Makaha	261	131
Turtle Bay	748	56
Maui:		
Kapalua	317	140
Wailea	1,401	48
Hawaii:		
Mauna Lani	400	158
Mauna Kea	406	263
Waikoloa Beach	696	46
Kauai - Princeville	712	45
Weighted average		85

(1) Calculated based on total hotel units average occupancy rates and average number of guests per unit.

Source: Estimated based on historical data, based on discussions with directors or representatives of the respective courses.

IV - GOLF COURSE MARKET ASSESSMENT

This chapter assesses the potential market for the Country Courses proposed for the North Shore of Oahu. The assessment is based upon the estimated demand for golf on Oahu and assumes the continued development of hotels, condominiums, and a second golf course as planned at the Kuilima Resort. The chapter concludes with an assessment of competitive courses, and the projected market mix and fees at the proposed courses.

PROJECTED DEMAND AND SUPPLY OF GOLF ROUNDS

This section projects the Kuilima Resort population, which is anticipated to emerge as the primary target market for the proposed courses, and projects demand and supply of golf course rounds.

Kuilima Resort Population

The Resort currently includes 368 condominium units and a hotel with 486 rooms. The different facilities would attract their own mix of guests, residents and potential golfers.

The condominium population at the resort is projected considering the factors presented below and summarized in Exhibit IV-A.

- Condominium units are estimated to be used about 20% for full-time residents, 35% for part-time residents and 45% for visitors.
- An average occupancy of 60% is estimated, based upon a 95% occupancy for full-time resident units, a 25% occupancy for part-time resident units and a 65% occupancy for visitor units.
- Party size is not expected to fluctuate significantly by type of condominium occupant and is estimated to average approximately 2.2 per unit.

Projected average daily overnight population at the Resort, including hotel residents and condominium occupants, is summarized in Exhibit IV-B. This exhibit extends to the year 2005 to include the future development and stabilized operations of five hotels at the Resort. Two additional hotels are proposed to open in 1992, two in 1996 and the final hotel in 2000. Hotel occupancy assumptions utilized in preparing this exhibit are as follows:

- Occupancy assumptions and party size are based upon actual results of the existing hotel and upon comparable Oahu hotels.
- The average occupancy rate assumes each new hotel opens at 65% and achieves a stabilized occupancy of 80% by its fourth year of operation.
- Party size is estimated to average 2.2 guests per unit.

Assumptions related to condominium population are as follows:

- A total of 1,000 additional condominium units are projected to be constructed over a five-year period beginning in 1995.

Exhibit IV-A

KUILIMA RESORT COMPANY

Assumptions for Resort Condominium Population Projections

Stabilized Occupancy and Party Size

	Distribution	Occupancy	Average party size
Full-time residents	20%	95%	2.3
Part-time residents	35	25	2.1
Visitors	45	65	2.3
Total or average, rounded	100%	60%	2.2

Source: Based upon discussions with the existing management company as well as data from other resorts that include condominiums.

KUILIMA RESORT COMPANY

Projected Average Daily Overnight Population at Kuilima Resort

1989 to 2005

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
At hotels:																	
Hotel openings(1)				H-1 H-2				H-3 H-4				H-5					
Number of rooms	486	486	486	1,549	1,549	1,549	1,549	2,585	2,585	2,585	2,585	3,000	3,000	3,000	3,000	3,000	3,000
Average occupancy(2)	70%	75%	75%	70%	73%	77%	80%	73%	76%	78%	80%	78%	79%	79%	80%	80%	80%
Average daily population(3)	700	800	800	2,400	2,500	2,600	2,700	4,200	4,300	4,400	4,500	5,100	5,200	5,200	5,300	5,300	5,300
At condominiums:(4)																	
Number of units	368	368	368	368	368	368	568	768	968	1,168	1,368	1,368	1,368	1,368	1,368	1,368	1,368
Average occupancy(5)	60%	60%	60%	60%	60%	60%	56%	56%	57%	57%	58%	59%	60%	60%	60%	60%	60%
Average daily population(6)	500	500	500	500	500	500	700	900	1,200	1,500	1,700	1,800	1,800	1,800	1,800	1,800	1,800

(1) By site, as shown on Resort masterplan, Exhibit I-A.
(2) Assumes each new hotel opens at about 65% occupancy and achieves a stabilized occupancy of 80% by its fourth year of operation.
(3) Assumes 2.2 guests per unit. Rounded to the nearest hundred.
(4) A total of 1,000 units are anticipated to be constructed at 200 units per year beginning in 1995.
(5) Assumes each phase of condominiums opens at about 50% occupancy and achieves a stabilized occupancy of 60% by the third year.
(6) Assumes 2.2 guests per unit. Rounded to the nearest hundred.

Exhibit IV-3

- The newly constructed condominium units are anticipated to average 50% occupancy at opening and achieve a stabilized rate of 60% by the third year.

- Average party size is estimated to be 2.2 guests or residents per unit, as shown in the prior exhibit.

Based upon these assumptions, the hotel population is projected to increase from 700 guests in 1989 to 5,300 in 2003, when all five hotels reach the stabilized occupancy rate of 80%. The condominium population is projected to increase from 500 in 1989 to 1,800 in 2000, when all the units attain a 60% stabilized occupancy.

Historical and Projected Demand

The demand for golf at the Country Courses is based upon the projected daily overnight population at the Resort and upon the anticipated number of other visitors and residents on Oahu. Demand for golf at the Resort and the Country Courses is projected to increase from an estimated 180 rounds per day in 1988 to about 1,040 rounds per day in 2005, or at an annual percentage growth rate of about 11%, as summarized in Exhibit IV-C. Demand is projected to be derived from five sources, as listed below.

- Resort hotel guests.
- Resort condominium guests and residents.
- Other Oahu visitors.
- Other Oahu residents.
- Players receiving complimentary rounds.

Each of these groups would be anticipated to generate varying amounts of demand for golf, as reflected in Exhibit IV-C. Rounds of golf played per 1,000 population in each of the five groups is summarized below.

- Resort Hotel Guests - Rounds per 1,000 are expected to grow about 10% per annum through 1992 and stabilize in 1993 at 85 daily rounds per 1,000 guests. This would result in up to 450 rounds by hotel guests per day.

- Resort Condominium Guests and Residents - The rate of play is expected to lead that of Resort hotel guests and to stabilize at 95 rounds per day per 1,000 guests. Historically, these players tend to play more golf than resort hotel guests.

- Other Oahu Visitors - The rate of play is anticipated to increase 6% per year reflecting a greater mix of Japanese and affluent visitors to Oahu. Together with increases in the numbers of visitors, this could result in demand for up to 200 rounds per day from this segment.

- Other Oahu Residents - Rounds are expected to grow 8% per year reflecting population growth as well as the continuing increasing popularity of golf among Hawaii residents.

- Nonpaying Guests - Rounds are expected to remain constant at about 4% of the total rounds played.

Exhibit IV-C

KUILIMA RESORT COMPANY

Historical and Projected Demand for Golf Course Rounds
at the Country Courses and Kuilima Resort

1988 to 2005

Year	Resort hotel guests: Average daily census(1)	Resort hotel guests: Rounds per 1,000(2)	Resort hotel guests: Average daily rounds	Resort condominium guests and residents: Average daily census(1)	Resort condominium guests and residents: Rounds per 1,000(3)	Resort condominium guests and residents: Average daily rounds	Other Oahu visitors: Average daily census(4)	Other Oahu visitors: Rounds per 1,000(5)	Other Oahu visitors: Average daily rounds	Other Oahu residents: Average daily census(6)	Other Oahu residents: Rounds per 1,000(7)	Other Oahu residents: Average daily rounds	Complimentary daily rounds(8)	Total daily rounds
Historical:														
1988(9)	748	56	42	486	66	32	74,389	0.75	56	841,157	0.05	43	7	180
Projected:														
1989	700	62	40	500	72	40	77,790	0.80	60	851,250	0.06	50	8	200
1990	800	68	50	500	78	40	81,050	0.85	70	861,350	0.06	50	8	220
1991	800	75	60	500	85	40	82,490	0.90	70	871,110	0.06	60	9	240
1992	2,400	82	200	500	92	50	82,330	0.95	80	880,870	0.07	60	16	410
1993	2,500	85	210	500	95	50	83,670	1.01	80	890,630	0.08	70	16	430
1994	2,600	85	220	500	95	50	85,010	1.07	90	900,390	0.08	70	17	450
1995	2,700	85	230	700	95	70	86,250	1.13	100	910,050	0.09	80	19	500
1996	4,200	85	360	900	95	90	86,050	1.20	100	914,430	0.09	90	26	670
1997	4,300	85	370	1,200	95	110	87,200	1.27	110	918,760	0.10	90	27	710
1998	4,400	85	370	1,500	95	140	88,450	1.35	120	923,090	0.11	100	29	760
1999	4,500	85	380	1,700	95	160	89,750	1.43	130	927,470	0.12	110	31	810
2000	5,100	85	430	1,800	95	170	90,600	1.51	140	931,900	0.13	120	34	890
2001	5,200	85	440	1,800	95	170	92,220	1.61	150	937,560	0.14	130	36	930
2002	5,200	85	440	1,800	95	170	93,740	1.70	160	943,220	0.15	140	36	950
2003	5,300	85	450	1,800	95	170	95,360	1.80	170	948,880	0.16	150	38	980
2004	5,300	85	450	1,800	95	170	96,980	1.91	190	954,540	0.18	170	39	1,020
2005	5,300	85	450	1,800	95	170	98,600	2.03	200	960,200	0.19	180	40	1,040
Compounded annual percentage increase: 1988 - 2005	12.2%	2.5%	15.0%	8.0%	2.2%	10.3%	1.7%	6.0%	7.8%	0.8%	8.0%	8.8%	10.9%	10.9%

(1) From Exhibit IV-B.

(2) Estimated for 1988, then inflated 10% per year until stabilization at 85 rounds per 1,000 guests.

(3) 1988 was estimated based upon the average number of rounds played by condominium guests and residents at five comparable resort golf courses. Subsequent years were estimated by increasing the rounds of golf played by resort hotel guests by 10 rounds until stabilization at 95 rounds per 1,000 guests.

(4) Based on total daily visitor census as reported by the Department of Business and Economic Development, "Population and Economic Projections for the State of Hawaii to 2010" (Series M-K), November 1988 less resort hotel guests and 50% of resort condominium guests and residents.

(5) Estimated for 1988, then inflated 6.0% per year.

(6) Population estimates and projections for Oahu as reported by the Department of Business and Economic Development, "Population and Economic Projections for the State of Hawaii to 2010" (Series M-K), November 1988 less 50% of resort condominium guests and residents.

(7) Estimated for 1988, then inflated 8% per year.

(8) Based upon actual experience of the Turtle Bay Golf Course which indicates 4% of the total rounds played are complimentary.

(9) Historical 1988 information is estimated based upon data available from the Turtle Bay Golf Course.

The above assumptions are based upon historical operating results of the existing Turtle Bay Golf Course located in the Resort and upon national and statewide trends summarized below:

- Nationally, the number of golfers increased by 7.4% from 1986 to 1987, as discussed in Chapter III.
- Growth in the 60-year and older age group is anticipated to be about two and one-half times that of the total population. This age group currently represents about 15% of the total golfing population, as previously shown in Exhibit III-A.
- The increasing proportion of eastbound visitors, who also tend to visit Oahu more frequently than westbound visitors, are usually avid golfers.
- More golfers are likely to choose the North Shore area of Oahu as a vacation destination because the variety of courses planned for this area will contribute to the area's reputation as a destination offering a quality golfing experience.

Projected Supply

The available golf rounds at the Country Courses and the Resort is anticipated to grow from the 180 rounds currently supported at the Turtle Bay Golf Course to 840 rounds of golf when all 6 courses are operational in 1997, as shown in Exhibit IV-D. The two courses at the Resort are considered in this supply analysis because hotel guests and residents would be expected to play at both the Resort courses and the Country Courses due to their proximity and marketing syneigies.

The number of rounds projected to be played at each of the six courses could be expected to vary due to the type of course. The Malaekahana course is proposed to be a very challenging tournament - level golf course; therefore, the average number of daily rounds is projected to be less than at other resort courses, or about 115. This would enable this course to support a superior golfing experience, and to be maintained in a condition befitting such a course. The second Punamano course is planned to be a championship golf course that would also be more challenging. Thus, average daily rounds of play at this course is projected to be limited to about 125. The other planned courses would be expected to experience rates of play typical for resort courses in the state. Thus, the 150 rounds of golf per day estimated for the Kuilima Resort courses and two of the Punamano courses is based upon the following data:

Rounds of Golf Per 18-hole Course
at Selected Resort Golf Courses in Hawaii

	Annual average	Peak season(1)	Slow season(2)
Low range	110	170	70
High range	200	280	190
Typical	150	-	-

(1) Usually from December through April.
(2) Usually from June through August.

Exhibit IV-D

KUILIMA RESORT COMPANY

Projected Supply of Golf Rounds at the Country Courses and Kuilima Resort

1989 to 2005

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
The Country Courses at Kahuku:																	
Malaekahana parcel	-	-	-	115	115	115	115	115	115	115	115	115	115	115	115	115	115
Punamano parcel	-	-	-	-	-	150	150	150	150	150	150	150	150	150	150	150	150
Punamano parcel	-	-	-	-	-	-	-	125	125	125	125	125	125	125	125	125	125
Punamano parcel	-	-	-	-	-	-	-	-	150	150	150	150	150	150	150	150	150
Kuilima Resort:																	
Turtle Bay Golf Course	180	180	-	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Second course	-	-	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Total rounds available	180	180	150	415	415	565	565	690	840	840	840	840	840	840	840	840	840

Utilization of golf courses on Oahu is currently higher than the state average, as was previously shown in Exhibit III-I. This is partially explained by the fact that Oahu has only two resort golf courses, yet it attracts the most visitors of all the islands. Consequently, the existing Turtle Bay Golf Course averages 180 rounds per day, with actual rounds per day ranging from approximately 130 to 215. The Sheraton Makaha Resort Golf Course, also located on Oahu, averages 190 rounds per day.

Supportable Rounds of Golf

Exhibit IV-E compares the projected demand for and availability of golf rounds at the four Country Courses and the two Resort courses. The Kuilima area is projected to continue to experience very tight golf market conditions, with insufficient supply, until the first Country Course at Malaekahana and both the Kuilima Resort courses are operational in 1992. With the opening of the last three Country Courses between 1994 and 1997, there could be more than ample supply to meet the projected demand for golf for the next several years. This would imply there could be fewer than the optimal number of rounds played per day at the courses, and competitive pricing. However, all six golf courses would be expected to be utilized near their optimum levels by 1999. With the opening of the final planned hotel at the Resort in 2000, demand is projected to slightly exceed supply. Thereafter, there could also be excess demand, implying further market support for other golf courses in the area and/or higher rates of play at the Country Courses and Resort courses.

Sensitivity Analysis

A second analysis is presented to show the sensitivity of the demand for rounds of golf to hotel and condominium occupancies. This sensitivity analysis shows that if hotels open at 55% occupancy and stabilize at 65% within the fourth year and condominiums range from 45% to a stabilized 50% occupancy within two years, an oversupply of courses could exist from 1992 to 2002, as shown in Exhibit IV-F. However, supply and demand would be approximately in equilibrium by 2003.

MARKET ASSESSMENT FOR THE COUNTRY COURSES AT KAHUKU

The following market assessment considers existing and planned competitive courses located on Oahu, describes the anticipated target market, and projects green and cart fees.

Competitive Courses

Courses located near the Resort are expected to be competitive in attracting guests and residents who stay in the Resort's hotels and condominiums. This target market is expected to represent 60% of the total market. Courses throughout the island of Oahu would be competitive in terms of the other 40% of the market consisting of other Oahu visitors and residents.

There are two existing 18-hole resort golf courses on Oahu: The Turtle Bay Golf Course located in the Kuilima Resort and the Sheraton Makaha Resort and Country Club Course. The Turtle Bay Golf Course is considered to be complementary to the Country Courses because of its location. Together, the Kuilima Resort and the Country Courses will provide six different types of golf courses and create a unique golfing community on the island.

Exhibit IV-E

KUILIMA RESORT COMPANY

Comparison of Supply and Demand Golf at the Country Courses and Kuilima Resort

1989 to 2005

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Average daily rounds demanded(1)	200	220	240	410	430	450	500	670	710	760	810	890	930	950	980	1,020	1,040
Average daily rounds available(2)	180	180	150	415	415	565	565	690	840	840	840	840	840	840	840	840	840
Excess (shortage) of rounds	(20)	(40)	(90)	5	(15)	115	65	20	130	80	30	(50)	(90)	(110)	(140)	(180)	(200)

(1) As shown in Exhibit IV-C.
(2) As shown in Exhibit IV-D.

Exhibit IV-F

KUILIMA RESORT COMPANY

Sensitivity of Projected Supportable Rounds to Occupancy Rates

1989 to 2005

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Excess (shortage) of rounds:																	
As projected in Exhibit IV-E(1)	(20)	(40)	(90)	5	(15)	115	65	20	130	80	30	(50)	(90)	(110)	(140)	(180)	(200)
As projected for comparison(2)	(10)	(30)	(70)	65	55	195	125	110	230	180	120	50	30	10	(20)	(60)	(90)
Net difference (number of rounds)	(10)	(10)	(20)	(60)	(70)	(80)	(60)	(90)	(100)	(100)	(90)	(100)	(120)	(120)	(120)	(120)	(110)

(1) Assuming that the hotels open at a 65% occupancy rate and reach a stabilized occupancy of 80% by the fourth year, and that the condominiums open at 50% occupancy and reach a stabilized rate of 60% by the third year of operation.

(2) Assuming that the hotels open at a 55% occupancy rate and reach a stabilized occupancy of 65% by the fourth year, and that the condominiums open at 45% occupancy and reach a stabilized rate of 50% by the second year of operation.

At least three other resort golf courses are planned for Oahu, as previously shown in Exhibit III-F, (some of the proposals are preliminary; therefore, the type of course has not yet been designated). These are summarized below:

- A second course is planned for the Kuilima Resort, which will complement the Country Courses.
- Two resort courses are planned for the Ko Olina Resort, which is located on the west side of the island. One of these courses has been approved and is currently under construction, but the other course has not yet been approved.

Approved planned golf courses that are located near the project include the Minami and Kahuku golf courses.

The Minami Golf Course is currently under construction; however, it is not anticipated to be competitive with the Country Courses because it is planned to be developed as a private course. The Kahuku Golf course expansion would be expected to make this course more competitive with the Country Courses. However, the Kahuku course is a municipal course and would most likely affect demand from the local market.

Proposed courses that are located near the Country Courses that have not yet been approved include the following:

- Mokuleia Golf Course
- Lihi-Lani Recreational Community (two courses)
- Waialua Golf Course

Three of the above are proposed to be developed as daily fee courses, and the second Lihi-Lani course is planned to be private. If approved and developed, the daily fee courses could be expected to be competitive with the Country Courses due to their similar quality.

The Royal Hawaiian Country Club, which includes one daily fee course and one private course, would not be expected to be highly competitive for Resort golfers because it is located further away from the Country Courses. However, this course could be competitive in attracting other Oahu visitors and residents.

The overall competitive environment will increase on Oahu if all the 29 planned courses are constructed; however, it is not anticipated that all of these will be completed. As noted previously, only three of these are currently under construction and only 11 have met all approvals. Currently, demand for golf exceeds supply on the island as evidenced by the high daily rounds played and the resultant overcrowded golf courses.

Target Markets and Utilization

The Country Courses and the Kuilima golf courses are expected to attract both visitors and residents of Oahu. Resort hotel guests, condominium guests and condominium residents could represent a higher percentage of the target market as the Resort continues to expand, as shown in Exhibit IV-G. Thus, the market is estimated to evolve from its historical mix to a stabilized one approximately as follows:

Exhibit IV-G

KUILIMA RESORT COMPANY

Historical and Projected Golf Market Mix

1988 to 2005

	Percent of total rounds per year					
	Kuilima Resort					
Year	Resort hotel guests	Condominium guests and residents	Subtotal	Other Oahu visitors	Other Oahu residents	Complimentary rounds
Historical:						
1988	23%	18%	41%	31%	24%	4%
Projected:						
1989	20	20	40	30	25	4
1990	23	18	41	32	23	4
1991	25	17	42	29	25	4
1992	49	12	61	20	15	4
1993	49	12	60	19	16	4
1994	49	11	60	20	16	4
1995	46	14	60	20	16	4
1996	54	13	67	15	13	4
1997	52	15	68	15	13	4
1998	49	18	67	16	13	4
1999	47	20	67	16	14	4
2000	48	19	67	16	13	4
2001	47	18	66	16	14	4
2002	46	18	64	17	15	4
2003	46	17	63	17	15	4
2004	44	17	61	19	17	4
2005	43	16	60	19	17	4

Projected Market Mix
at Country Courses and
Kuilima Resort Courses

	Historical market mix (1988)	Anticipated stabilized market mix (2005)
Resort hotel guests	25%	45%
Condominium guests and residents	20	15
Other Oahu visitors	30	20
Other Oahu residents	25	20
Total	100%	100%

The above categories also include a few complimentary rounds.

Projected Green and Cart Fees

Green and cart fees on Oahu range from $2 to $120 for all types of courses, as previously shown in Exhibit III-E. Fees for resort courses vary between resort guests and nonguests. Resort weekday fees range from $40 to $85 and weekend fees range from $40 to $90.

Based on the current fees at Oahu's courses and the design plans for the four courses, the published green and cart fees at the courses are estimated to range from $40 to $90 for resort guests and from $40 to $110 for nonguests in 1989 dollars. The lower range is considered appropriate for two of the Punamano courses. The second Punamano course and the Malaekahana course could command the higher range due to their superior quality.

APPENDIX H

PROPOSED COUNTRY COURSES AT KAHUKU:
IMPACT ON AGRICULTURE

PREPARED FOR:

Kuilima Resort Company

PREPARED BY:

Decision Analysts Hawaii, Inc.

February 1989

CONTENTS

TABLES

Executive Summary

The proposed Country Courses at Kahuku, a complex of four golf courses, would result in the development of approximately 228 acres of agricultural land at Malaekahana and 638 acres at Punamano.

Soil Quality

Based on various soil surveys, 18 to 42 percent of the Malaekahana site and 48 to 71 percent of the Punamano site are comprised of goods soils. However, these good soils are scattered throughout the properties, with gulches and steep slopes intersecting the more gently sloping terrain. It should also be noted that some of the soil ratings are relatively old (1972) and, based on the agricultural experiences of the current lessee (see below), may be inaccurate in that much of the topsoil may since have eroded.

Past and Current Agricultural Uses of the Property

Until 1971, the Malaekahana property was cultivated in sugarcane as part of Kahuku Plantation Company. This plantation closed partially because of poor agronomical conditions in the Kahuku area. The Malaekahana property is now being used by the Gunstock Ranch under a short-term lease, for grazing about 100 head of cattle and 40 horses. The operations would continue on other lands leased by the Ranch, but the number of livestock would have to be approximately halved, unless other lands can be leased from Campbell Estate. Such a lease is regarded as likely.

Also until 1971, the Punamano lands were cultivated in sugarcane as part of Kahuku Plantation Company. Since 1973, the property has been leased to Amorient Aquaculture International ("Amorient"), a local firm. However, after over a decade of analyzing the economic feasibility of number crops, including field testing of the more promising ones, the company has not identified a profitable use for the property, and the lands now lie fallow. Amorient concluded that the Punamano lands are completely unsuited for crop production, and have expressed a desire to be released from their lease obligation to Campbell Estate. The principal difficulties cited were the cost of pumping water to irrigate mauka fields; soils that are poor and thin, and subject to erosion on the steeper slopes, and very rocky at the lower elevations; difficult terrain, with the area chopped up by gullies and ravines; and excessive winds which damage plants.

AVAILABILITY OF ADDITIONAL AGRICULTURAL LAND

Additional agricultural lands will soon become available in the Kahuku area with the completion of the State's Kahuku Agricultural Park. This development will have 220 usable acres of land divided into 24 lots available for nursery products, truck crops, and orchards.

IMPACT ON THE GROWTH OF DIVERSIFIED AGRICULTURE

The development of the Country Courses at Kahuku would eliminate the possibility of using the affected lands for diversified agriculture. However, it is extremely doubtful that the project would adversely affect the growth of diversified agriculture in Hawaii. There are four reasons for this assessment: (1) an extensive amount of prime-agricultural land and water has been freed from sugar and pineapple production because of past plantation closings and reductions in operations, with most of this land and water remaining available for diversified agriculture activities; (2) a very real possibility exists that additional land and water will be freed from sugar production given the outlook for low sugar prices; (3) most of the sugar operations would make their lands available for profitable replacement crops to the extent that such crops are available; and (4) compared to the available supply, a very small amount of land and water is required to grow proven and promising crops to achieve a realistic level of food and animal-feed self-sufficiency, and to increase exports.

CONSISTENCY WITH STATE AND COUNTY PLANS

The proposed Country Courses at Kahuku would not adversely affect plantation agriculture, since none exists on the property involved; would not adversely affect existing diversified agricultural crop production, since none exists on the property; probably would not adversely affect grazing operations, since other lands could be made available for relocating the cattle and horses which now occupy the *Malaekahana* lands; and would not limit the growth of diversified agriculture. On the other hand, the project would contribute to the State's recreational facilities and to employment. Consequently, the project is consistent with the major thrust of the Hawaii State Plan, the State Agriculture Functional Plan, and the General Plan of the City and County of Honolulu.

PROPOSED COUNTRY COURSES AT KAHUKU IMPACT ON AGRICULTURE

The proposed Country Courses at Kahuku, a complex of four golf courses, would result in the development of approximately 638 acres at Punamano and 228 acres at Malaekahana, or a total of 866 acres.[1] The impact of this development on the potential growth of agriculture is summarized in this report.

AGRONOMICAL CONDITIONS

General Conditions[2,3]

At the *Malaekahana* site, the terrain is comprised of rolling hills with some broad areas of gently sloping grasslands; elevations range from 25 feet to 450 feet above sea level. For most of the land area, rainfall ranges between 40 and 50 inches per year.

At *Punamano*, where the elevation ranges from 20 feet to 275 feet above sea level, the terrain is comprised of broad open areas and gentle slopes including some hills, and some steep slopes and cliffs. Three intermittent-stream gulches cross the site. For most of the land area, rainfall ranges between 40 and 45 inches per year.

Groundwater is available in the area; however, since these are mauka lands the water must be pumped up to the surface and the cost of the water is correspondingly high.

Heavy winds in the area limit the choice of crops and/or require windbreaks.

Soil Quality of Affected Acreage

The affected acreage consists of seven soil types at Malaekahana, and 22 soil types at Punamano.[4] At *Malaekahana*, the soil types, listed according to the amount of acreage, are:

LaC	Lahaina silty clay, 7 to 15 percent slope;
CR	Coral outcrop;
PeE	Paumalu silty clay, 25 to 40 percent slope;
PZ	Paumalu-Badland complex;

LaB	Lahaina silty clay, 3 to 7 percent slope;
PeB	Paumalu silty clay, 3 to 8 percent slope; and
PeD	Paumalu silty clay, 15 to 25 percent slope.

At *Punamano*, the soil types are:

LaB	Lahaina silty clay, 3 to 7 percent slope;
LaC	Lahaina silty clay, 7 to 15 percent slope;
CR	Coral outcrop;
PeC	Paumalu silty clay, 8 to 15 percent slope;
WkB	Waialua silty clay, 3 to 8 percent slope;
PeB	Paumalu silty clay, 3 to 8 percent slope;
KaB	Kaena clay, 2 to 6 percent slope;
KanE	Kaena very strong clay, 10 to 35 percent slope;
PeF	Paumalu silty clay, 40 to 70 percent slope;
KaC	Kaena clay, 6 to 12 percent slope;
KaeC	Kaena stony clay, 6 to 12 percent slope;
KpB	Kemoo silty clay, 2 to 6 percent slope;
PeD	Paumalu silty clay, 15 to 25 percent slope;
WkA	Waialua silty clay, 0 to 3 percent slope;
KPZ	Kemoo-Badland complex;
KpC	Kemoo silty clay, 6 to 12 percent slope;
Ph	Pearl Harbor clay;
KpD	Kemoo silty clay, 12 to 20 percent slope;
Kfa	Kaloko clay;
PeE	Paumalu silty clay, 25 to 40 percent;
LRK	Rock; and
PZ	Paumalu-Badland complex.

For each soil type, Table 1 (for Malaekahana) and Table 2 (for Punamano) show the approximate acreage, possible agricultural uses, and two soil ratings (explained below).

The predominate soil types at *Malaekahana*—LaC, CR and PeE—comprise about 72 percent of the project area. Of the total area, 65 percent can be used for sugar, pineapple or truck crops; the remaining land can be used for pasture or is unsuited for agriculture.

The predominate soil types at *Punamano*—LaB, CR, LaC and PeC—comprise about 52 percent of the project area, while the remaining land contains 18 different soil types. Of the total area, 77 percent can be used for sugar, pineapple or truck crops; the remaining land can be used for pasture or is unsuited for agriculture.

The soils within the petition area have been rated in terms of four classification systems commonly used in Hawaii: (1) Land Capability Grouping, (2) Agricultural Lands of Importance to the State of Hawaii, (3) Overall Productivity Rating, and (4) Proposed Land Evaluation and Site Assessment. These classification systems are discussed below.

(1) *Land Capability Grouping by the United States Department of Agriculture Soil Conservation Service (SCS).*

This classification system rates soils into eight levels, ranging from the highest classification level, "I," to the lowest level, "VIII." The ratings for the two sites, which are made under the assumption that the land is irrigated, are shown in Tables 1 and 2.

At *Malaekahana,* 15 percent of the land has a rating of IIe, which indicates that the soils have moderate limitations that reduce the options on plants that can be grown successfully, or indicates that moderate conservation practices are required.

Table 1.— PROPOSED GOLF COURSE AT MALAEKAHANA: SOIL TYPES, AGRICULTURAL USES, AND LESA AND SCS RATINGS

Soil Type	Acreage	Agricultural Uses	SCS Rating[1]	LESA Rating
LaC	61.3	Sugar, Pineapple	IIIe	82
CR	55.4	None	VIIIs	—
PeE	47.7	Pasture, Sugar	VIe	39
PZ	24.5	Pasture	VIIe	—
LaB	16.9	Sugar, Pineapple, Truck Crops, Pasture	IIe	90
PeB	16.9	Sugar, Pasture	IIe	85
PeD	5.1	Pasture, Sugar	IVe	57

1. Assuming that the soils are irrigated.

Source: U.S. Department of Agriculture, Soil Conservation Service in cooperation with The University of Hawaii Agricultural Experiment Station, *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai,* State of Hawaii, Washington, D.C., August 1972.

Table 2.— PROPOSED GOLF COURSES AT PUNAMANO: SOIL TYPES, AGRICULTURAL USES, AND LESA AND SCS RATINGS

Soil Type	Acreage	Agricultural Uses	SCS Rating[1]	LESA Rating
LaB	107.9	Sugar, Pineapple, Truck Crops, Pasture	IIe	90
LaC	80.7	Sugar, Pineapple	IIIe	82
CR	74.3	None	VIIIs	—
PeC	73.1	Sugar, Pasture	IIIe	76
WkB	44.8	Sugar, Truck Crops, Pasture	IIe	91
PeB	38.9	Sugar, Pasture	IIe	85
KaB	35.9	Sugar, Truck Crops, Pasture	IIIw	79
KanE	35.6	Pasture	VIs	41
PeF	25.4	Pasture	VIIe	20
KaC	24.3	Sugar, Pasture	IIIw	70
KaeC	20.4	Sugar, Pasture	IIIw	62
KpB	18.2	Sugar, Pasture	IIe	87
PeD	16.5	Pasture, Sugar	IVe	57
WkA	13.2	Sugar, Truck Crops, Pasture	I	93
KPZ	6.5	Pasture	VIIe	23
KpC	6.4	Sugar, Pasture	IIIe	85
Ph	4.0	Sugar, Taro, Bananas, Pasture	IVw	43
Kfa	3.2	Sugar, Pasture	IIIw	81
KpD	3.2	Pasture, Sugar	IVe	69
PeE	2.2	Pasture, Sugar	VIe	39
LRK	1.9	None	—	—
PZ	1.1	Pasture	VIIe	—

1. Assuming that the soils are irrigated.

Source: U.S. Department of Agriculture, Soil Conservation Service in cooperation with The University of Hawaii Agricultural Experiment Station, *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai*, State of Hawaii, Washington, D.C., August 1972.

Subclassification "e" indicates that the limitation is due to the risk of erosion, and therefore the soils require protection when cultivated. About 27 percent of the land is rated IIIe, which indicates that the soils have severe limitations that reduce the choice of plants, require special conservation practices, or both. About 2 percent of the land is rated IVe, which indicates that the soils have very severe limitations that reduce the choice of plants, require very careful management, or both. The remaining 56 percent of the lands have ratings of VI or higher, which indicate that they have severe problems which make them generally unsuited for agriculture. The problems are due to erosion or stoniness.

At *Punamano*, about 2 percent of the proposed project has a land capability rating of I; this indicates that the soils have few limitations that restrict their use. About 33 percent of the project has a land capability rating of IIe; this indicates that the soils have moderate limitations that reduce the options on plants that can be grown successfully, or indicates that moderate conservation practices are required. About 38 percent of the project has a capability rating of IIIe or IIIw, which indicates that the soils have severe limitations that reduce the options on plants, require special conservation practices, or both. The "w" indicates that the problem is excess water. About 4 percent of the project area has a soil classification of IVe or IVw which indicates that the soils have very severe limitations that reduce the options on plants, require very careful management, or both. The remaining lands, about 23 percent of the total area, are in soil classifications VI or above, which reflects the severe limitations that make them generally unsuited for cultivation—either because of erosion or stoniness.

(2) *Agricultural Lands of Importance in the State of Hawaii (ALISH), by the SCS, University of Hawaii (UH) College of Tropical Agriculture and Human Resources, and the State of Hawaii, Department of Agriculture.*[5,6]

This system classifies lands into three categories: (a) prime agricultural land which is land that is best-suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (b) unique agricultural land which is non-prime agricultural land that is currently used for the production of specific high-value crops; and (c) other agricultural land which is non-prime and non-unique agricultural land that is of importance to the production of crops.

At *Malaekahana*, about 25 percent of the lands proposed for the golf course are rated as "prime" agricultural lands; 43 percent as "unique;" and 32 percent as "other."

At *Punamano*, 69 percent of the lands are rated as "prime" agricultural lands; 15 percent as "unique;" and 16 percent as "other."

(3) *Overall Productivity Rating, by the UH Land Study Bureau (LSB).*[7]

This classification rates soils according to five levels, where "A" represents the class of highest productivity and "E" the lowest.

At *Malaekahana*, none of the lands have soils rated "A," while 18 percent are rated "B;" 37 percent are rated "C;" 3 percent "D;" and 42 percent "E." A reservoir is also present on the property and is not rated.

At *Punamano*, 9 percent of the lands are rated "A;" 51 percent are rated "B;" 11 percent are rated "C;" 1 percent are rated "D;" and 27 percent are rated "E." A quarry and a reservoir take up less than 1 percent of the area, and are not rated.

(4) *Proposed Land Evaluation and Site Assessment (LESA) System, by the State of Hawaii Land Evaluation and Site Assessment Commission.*[8]

Based on soil quality, locational attributes, improvements, nearby activities, and land-use plans, this proposed classification system attempts to designate a sufficient amount of the better agricultural lands to meet projected agricultural goals. If the LESA classification approach were applied to the *Malaekahana* site, 42 percent of the lands would be termed "important agricultural lands" (IAL), which would include all lands having a rating of 66 or above, out of a possible total of 100. At the *Punamano* site, about 71 percent of the lands would be termed IAL. Again, the ratings for each soil type are shown in Tables 1 and 2. However, the designations would be subject to change based on a change in nearby activities and a change in County land-use plans. Also, the designation could be changed if an overriding public benefit is demonstrated.

Based on the various soil surveys, 18 to 42 percent of the *Malaekahana* site and 48 to 71 percent of the *Punamano* site are comprised of goods soils. However, these good soils are scattered throughout the properties, with gulches and steep slopes intersecting the more gently sloping terrain. It should also be noted that some of the soil ratings are relatively old (1972) and, based on the agricultural experiences of the current lessee (see below), may be inaccurate in that much of the topsoil may since have eroded.

Possible Crops

Studies for the nearby Kahuku Agricultural Park, which is located on similar terrain between the Malaekahana and Punamano sites, indicates that vegetables, fruits and melons, and flowers and nursery products can be grown in the Kahuku foothills.[3] Vegetables could include snap beans, green peppers, cucumbers, eggplant, ginger root, mustard cabbage, green onions, Italian squash, sweet potatoes, sweet corn, and tomatoes. Vegetables unsuited for the Kahuku area include carrots, broccoli, celery, lettuce, and dry onions. Fruits and melons which can be cultivated include avocados, bananas, guava, papaya, tangerines, passion fruit, and various kinds of melons. Flower and nursery products include ornamental potted plants and dendrobiums.

PAST AND CURRENT AGRICULTURAL USES OF THE PROPERTY

Malaekahana

Until 1971, the Malaekahana property was cultivated in sugarcane as part of Kahuku Plantation Company. This plantation closed primarily because of poor agronomical conditions in the Kahuku area, and because of its small size and lack of scale economies. The Malaekahana property is now being used by the Gunstock Ranch under a short-term lease, for grazing about 100 head of cattle and 40 horses. The operations would continue on other lands leased by the Ranch, but the number of livestock would have to be approximately halved, unless other lands can be leased from Campbell Estate. Such a lease is regarded as likely.

Punamano[9]

Also until 1971, the Punamano lands were cultivated in sugarcane as part of Kahuku Plantation Company. Since 1973, the property has been leased to Amorient Aquaculture International ("Amorient"), a local firm. However, to date, the company has not identified a profitable use for the property, and the lands now lie fallow. Amorient has investigated the economic feasibility of numerous candidate crops on this land, including test cultivation of Christmas trees, pineapple, hale koa seed for export, and other crops. They also analyzed the economics of feed corn, sorghum, sudex, hay and other fodder crops.

After over a decade of effort, they concluded that in today's economic environment the lands are unsuitable for commercial agricultural crop production, with the principal difficulties being the cost of pumping water to irrigate mauka fields, poor soils, difficult terrain, and excessive wind. Because Amorient has considerable experience with wind power, it had hoped that windmills might reduce pumping costs. The firm concluded, however, that the initial cost of wind turbines, coupled with the very poor reliability of commercially available units and the consequent high cost of maintenance, made this option economically unfeasible.

Amorient also concluded that the soils over most of the lands are poor and thin—a condition which was made worse by nearly 50 years of sugarcane production and the consequent severe loss of topsoil that resulted from the standard farming practices for sugar. In many areas, relatively steep slopes make it difficult to conserve soil and, furthermore, crop cultivation would cause an unacceptable increase in erosion rates. Also, lands at the lower elevations are rocky and therefore difficult to plow. Furthermore, the whole area is chopped up by gullies and ravines. In their view, these conditions severely limit the available options for suitable crops. Amorient's experience with the property strongly suggests that some of the soil surveys, most of which are based on conditions when the land was cultivated in sugarcane, overstate the quality of the soils.

The winds in the area, which are high and virtually constant, severely restrict options on crops, since a number of candidate species are either stunted or experience extensive lodging under these wind conditions.

Amorient ultimately concluded that the Punamano lands are completely unsuited for crop production, and have expressed a desire to be released from their lease obligation to Campbell Estate because of their inability to find a profitable crop to grow on the site.

AVAILABILITY OF ADDITIONAL AGRICULTURAL LAND

Additional agricultural lands will soon become available in the Kahuku area with the completion of the State's Kahuku Agricultural Park. This development will have 220 usable acres of land divided into 24 lots, under a 30-year lease from Campbell Estate. Lands will be available for nursery products, truck crops, and orchards.[3]

IMPACT ON GROWTH OF DIVERSIFIED AGRICULTURE

The development of the Country Courses at Kahuku is a commitment of small amount of prime agricultural land to recreational use. For the purposes of this discussion, prime agricultural land is loosely defined to mean any high-quality agricultural land capable of providing high yields for a variety of crops and, based on the soil surveys, would include between 40 and 100 acres at *Malaekahana* and between 300 and 450 acres at Punamano. This commitment raises the question of whether the Country Courses at Kahuku would affect adversely the development of diversified agriculture—either immediately or over the long term. Thus the demand for and the supply of prime agricultural land for diversified agriculture are clarified below.

Demand for Prime Agricultural Land

As part of its analysis to identify IAL (see page 6), the LESA Commission adopted projections of the amount of agricultural land required to increase food and animal-feed self-sufficiency given projected resident-plus-visitor population growth, and increased crop exports. The LESA projections for the State and Oahu are shown in Tables 3 and 4, respectively. As indicated, LESA projects that an estimated 52,684 additional acres will be required Statewide to accommodate the increase in production for the 1983-to-1995 period. The corresponding figure for Oahu is 7,979 acres. The crops and acreage requirements are categorized according to those which generally do not require prime agricultural land (although some crops may be grown profitably on prime agricultural land), those which generally do require prime agricultural land, plus a contingency of 10 percent of all acreage used for purposes other than beef and cattle production.

It should be noted that the LESA projections and the corresponding Illustrative Generalized IAL Maps contain, or appear to contain, a number of major flaws which have led to a gross overestimation of the amount of agricultural land required:

- Based on a thorough, in-depth, and widely reviewed analysis of the market potential for crops grown on Molokai,[10] and analysis of previous projections distributed by the State of Hawaii Department of Agriculture, the LESA projection for diversified agriculture appears to be excessively high. Apparently, it is assumed that many unprofitable crops will become profitable, that Hawaii farmers will be able to undersell low-cost summer crops from California, and that each and every activity will experience rapid growth. Verification of the exent of these flaws is hampered by the fact that the assumptions and analysis which underlie the LESA projections have not been made available for public inspection.
- Some of the LESA acreage estimates are for harvested acreage, which leads to an overestimate of the land requirements for those crops which are harvested more than once a year (i.e., the acreage requirements for a crop harvested twice a year should be halved).
- The LESA contingency of 29,500 acres is excessive, particularly since LESA projects a requirement for less than 9,000 additional acres of prime agricultural lands. The contingency is large primarily because the LESA methodology implicitly allows for expansion of sugar operations—a grossly unrealistic possibility. Furthermore, the contingency amounts to double counting since the high projections already contain a built-in contingency.

Table 3.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, STATE OF HAWAII: 1983 AND 1995

Crop or Activity	1983	1995	Increase
Crops and Activities which Generally Do Not Require Prime Agricultural Lands			
Beef/cattle [1,2]	765,450	365,090	--
Livestock:			
Dairy	1,000	1,182	182
Eggs/Poultry	281	515	234
Swine	600	1,050	450
Subtotal for Livestock	1,881	2,747	866
Unique Crops:			
Aquaculture	500	4,500	4,000
Coffee	2,000	5,700	3,700
Flowers/Nursery	1,786	3,040	1,254
Papaya	2,120	11,850	9,730
Taro/Watercress	400	527	127
Subtotal for Unique Crops	6,806	25,617	18,811
Macadamia Nuts	15,800	27,000	11,200
Crops and Activities which Generally Do Require Prime Agricultural Lands			
Plantation:			
Sugarcane [2,3]	194,300	177,700	-16,600
Pineapple	36,000	36,049	49
Subtotal for Plantation	230,300	213,749	-16,551
Other:			
Guava	965	1,400	435
Seed Corn	730	1,060	330
Bananas	1,100	2,200	1,100
Feed/Forage [2,4]	8,705	12,495	3,790
Fruits	635	1,156	521
Vegetables/Melons [5]	4,340	7,022	2,682
Subtotal for Other Crops	16,475	25,333	8,858
Contingency [6]	--	29,500	29,500
TOTAL	1,036,712	689,036	--
TOTAL, Excluding Beef/Cattle	271,262	323,946	52,684

Table 3.—LESA AGRICULTURAL ACREAGE REQUIREMENTS, STATE OF HAWAII: 1983 AND 1995
(continued)

Source: Derived from State of Hawaii Land Evaluation and Site Assessment Commission, *A Report on the State of Hawaii Land Evaluation and Site Assessment System*, Legislative Reference Bureau, Honolulu, Hawaii, February 1984.

1. Includes marginal grazing and pasture lands. The 1983 figure includes arid zones and other areas having low carrying capacity, while the 1995 figure does not.
2. Often includes land in a holding operation awaiting discovery of profitable uses.
3. The decline in acreage primarily reflects the loss of Puna Sugar Co.
4. Includes some pastureland and 8,000 acres of guinea grass on Molokai.
5. Overstated in that the acreage figures are for harvested acres, rather than for the amount of land required (i.e., the acreage requirements for a crop harvested twice a year should be halved).
6. Based on 10% of all acreage other than that for beef/cattle. This contingency amounts to double counting in that the LESA projections are already high. Also, the contingency figure allows for an additional 17,770 acres for expansion of sugarcane, even though the sugar industry is expected to decline, not expand.

Table 4.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, CITY AND COUNTY OF HONOLULU: 1983 AND 1995

Crop or Activity	1983	1995	Increase
Crops and Activities which Generally Do Not Require Prime Agricultural Lands			
Beef/cattle [1,2]	18,200	10,090	--
Livestock:			
Dairy	340	40	62
Eggs/Poultry	250	390	140
Swine	144	200	56
Subtotal for Livestock	734	992	258
Unique Crops:			
Aquaculture	300	2,400	2,100
Flowers/Nursery	495	850	355
Papaya	70	170	100
Taro/Watercress	60	85	25
Subtotal for Unique Crops	925	3,505	2,580
Crops and Activities which Generally Do Require Prime Agricultural Lands			
Plantation:			
Sugarcane [2]	27,200	25,300	-1,900
Pineapple	11,829	11,800	-29
Subtotal for Plantation	39,029	37,100	-1,929
Other:			
Guava	--	242	242
Seed Corn	125	180	55
Bananas	540	836	296
Feed/Forage [2,3]	1,741	2,912	1,171
Fruits	90	200	110
Vegetables/Melons [4]	1,155	1,595	440
Subtotal for Other Crops	3,651	5,965	2,314
Contingency [5]	--	4,756	4,756
TOTAL	62,539	62,408	--
TOTAL, Excluding Beef/Cattle	44,339	52,318	7,979

Table 4.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, CITY AND COUNTY OF HONOLULU: 1983 AND 1995 (continued)

Source: Derived from State of Hawaii Land Evaluation and Site Assessment Commission, *A Report on the State of Hawaii Land Evaluation and Site Assessment System*, Legislative Reference Bureau, Honolulu, Hawaii, February 1984.

1. Includes marginal grazing and pasture lands. The 1983 figure includes arid zones and other areas having low carrying capacity, while the 1995 figure does not.
2. Often includes land in a holding operation awaiting discovery of profitable uses.
3. Includes some pasture.
4. Overstated in that the acreage figures are for harvested acres, rather than for the amount of land required (i.e., the acreage requirements for a crop harvested twice a year should be halved).
5. Based on 10% of all acreage other than that for beef/cattle. This contingency amounts to double counting in that the LESA projections are already high. Also, the contingency figure allows for an additional 17,770 acres for expansion of sugarcane, even though the sugar industry is expected to decline, not expand.

- The LESA methodology assumes that prime agricultural lands that were freed from sugar and pineapple production and placed in pasture or some other low-profit operation will stay in these uses. This is very unrealistic in that these are holding operations for land until profitable crops can be identified.
- The LESA methodology incorrectly assumes that sugar is a healthy industry and, therefore, that sugar lands would be unavailable for more profitable replacement crops.
- The Illustrative Generalized IAL Maps incorrectly allocate prime agricultural lands to certain activities which do not need such lands (e.g., aquaculture should be allocated the agriculturally low-quality coastal lands at Kahuku).

The relevant figures from Tables 3 and 4 are not the total figures, but the increase in the amount of prime agricultural land required to accommodate diversified agriculture: the increase is 8,858 acres for the State, and 2,314 acres for Oahu. As discussed above, these figures are excessive; a more realistic estimate for the State is probably closer to 1,500 acres.[10] Nevertheless, even using the excessive LESA estimate, the amount of additional prime agricultural land that would be required to accommodate diversified agriculture, and provide the hope (but not the realistic expectation) of profitable operations, is surprisingly small.

If diversified agriculture is to require a large amount of prime agricultural land, then additional crops will have to be grown for the export market rather than for the small Hawaii market. However, it is important to note the extreme difficulty of identifying new export crops, and developing them into new and profitable industries. For over a century, numerous and extensive crop searches and experiments have been conducted by many people and organizations, and have led to surprisingly few major long-term successes in Hawaii. Furthermore, the difficulty in developing export markets is increasing because of increasing competition from other sugarcane-growing areas.[11] Low sugar prices have led nearly all sugarcane operators throughout the world to search for profitable replacement crops, particularly crops which can increase the level of earnings from exports. Thus far, few successes have materialized.

Supply of Prime Agricultural Land

Regarding the supply of land, an enormous and growing supply of prime agricultural land is available for other uses. Since 1968, about 90,000 acres of Hawaii's prime agricultural land has been freed from sugar and pineapple production: about 62,700 acres of land freed from sugar production (about 15,200 acres on Oahu and 47,500 acres on the Neighbor Islands), and about 27,300 acres freed from pineapple production (about 6,600 acres on Oahu and 20,700 acres on the Neighbor Islands).[12-14] Some of the land freed from sugar and pineapple production has or will be converted to urban, diversified agriculture, and aquaculture uses. After making allowances for the various conversions, uncommitted acreage which remains available to diversified agriculture and aquaculture amounts to many tens of thousands of acres, with a large portion of this on Oahu. Much of this land is fallow, in pasture, or in some other low-value land-holding operation.

This supply of prime agricultural land probably will increase given the very real possibility of future sugar company closings. The outlook for sugar prices is unfavorable, and some unprofitable plantations are in operation today only because they have lease and/or energy contracts which make closing too expensive. However, these contracts eventually will end.

Furthermore, a portion of the sugarcane land is in a holding pattern awaiting the discovery of profitable replacement activities; this land forms part of the supply of prime agricultural land available to profitable diversified agriculture crops, and includes over 70,000 acres.[15]

Many of the lands freed, to be freed, or which can be freed from sugar and pineapple production have excellent agricultural qualities and climatic conditions, and are well-suited for a variety of crops. Also, water is available for most of these lands, especially lands freed from sugar production.

Additional lands which have been made available for diversified agriculture are in government-sponsored agricultural parks throughout the State, and including a new park at Kahuku. Lands for agricultural activities which do not require prime agricultural land include pasture land, land for livestock operations, and "unique" lands as classified by ALISH (see page 5). Unique lands are not prime agricultural lands, but are important lands for certain crops, the principal examples are the coffee lands in Kona, and certain lava lands in Puna that are particularly well-suited for growing papaya. The supply of unique lands is quite large and is distinct from the supply of prime agricultural lands.

Availability of Land to Small-Scale Farmers

Even though considerable agricultural land exists, small agricultural parcels are seldom available to small-scale farmers under long-term leases because land-use regulations and the political environment make it unprofitable and too risky to the landowner to lease out small farm parcels. Agricultural use constitutes a low-value use of the land and, correspondingly, farmers pay relatively low lease rents. At the same time, in order to rent to small-scale farmers, landowners are required to subdivide the property. Applicable County subdivision regulations (designed for rural estates) require expensive electrical power, paved rather than gravel roads, and buried rather than surface water lines. The combination of low rents and expensive subdivision requirements makes it unprofitable for the landowner to subdivide land for small farms.

For example, rather than developing the State agricultural park in Kahuku, it would have been—as surprising as it may seem—less expensive for the State to give each farmer in the park $100,000[1]. In addition, there is the risk that when the leases expire, small-scale farmers will turn to the Legislature in an attempt to prevent landowners from raising lease rents, or to prevent landowners from evicting them in favor of a higher and more profitable use of the landowner's land—this often occurs in long-term leases for land on which small-scale farmers have built homes (e.g., Waihole-Waikane, Kona, Waianae, Kalama Valley). Such an economic environment favors leases to large-scale operators (including cooperatives consisting of many small-scale farmers), short-term and illegal leases of unsubdivided land, subdivision of the land into rural estates for sale to buyers who can afford the costs of the subdivision requirements, or leaving the land fallow.

In summary, the shortage of small parcels of land for farmers is a serious problem. Nevertheless, a vast supply of prime agricultural land does exist and is available for those profitable diversified agricultural activities that are large in scale, or for which the subdivision requirements are somehow circumvented.

Outlook for Diversified Agriculture

Based on the above analysis, ample prime agricultural land will be available to easily accommodate the requirements of diversified agriculture. This conclusion derives from the fact that a vast amount of prime agricultural land and water is available, having been freed from sugar and pineapple production in recent years; the very real possibility that additional sugarcane acreage and water will be freed, given the outlook for low sugar prices; the fact that most of the sugar operations would make their lands available for profitable replacement crops; and, in contrast, land requirements for diversified agriculture that are surprisingly modest. In other words, the limiting factor will be the market, not the land supply. The proposed Country Courses at Kahuku involves far too little land to affect this conclusion. Therefore, the Country Courses at Kahuku would not affect adversely the growth of diversified agriculture.

1. This is based on 220 usable acres divided into 24 lots, a land cost to the State of $50 per acre per year; improvement costs for developing the farm plots (electric power, roads, etc.) of $3.4 million; rents received from farmers of $300 per acre per year; an 8-percent discount rate based on State bonds; and a 30-year term for the bond and the lease. Improvements are not to County standards.

Consistency with Overseas Long-Term Trends

The increased availability of prime agricultural land in Hawaii compared to that of prior decades results from some very long-term and accelerating trends that are occurring throughout the United States, Europe, and many developed and developing market economies.[15] For example, U.S. farmers are paid by the government not to farm their land. This has resulted in 30 million acres of agricultural land lying fallow in 1984.[16] In Europe, quotas are used to limit production. The principal agricultural problem has been overproduction, which has occurred as a result of the tremendous success of increasing yields, coupled with a slowing of the population growth rate. Because yields increase faster than population growth, resources must be freed from agriculture in order to restore balanced markets, and to increase income to the farmers who remain. Otherwise agricultural products glut the market; this is followed by low prices, a fall in farmers' income, and bankruptcies.

Furthermore, the export market has not been able to absorb the excess production, partly due to the agricultural successes achieved in many developing counties. For example, India once suffered from severe food problems. With the introduction of modern agriculture, however, its farm industry has been transformed, making India self-sufficient and even an exporter of many foods it once had to import. Similar gains have been achieved throughout Asia and Central and South America.

Of significance to Hawaii, Sugar is clearly part of this trend which, over the long term, shows supply increasing more quickly than demand. In fact, some of the newer sweeteners have the theoretical potential of causing the release of all the land in the world that is now planted in sugarcane and sugarbeets.

The major agricultural problem facing the United States and many other economies, therefore, is how to make the reduction in production an orderly one so as to minimize social problems. This is a problem that arises from the tremendous successes in agriculture production, and contrasts sharply with, and invalidates, the 200-year old prediction of Thomas Malthus that population will increase faster than the food supply.

CONSISTENCY WITH STATE AND COUNTY PLANS

The proposed Country Courses at Kahuku would not adversely affect plantation agriculture since none exist on the property involved, would not adversely affect existing diversified agricultural crop production since none exists on the property, probably would not adversely affect grazing operations since other lands could be made available for relocating the cattle and horses which now occupy the *Malaekahana* lands, and would not limit the growth of diversified agriculture. On the other hand, the project would contribute to the State's recreational facilities and to employment. Consequently, the project is consistent with the major thrust of the Hawaii State Plan, the State Agriculture Functional Plan, and the General Plan of the City and County of Honolulu. This thrust in all three plans calls for preserving the economic viability of plantation agriculture and promoting the growth of diversified agriculture (see Table 5). To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured. The thrust of these plans is not to preserve prime agricultural lands simply for the sake of preserving them—preservation is to occur only if a potential need for these agricultural lands exists.

Table 5.-- SELECTED STATE AND COUNTY OBJECTIVES, POLICIES, AND GUIDELINES RELATED TO AGRICULTURAL LANDS

HAWAII STATE PLAN (Chapter 226, Hawaii Revised Statutes, as amended):

Section 226-7 Objectives and policies for the economy--agriculture.

(a) Planning for the State's economy with regard to agriculture shall be directed towards achievement of the following objectives:

(1) Continued viability in Hawaii's sugar and pineapple industries.

(2) Continued growth and development of diversified agriculture throughout the State.

(b) To achieve the agricultural objectives, it shall be the policy of the State to:

(6) Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs.

Section 226-103 Economic priority guidelines.

(c) Priority guidelines to promote the continued viability of the sugar and pineapple industries:

(1) Provide adequate agricultural lands to support the economic viability of the sugar and pineapple industries.

(d) Priority guidelines to promote the growth and development of diversified agriculture and aquaculture:

(1) Identify, conserve, and protect agricultural and aquacultural lands of importance and initiate affirmative and comprehensive programs to promote economically productive agricultural and aquacultural uses of such lands.

Section 226-104 Population growth and land resources priority guidelines.

(b) Priority guidelines for regional growth distribution and land resource utilization:

(2) Make available marginal or non-essential agricultural lands for appropriate urban uses while maintaining agricultural lands of importance in the agricultural district.

Table 5.-- SELECTED STATE AND COUNTY OBJECTIVES,
POLICIES, AND GUIDELINES RELATED
TO AGRICULTURAL LANDS
(continued)

STATE AGRICULTURAL FUNCTIONAL PLAN (June 1985)
(Functional plans are guidelines for implementing the State Plan, and are not adopted by the State Legislature.)

B. Objective: Achievement of Productive Agricultural Use of Lands Most Suitable and Needed for Agriculture.

(5) Policy: Provide greater protection to agricultural lands in accordance with the Hawaii State Constitution.

(c) Implementing Action: Identify important agricultural lands to promote diversified agriculture, increased agricultural self-sufficiency, and assure the availability of agriculturally suitable lands.

(d) Implementing Action: Until standards and criteria to conserve and protect important agricultural lands are enacted by the Legislature, important agricultural lands should be classified in the State Agricultural District and zoned for agricultural use, except where, by the preponderance of the evidence presented, injustice or inequity will result or overriding public interest exists to provide such lands for other objectives of the Hawaii State plan.

CITY AND COUNTY OF HONOLULU
GENERAL PLAN, Objectives and Policies (Resolution No. 82-188)

Economic Activity

Objective C. To maintain the viability of agriculture on Oahu.

Policy 4. Provide sufficient agricultural land in Ewa, Central Oahu, and the North Shore to encourage the continuation of sugar and pineapple as viable industries.

Policy 5. Maintain agricultural land along the Windward, North Shore, and Waianae coasts for truck farming, flower growing, aquaculture, livestock production, and other types of diversified agriculture.

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APPENDIX I

ENVIRONMENTAL IMPACT

OF

FERTILIZER, HERBICIDE AND PESTICIDE USE

ON THE PROPOSED

PUNAMANO GOLF COURSE

A REPORT TO

Group 70

February 13, 1989

PREPARED BY

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I. INTRODUCTION

The development of the proposed Punamano golf course will require application of fertilizers to supply essential nutrients to turfgrasses and ornamental plants, and herbicides, fungicides and insecticides to control their associated weed, disease, and insect pests. These chemicals may be subject to movement from the site of application, either by runoff during high intensity storms, or by movement toward groundwater when water infiltration exceeds evapotranspiration (ET). The Punamano site is a relatively low-rainfall, high-ET area; high-intensity storms occur occasionally, resulting in runoff through drainage ways to the coast. In addition, irrigation in excess of ET may contribute water recharge to groundwater or runoff, thus irrigation management is an important determinant in the control of chemical movement.

This report provides an assessment of the anticipated environmental impact of chemicals applied to a golf course at this site, based on an analysis of site factors and recommended management practices.

II. APPROACH AND INFORMATION RESOURCES

Orientation to the project was provided by a site visit on December 21, 1988. A topographic map was provided by Group 70. Detailed soil descriptions and maps by Foote et al. (1972) were used for an assessment of the potential for pesticide retention at the site of application. Recommendations for fertilizer and pesticide use are based on local requirements and environmental conditions. Conclusions about pesticide behavior in soils and impact on the environment are based primarily on published information on pesticide properties, the resulting pesticide-soil interactions, and our experience with pesticide use in Hawaii.

III. ANALYSIS OF RELEVANT FACTORS WHICH MAY IMPACT ON CHEMICAL MOVEMENT

A. Site Factors

1. Topography, soils, geology

The project area consists of 605 acres located south of Kahuku Point, Oahu on the northern-most end of the Koolau Range. The northern side of the development is bounded by Kamehameha Highway at an elevation of 20 to 25 feet. This low-lying area extends southward several hundred yards where steep cliffs or steeply sloping lands are encountered, increasing in elevation to 100 to 300 feet in a few hundred yards. In the upland area the elevation is generally 100 to 200 feet, the landscape being somewhat segmented by two major drainage ways, Hoolapa and Kalaeokahipa gulches. Lowland areas consist of alluvial fans and talus slopes. Upland areas consist principally of alluvium and colluvium derived from basic igneous rock of the Koolau volcanic series; the northeast corner consists of an ancient coral outcrop with little soil development.

There are five principal soil series in the project area, as shown in the following list. The approximate percentage of the total area occupied by each soil type and also the slope range of each are indicated.

Soil Type	Soil mapping unit	Slope (%)	Percent of area
Lahaina silty clay loam	LaB	3-7	20
(Typic Torrox)	LaC	7-15	5
Paumalu silty clay	PeB	3-8	8
(Humoxic Tropohumults)	PeC	8-15	8
	PeD	15-25	5
	PeF	40-70	5
Kemoo silty clay	KpB	2-6	5
(Oxic Rhodustalfs)			
Kaena clay	KaB	2-6	10
(Typic Pelluderts)	KaC	6-12	3
Kaena stony clay	KaeC	6-12	3
Kaena very stony clay	KanF	10-35	3
Waialua silty clay	WkB	3-8	10
(Typic Haplustolls)			
Coral outcrop	CR		15

The Lahaina soil is generally well drained and has a good water holding capacity. Although it is deep at many locations, the presence of much coral outcrop at this site suggests that the Lahaina soil may be relatively shallow in some of the areas (e.g. one to two feet rather than several feet).

The Paumalu silty clay is found principally on moderate to steep slopes. The surface horizon is generally relatively shallow, but subsoils are 30 to 60 inches thick. The substratum is highly weathered gravel. Permeability is moderately rapid; runoff is medium and the erosion hazard is moderate.

The Kemoo series consists of well-drained soils developed in material weathered from basic igneous rock. Permeability is moderate to moderately rapid. Runoff is slow to medium and the erosion hazard is slight.

The Kaena series consists of very deep, poorly drained soils on alluvial fans and talus slopes. Permeability is slow, but runoff is generally slow because of the level landscapes where these soils occur.

The Waialua soil at this site is east of the Kaena soil in the low-lying area near Kamehameha Highway. In contrast to the Kaena soil, the Waialua soil is moderately well-drained.

With approximately 20% of the land area having slopes exceeding 15%, erosion hazard must be considered during land shaping operations.

The organic carbon content of surface horizons of all of the soils in the project area is relatively high, ranging from a low of about 2% for the Waialua silty clay to about 4% for the Paumalu soil in areas that have not suffered much erosion (Loague, et al., 1989). The presence of abundant soil organic matter in surface soils is significant in retarding pesticide leaching.

2. Climate and hydrology

Monthly median rainfall for the site varies from a low of 50 to 75 mm for the period May through July, to a high of about 150 to 175 mm in December and January (Giambelluca et al., 1986). Mean annual total precipitation for the area is approximately 1000 to 1500 mm (39 to 59 inches). Mean annual pan evaporation for the area is approximately 2000 to 2500 mm and ranges from a high of approximately 225 mm per month for the period June through August to a low of about 100 mm/month for November through January (Ekern and Chang, 1985). Thus, without irrigation and neglecting runoff there is a slight water deficit. The data indicate that unirrigated cropped or grassed areas providing a full canopy for ET would not contribute recharge to the groundwater aquifer. Because of the water deficit, vigorous turf could not be sustained without irrigation through the dry months.

B. Management Factors

1. Fertilizers

Fertilizers are applied to golf courses to supply those essential nutrients which are used in large amounts and which are deficient in most soils. In typical soils, the elements which are normally applied in a turfgrass fertilization program are nitrogen (N), phosphorus (P), and potassium (K). Fertilizers are normally applied to only the greens, tees, fairways, and part of the roughs of a golf course. Typical areas in each of these types of turf are estimated in the discussion below.

Turfgrasses use much more N than other elements. Based on turfgrass clipping composition, it has been shown that the turfgrasses grown in Hawaii use about twice as much N as K and about 4 times as much N as P.

The primary fertilizer elements of concern for contamination of ground and surface waters are nitrogen and phosphorus. Phosphorus is attached very tightly to soil clays and moves little if any from the site of application. Phosphorus,therefore will not cause any problem with contamination of drainage water. Ammonium nitrogen (NH_4) likewise moves little in soils. Nitrogen applied in the ammonium form, however, is rapidly converted to the nitrate form (NO_3) which is not bound to the soil and moves readily with water. Because of high nitrogen use rates by turfgrasses, however, nitrogen will be used rapidly after application. Only under conditions where rainfall occurs soon after application of a soluble nitrogen source would there be excessive loss by surface runoff or by leaching below the root zone. Thus nitrogen movement can be mitigated by applying a slow-release nitrogen fertilizer in which the nitrogen is in an insoluble form when applied.

Fertilizer use rates for the different golf course areas are shown in Table 1. Complete fertilizers (ones containing N, P, and K) are usually applied. Because nitrogen is applied in larger quantities and also because it is the only fertilizer element likely to cause contamination of ground or surface waters, only nitrogen application rates are given.

Table 1. Approximate fertilizer use rates for different areas of a 54-hole golf course in Hawaii.

Type of Turf	Area (acres)	Application rate (lbs. N/1000 ft2)	Application Freq. (weeks)	Total Annual Application (tons)
Greens	9	0.5	2 weeks	2.55
Tees	9	1.0	4 weeks	2.55
Fairways	150	1.5	8 weeks	31.85
Rough	80	1.0	3 months	6.97
Total	248			43.92

2. Pesticides

There are a number of weed, insect and disease pests of turfgrasses in Hawaii which sometimes require application of chemical pesticides. Pesticides are normally applied only in response to outbreaks of pests. There are few instances in which pesticides other than herbicides are applied in a regularly scheduled, preventative program. A typical pesticide program for golf courses in Hawaii is given in Table 2 below. There are several chemicals which may be substituted for certain ones in this suggested program. Properties of the chemicals listed in Table 2, as well as those of most chemicals used in turf in Hawaii, are given in Appendix Table 1.

Table 2. A typical pesticide program for a 54-hole golf course in Hawaii.

Turfgrass area	Area (acres)	Chemical	Frequency	Rate/application	Annual total
I. Herbicides					
A. Greens	9	MSMA	6 times/year	2 lb. ai/acre	108 lb. ai
		bensulide	2 times/year	12 lb ai/acre	216 lb. ai
B. Tees	9	MSMA	6 times/year	2 lb. ai./acre	108 lb. ai
		33 Plus	3 times/year	1 pint/acre	3.4 gallons
		bensulide	2 times/year	12 lb. ai./acre	216 lb. ai
C. Fairways	150	MSMA	6 times/year	2 lb. ai./acre	1,800 lb. ai
		33 Plus	3 times/year	1 pint/acre	56 gallons
		metribuzin	2 times/year	0.75 lb. ai/acre	225 lb. ai.
D. Perimeter areas	60	glyphosate	3 times/year	1.5 lb ai./acre	270 lb. ai.
II. Insecticides					
A. Greens	9	chlorpyrifos	As needed	1 lb. ai./acre	54 lb. ai.
B. Tees	9	chlorpyrifos	As needed	1 lb. ai. acre	54 lb. ai.
C. Fairways	Spot treatments	chlorpyrifos	As needed	1 lb. ai./acre	150 lb. ai.
III. Fungicides					
A. Greens	9	metalaxyl	As needed	1.3 lb. ai./acre	75 lb. ai.
		chlorothalonil	As needed	8 lb. ai./acre	216 lb. ai.
B. Tees	9	metalaxyl	As needed	1.3 lb. ai./acre	75 lb. ai.
		chlorothalonil	As needed	8 lb. ai./acre	216 lb. ai.
C. Fairways	Spot treatments	chlorothalonil	As needed	8 lb. ai./acre	750 lb. ai.

3. Irrigation

Because rainfall is not uniformly distributed throughout the year, all golf courses are irrigated to supplement rainfall. Golf courses usually have permanent sprinkler irrigation systems with sophisticated control systems. Many are computer controlled, so that each sprinkler head on the golf course can be adjusted to apply a selected amount of water on each cycle.

Because golf greens are constructed of sand (or primarily sand), the water holding capacity is less than for other areas containing soil. For this reason, golf greens must be watered more frequently than other areas.

Typical evapotranspiration rates for well-watered turf in Hawaii range from 0.1 to 0.3 inches per day, depending on temperature, the amount of sunlight, relative humidity, wind speed, the amount of available water in the soil, etc. Soils store approximately 0.5 to 2.5 inches of available water per foot of depth, depending on soil texture. Sands hold less, clays hold more. Irrigation should be applied when about one-half the available water has been used. The effective rooting depth for mown turf is approximately one foot. Therefore, turfgrasses will need to be watered every day to about once a week depending upon the type of soil and the water use rate. Amounts of water applied at each irrigation for the two 18-hole golf courses would be about 40,000 gal. for greens and 1,000,000 gals. for fairways.

Irrigation practices may have a large influence on the movement of soluble nitrogen fertilizers in soils. If excessive irrigation water is applied soon after application of soluble nitrogen sources, the likelihood of runoff or leaching of nitrogen below the root zone is increased. Because of the high cost of irrigation water, there is little incentive to over-water golf courses.

IV. ENVIRONMENTAL IMPACT OF CHEMICALS APPLIED TO THE PROPOSED GOLF COURSE

A. Groundwater and runoff

Recharge of groundwater from infiltration of rainfall in the development area will be minimal due to relatively low rainfall much of the year, high evapotranspiration most of the year, and high potential for runoff on steeply sloping areas which comprise about 20% of the land area at this site. The soils which dominate the area contain sufficient organic carbon (2% or more) in the surface horizon to retard movement of pesticides through the soil profile. Although the golf course will occupy almost all of the project area, the major portion of the developed area will be at elevations exceeding 100 feet above sea level. This great leaching distance will reduce the likelihood of pesticides reaching groundwater, as both degradation and dispersion reduce the concentration of any pesticide which may move below the root zone.

The area which might be impacted most by chemical application on the proposed golf course is the marsh land north of Kamehameha Highway. Both Hoolapa and Kalaeokahipa Gulches pass through the area to be developed and drain into the marshes. The soil in the marsh area is principally Pearl Harbor Clay (Typic Tropaquepts), a very low permeability clay soil underlain by muck or peat. The relatively poor drainage of this area plus water inputs from both surface runoff and groundwater seepage contribute to the maintenance of the wet condition of the marsh. Hydraulic heads of the aquifer in the marsh area are thought to be about 10 feet above mean sea level (K. Muranaka, personal communication); groundwater flux toward the ocean and the high water table should maintain the marsh water relatively free of salinity.

Groundwater and shoreline waters are not likely to be affected adversely by chemicals applied to the proposed golf courses; however, the marshes north of Kamehameha Highway, in and around James Campbell National Wildlife Refuge, are likely to receive runoff from the golf courses, thus the water in these marshes is more vulnerable to impact of transported chemicals than are coastal waters. Estimates of runoff rates from the developed onsite areas relative to existing offsite areas in the same watersheds (data from Engineering Concepts Inc., Jan. 1989) suggest that developed areas (616 acres) will contribute about 47% of the total runoff from the 1303 acre watershed in which the development is located. The approximate area to be treated with chemicals is about 250 acres (three 18-hole golf courses), which is less than 20% of the entire watershed in which the golf courses are located. While movement of applied chemicals in runoff from turfed areas is not considered a major problem under these conditions, caution should be exercised in applying the chemicals during the rainy season (November through February) when high rainfall intensity and duration might move recently applied chemicals, especially nitrogen fertilizer, to lowland areas in runoff.

B. Impact on Migratory Birds and Endangered Hawaiian Waterbirds.

The fertilizers, herbicides, and fungicides used in golf course maintenance pose little or no hazard to birds frequenting the grassed areas or ponds associated with golf courses. Fertilizers are relatively non-toxic unless ingested in large amounts. All herbicides and fungicides used in golf course maintenance in Hawaii are of low to moderate toxicity (Appendix Table 1). The only chemicals used in golf course maintenance in Hawaii which are highly toxic to birds are the organic phosphate insecticides, especially chlorpyrifos.

Although chlorpyrifos is highly toxic to birds, it is strongly adsorbed on the thatch layer of turf and moves little from the site of application. One reason for its weakness in controlling soil infesting insects is the inability to get the insecticide through the thatch layer to the depth needed to contact these insects. Recent studies (Sears and Chapman, 1980; Tashiro, 1980) have shown that chlorpyrifos applied to turfgrasses does not penetrate more than 2 to 3 centimeters in the soil. In addition to resistance to movement in the soil, it has been shown that it is rapidly degraded in the soil, both by hydrolysis and microbial action (Miles et al. 1979).

Because of the adsorption of organic phosphate insecticides on organic layers in turf and their rapid break down, there is little chance of their movement from grassed areas into the ponds associated with the proposed golf course. Label instructions for application of these pesticides (which turfgrass managers are required by law to follow) specifically prohibit their direct application to streams and ponds.

The likelihood of bird injury by pesticides used in maintenance of the proposed golf course can be reduced by proper application of pesticides with reduced toxicity to birds. The attached table shows that carbaryl and trichlorfon are less toxic to birds than chlorpyrifos. In most cases these insecticides may be substituted for chlorpyrifos with little loss of effectiveness.

Golf courses are excellent habitats for birds. As far as we are aware, there have been no reported incidents of bird kill in Hawaii from chemicals applied in golf course management. Waterfowl and fish appear to thrive in ponds and water hazards on golf courses in Hawaii. Many golf courses cultivate white amur fish in the ponds to control algae. Mosquito fish are generally stocked to prevent mosquito problems. We are aware of no incidents of fish or waterfowl injury from chemicals applied to golf courses.

The labeling of herbicides and pesticides for particular uses by EPA with strict laws (enforced by the Hawaii Department of Agriculture) for their use are perhaps the best assurance of protection of humans and wildlife from their hazards. All pesticides must be applied in compliance with federal and state laws regulating their use. Hazards to both humans and wildlife are included in the decision to label a pesticide for specific uses, including use on golf courses, and in developing regulations on allowable application procedures of the pesticide for various uses.

C. Impact on Air Quality.

Most herbicides and pesticides used on golf courses are of relatively low mammalian toxicity, ranging from hundreds to several thousand mg/kg body weight (Appendix Table 1). Because they are not highly volatile and are applied in dilute sprays (50 to 100 gallons of spray solution per acre) to open areas, there is little likelihood of volatility once the pesticides are applied. The greatest danger of significant airborne concentrations of pesticides is from aerial application. Golf course pesticides are applied with ground spray equipment. Boom height of spray equipment is less than one meter. Low spray pressures (20 to 40 psi) and coarse spray droplets further reduce the hazard of airborne fine droplets. Droplets larger than 100 micrometers diameter are not highly subject to drift. Most of the spray volume from typical flat-fan nozzles used in agricultural spray equipment is from droplets larger than 100 micrometers. At the low concentrations used in pesticide application, this would not result in significant quantities of pesticides being carried downwind. High wind speed would increase the likelihood of drift of fine spray droplets, however, because high wind speed distorts spray patterns and results in poor pesticide coverage; spraying in periods of high wind is not common practice. Even under high wind conditions (almost 10 mph) and spraying at 40 psi, 90% of the spray volume is applied within 17 feet from the nozzle (Hofman, et al., 1986).

To facilitate spray operations and to comply with label instructions of some pesticides, spray applications are only made in late afternoon or early morning hours when golfers are not on the golf course. This reduces the risk of exposure of people to airborne spray particles. Sufficient buffer space with tall vegetation between the golf course and housing sites and facilities (such as the clubhouse) which will be used by people will further reduce the chance of exposure to airborne pesticide particles.

The greatest danger of airborne pesticides is to the applicators of pesticides themselves. Mixing of wettable powder formulations and being in close proximity to airborne spray particles, particularly when operating spray equipment in a downwind position, places spray operators in particularly vulnerable positions.

EPA and OSHA have strict standards which specify that spray operators wear appropriate protective clothing and breathing apparatuses.

V. SUMMARY AND CONCLUSIONS

Fertilizers and pesticides applied to golf courses are not expected to contaminate groundwater except in situations where the groundwater level is near the soil surface (e.g. less than 10 feet deep), soils are permeable and low in organic matter, and water recharge from rainfall and irrigation is sufficient to carry chemicals through a shallow soil profile to groundwater. These conditions do not exist at the proposed Punamano Golf Course site. Similarly, contamination of shoreline waters by runoff requires that chemicals removed from greens and fairways by heavy rainfall soon after application be delivered in runoff water to the shoreline with little dilution by runoff and streamflow from contiguous areas in the watershed. This situation does not exist in the project area either, since the watershed contributing runoff to shoreline waters is large relative to the area to be developed. Also, most of the runoff in the major watersheds of the Kahuku area originates in higher-elevation mauka areas where rainfall is much greater. On the other hand, runoff from the project area is likely to pass into the marsh area north of the project location with less dilution than would be the case for shoreline waters. Nitrogen in the form of nitrate is the chemical most likely to move from the site of application because it is applied most heavily in turfgrass management and is highly water soluble.

The chemicals applied in golf course management pose little hazard for birds or wildlife. Fertilizers are relatively non-toxic unless ingested in large amounts. With the exception of chlorpyrifos, the pesticides are of low toxicity to birds.

There will be no significant adverse effects on air quality from application of herbicides or pesticides in golf course management provided that appropriate application techniques are used. The spray equipment used in golf course maintenance is ground-operated. Nozzle heights are typically less than 2 feet. Low spray pressures and coarse nozzle openings result in relatively large droplet sizes which are not highly subject to drift.

VI. RECOMMENDATIONS

- Irrigation management is critical to the conclusions reached above. For this reason we recommend that a U. S. Weather Bureau class A evaporation pan be used to measure evaporation and schedule irrigation application in the management of the proposed golf course. An excellent discussion of irrigation scheduling can be found in the book <u>Golf Course and Grounds Irrigation and Drainage</u> (Jarret, 1985).

- Where grading is necessary, topsoil should be stockpiled and replaced over the areas to which chemicals will be applied; the high-organic matter containing surface soils will retard pesticide movement.

- Judicious use of fertilizers and pesticides, especially in the early establishment of turf, is essential, since pesticides and nitrogen will be more likely to move before an extensive root system and thatch layer are developed.

- Slow-release nitrogen fertilizers should be used during the rainy season (November through February) to reduce the likelihood of nitrate-enriched runoff waters.

- Although we do not anticipate significant movement of applied chemicals in either leachate or runoff, a modest monitoring program of marshland waters seems appropriate. Since NO_3 from fertilizers is applied in largest amounts and it is the most mobile chemical used in golf course management, it would be the most logical chemical for which to test initially. Pre-development samples should be taken three times at one-to two-month intervals during the period, November through March to provide an adequate reference NO_3 level. If, after development of the golf course, NO_3 levels increase in the marshy areas, then analysis for selected pesticides should be initiated.

- As our conclusions are based on the assumption that sound management practices will be followed with regard to fertilizer and pesticide application and irrigation, we recommend that a qualified Golf Course Superintendent be given the responsibility of managing the golf course.

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APPENDIX

Appendix Table 1. Properties of pesticides used on turf in Hawaii.

Pesticide common name	Trade name (s)	Oral LD-50 (mg/kg body wt.)*	Toxicity to fish and wildlife*	Soil sorption index (Koc)**	Water solubility (mg/l)**	Half-life in soil (days)**	Surface loss potential**	Leaching potential**
I. Herbicides								
MSMA	WeedHoe etc.	1800	Low	10000	1000000	100	Large	Small
glyphosate	Roundup, Kleenup	150	Mod. to birds, none to fish	10000	1000000	30	Large	Small
metribuzin	Sencor	2200	Moderate	41	1220	30	Medium	Large
2,4-D	part of mixtures	370-700	High to fish	109	300000	10	Medium	Medium
mecoprop	ditto	700-1500	Low	3	660000	21	Small	Large
dicamba	ditto	1000-2000	Non toxic to fish	800000	800000	14	Small	Large
oryzalin	Surflan	10000	Mod. to birds, toxic to fish	2700	2.5	60	Large	Small
oxadiazon	Ronstar	8000	Toxic to fish		0.7			
propyzamide	Kerb	5620-8350	Low	990	15	30	Large	Small
simazine	Princep	>5000	Low	138	3.5	75	Medium	Large
chlorthal-dimethyl	Dacthal	>3000	Low	5000	0.5	30	Large	Small
bensulide	Betasan, Betamec	770	Mod. to fish	10000	25	60	Large	Small
parquat dichloride	Ortho Paraquat CL	150	Mod. to birds, none to fish	100000	1000000	3600	Large	Small
benfluralin	Balan	10000	Low to birds, high to fish	11000	0.1	30	Large	Small
II. Insecticides								
chloropyrofos	Dursban	135-163	High	6070	2	30	Large	Small
bendiocarb	Ficam	40-156	High					
carbaryl	Sevin	400-850	Moderate	229	40	7	Medium	Small
trichlorfon	Dylox	450-630	Moderate	2	154000	27	Small	Large
III. Fungicides								
anilazine	Dyrene	<5000	Low	3000	10	1	Small	Small
benomyl	Benlate	9590	Low	2100	2	100	Large	Small
chlorothalonil	Daconil 2787	>10000	Low to birds, mod. to fish	1380	0.6	20	Large	Small
iprodione	Chipco 26019 RP	3500	Low	500	13	20	Medium	Small
mancozeb	Dithane M-45	>8000	Low	1000	0.5	35	Large	Small
qunitozone	PCNB, Terrachlor	12000	Non-toxic	1000	0.44	21	Large	Small
thiram	Tersan	7500	Low	383	30	20	Medium	Medium
triadimefon	Bayleton	568	Low	273	260	21	Medium	Medium
metalaxyl	Subdue	669	Non-toxic	16	7100	7	Small	Medium
thiophanate-methyl	Cleary 3336	7500	Low	1000	3.5	0	Small	Small

*From: Hartley, Douglas and Hamish Kidd (Eds.) 1983. The Agrochemicals Handbook. Unwin Bros., Ltd. Old Working., Surrey, England.

**From: Wauchope, R. D. 1988. U. S. D. A.-ARS Interim Pesticide Properties Database, Version 1.0. Unpublished

Appendix Table 2. Toxicity classes of pesticides.

Class	Description	Warning Statement	Oral LD50
1	Highly Toxic	Poison, Skull & Crossbones	1-50
2	Moderately Toxic	Danger	51-500
3	Low Toxicity	Warning	500-5,000
4	Very Low Toxicity	Caution	>5,000

APPENDIX J

ENVIRONMENTAL IMPACT

OF

FERTILIZER, HERBICIDE AND PESTICIDE USE

ON THE PROPOSED

MALAEKAHANA GOLF COURSE

A REPORT TO

Group 70

January 30, 1989

PREPARED BY

Charles L. Murdoch, Ph. D

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I. INTRODUCTION

The development of the proposed Malaekahana golf course will require application of fertilizers to supply essential nutrients to turfgrasses and ornamental plants, and herbicides, fungicides and insecticides to control their associated weed, disease, and insect pests. These chemicals may be subject to movement from the site of application, either by runoff during high intensity storms, or by movement toward groundwater when water infiltration exceeds evapotranspiration (ET). The Malaekahana site is a relatively low-rainfall, high-ET area; high-intensity storms occur occasionally, resulting in runoff through drainage ways to the coast. In addition, irrigation in excess of ET may contribute water recharge to groundwater or runoff, thus irrigation management is an important determinant in the control of chemical movement.

This report provides an assessment of the anticipated environmental impact of chemicals applied to a golf course at this site, based on an analysis of site factors and recommended management practices.

II. APPROACH AND INFORMATION RESOURCES

Orientation to the project was provided by a site visit on December 21, 1988. A topographic map was provided by Group 70. Detailed soil descriptions and maps by Foote et al. (1972) were used for an assessment of the potential for pesticide retention at the site of application. Recommendations for fertilizer and pesticide use are based on local requirements and environmental conditions. Conclusions about pesticide behavior in soils and impact on the environment are based primarily on published information on pesticide properties, the resulting pesticide-soil interactions, and our experience with pesticide use in Hawaii.

III. ANALYSIS OF RELEVANT FACTORS WHICH MAY IMPACT ON CHEMICAL MOVEMENT

A. Site Factors

1. Topography, soils, geology

The project area is located on the northeast slopes of the Koolau mountains on Oahu, just west of Laie Bay. The east boundary of the area to be developed (not including the entry road) is about one-half mile from the coastline. The soil map which includes the area is on sheet number 47 in Foote et al. (1972). The proposed area of the development is about 228 acres. The elevation varies from a minimum of about 25 feet at the east boundary to a maximum of 375 feet at the west boundary. The topography is undulating throughout. No major streams dissect the parcel itself, but the general area is bounded by Malaekehana Stream to the north and Kahawainui Stream to the south. Both of these streams drain to the coastline, the former into Malaekehana Bay and the latter into Laie Bay.

The soils are formed principally from alluvium and colluvium derived from basic igneous rock of the Koolau volcanic series. The major soil series are Lahaina silty clay on the ridges and gentle slopes of the east end (toward the ocean) and Paumalu silty clay at the higher elevations on the west side. Both soils generally have organic carbon contents of 2% or higher in the surface horizon. Interspersed between parcels of the Lahaina soil series at elevations up to about 200 feet are fairly extensive areas of "coral outcrop", a sandstone which apparently developed from coral sands deposited during a period when the ocean was at a much higher level. The coral outcrop areas are expected to have low permeability and little potential for vegetation.

The Lahaina soil is classified as clayey, kaolinitic, isohyperthermic Typic Torrox. This soil is generally well drained and has a good water holding capacity. Although it is deep at many locations, the presence of much coral outcrop at this site suggests that the Lahaina soil may be relatively shallow in some of the area (e.g. one to two feet rather than several feet).

The Paumalu silty clay is classified clayey, oxidic, isothermic Humoxic Tropohumults. These soils are found principally on moderate to steep slopes. The surface horizon is generally relatively shallow, but subsoils are 30 to 60 inches thick. The substratum is highly weathered gravel. Permeability is moderately rapid; runoff is medium and the erosion hazard is moderate.

The approximate percentage of the total land area in the project area occupied by each soil mapping unit and the slope are as follows:

Soil mapping unit	Map symbol	% Slope	Percent of Area
Lahaina Silty clay loam	LaB	3-7	15
	LaC	7-15	20
Paumalu silty clay loam	PeB	3-8	10
	PeD	15-25	5
	PeE	25-40	15
Paumalu Badland cmplx.	PZ		15
Coral outcrop	CR		20

With over 50% of the land area having slopes exceeding 15%, erosion hazard must be considered during land shaping operations.

2. Climate and hydrology

Monthly median rainfall for the site varies from a low of 25 to 50 mm for the period May through September, to a high of about 125 to 150 mm in December and January (Giambelluca et al., 1986). Mean annual total precipitation for the area is approximately 1000 to 1500 mm (39 to 59 inches). Mean annual pan evaporation for the area is approximately 1700 to 2000 mm and ranges from a high of approximately 200 mm per month for the period June through August to a low of about 75 mm/month for November through January (Ekern and Chang, 1985). Thus, without irrigation and neglecting runoff there is a slight water deficit. The data indicate that unirrigated cropped or grassed areas providing a full canopy for ET would not contribute recharge to the groundwater aquifer. Because of the water deficit, vigorous turf could not be sustained without irrigation through the dry months.

B. Management Factors

1. Fertilizers

Fertilizers are applied to golf courses to supply those essential nutrients which are used in large amounts and which are deficient in most soils. In typical soils, the elements which are normally applied in a turfgrass fertilization program are nitrogen (N), phosphorus (P), and potassium (K). Fertilizers are normally applied to only the greens, tees, fairways, and part of the roughs of a golf course. Typical areas in each of these types of turf are estimated in the discussion below.

Turfgrasses use much more N than other elements. Based on turfgrass clipping composition, it has been shown that the turfgrasses grown in Hawaii use about twice as much N as K and about 4 times as much N as P.

The primary fertilizer elements of concern for contamination of ground and surface waters are nitrogen and phosphorus. Phosphorus is attached very tightly to soil clays and moves little if any from the site of application. Phosphorus, therefore will not cause any problem with contamination of drainage water. Ammonium nitrogen (NH_4) likewise moves little in soils. Nitrogen applied in the ammonium form, however, is rapidly converted to the nitrate form (NO_3) which is not bound to the soil and moves readily with water. Because of high nitrogen use rates by turfgrasses, however, nitrogen will be used rapidly after application. Only under conditions where rainfall occurs soon after application of a soluble nitrogen source would there be excessive loss by surface runoff or by leaching below the root zone. Thus nitrogen movement can be mitigated by applying a slow-release nitrogen fertilizer in which the nitrogen is in an insoluble form when applied.

Fertilizer use rates for the different golf course areas are shown in Table 1. Complete fertilizers (ones containing N, P, and K) are usually applied. Because nitrogen is applied in larger quantities and also because it is the only fertilizer element likely to cause contamination of ground or surface waters, only nitrogen application rates are given.

Table 1. Approximate fertilizer use rates for different areas of an 18 hole golf course in Hawaii.

Type of Turf	Area (acres)	Application rate (lbs. N/1000 ft2)	Application Freq. (weeks)	Total Annual Application (tons)
Greens	3	0.5	2 weeks	0.85
Tees	3	1.0	4 weeks	0.85
Fairways	50	1.5	8 weeks	10.63
Rough	30	1.0	3 months	2.60
Total	86			14.93

2. Pesticides (including herbicides)

There are a number of weed, insect and disease pests of turfgrasses in Hawaii which sometimes require application of chemical pesticides. Pesticides are normally applied only in response to outbreaks of pests. There are few instances in which pesticides other than herbicides are applied in a regularly scheduled, preventative program. A typical pesticide program for golf courses in Hawaii is given in Table 2 below. There are several chemicals which may be substituted for certain ones in this suggested program. Properties of the chemicals listed in Table 2, as well as those of most chemicals used in turf in Hawaii, are given in Appendix Table 1.

Table 2. A typical pesticide program for an 18 hole golf course in Hawaii.

Turfgrass area	Area (acres)	Chemical	Frequency	Rate/application	Annual total
I. Herbicides					
A. Greens	3	MSMA	6 times/year	2 lb. ai/acre	36 lb. ai
		bensulide	2 times/year	12 lb ai/acre	72 lb. ai
B. Tees	3	MSMA	6 times/year	2 lb. ai./acre	36 lb. ai
		33 Plus	3 times/year	1 pint/acre	9 pints
		bensulide	2 times/year	12 lb. ai./acre	72 lb. ai
C. Fairways	50	MSMA	6 times/year	2 lb. ai./acre	600 lb. ai
		33 Plus	3 times/year	1 pint/acre	19 gallons
		metribuzin	2 times/year	0.75 lb. ai/acre	75 lb. ai.
D. Perimeter areas	20	glyphosate	3 times/year	1.5 lb ai./acre	90 lb. ai.
II. Insecticides					
A. Greens	3	chlorpyrifos	As needed	1 lb. ai./acre	18 lb. ai.
B. Tees	3	chlorpyrifos	As needed	1 lb. ai. acre	18 lb. ai.
C. Fairways	Spot treatments	chlorpyrifos	As needed	1 lb. ai./acre	50 lb. ai.
III. Fungicides					
A. Greens	3	metalaxyl	As needed	1.3 lb. ai./acre	25 lb. ai.
		chlorothalonil	As needed	8 lb. ai./acre	72 lb. ai.
B. Tees	3	metalaxyl	As needed	1.3 lb. ai./acre	25 lb. ai.
		chlorothalonil	As needed	8 lb. ai./acre	72 lb. ai.
C. Fairways	Spot treatments	chlorothalonil	As needed	8 lb. ai./acre	250 lb. ai.

3. Irrigation

Because rainfall is not uniformly distributed throughout the year, all golf courses are irrigated to supplement rainfall. Golf courses usually have permanent sprinkler irrigation systems with sophisticated control systems. Many are computer controlled, so that each sprinkler head on the golf course can be adjusted to apply a selected amount of water on each cycle.

Because golf greens are constructed of sand (or primarily sand), the water holding capacity is less than for other areas containing soil. For this reason, golf greens must be watered more frequently than other areas.

Typical evapotranspiration rates for well-watered turf in Hawaii range from 0.1 to 0.3 inches per day, depending on temperature, the amount of sunlight, relative humidity, wind speed, the amount of available water in the soil, etc. Soils store approximately 0.5 to 2.5 inches of available water per foot of depth, depending on soil texture. Sands hold less, clays hold more. Irrigation should be applied when about one-half the available water has been used. The effective rooting depth for mown turf is approximately one foot. Therefore, turfgrasses will need to be watered every day to about once a week depending upon the type of soil and the water use rate. Amounts of water applied at each irrigation are about 20,000 gal. for greens and 500,000 gals. for fairways.

Irrigation practices may have a large influence on the movement of soluble nitrogen fertilizers in soils. If excessive irrigation water is applied soon after application of soluble nitrogen sources, the chances for runoff or leaching of nitrogen below the root zone is increased. Because of the high cost of irrigation water, there is little incentive to over-water golf courses.

IV. ENVIRONMENTAL IMPACT OF CHEMICALS APPLIED TO THE PROPOSED GOLF COURSE

A. Groundwater and runoff

Recharge of groundwater from infiltration of rainfall in the development area will be minimal due to relatively low rainfall much of the year, high evapotranspiration most of the year, and high potential for runoff on steeply sloping areas which comprise about 50% of the land area at this site. The two soils which dominate the area (Lahaina and Paumalu) contain sufficient organic carbon (1-2%) in the surface horizon to retard movement of pesticides through the soil profile. Although the golf course will occupy almost all of the project area, the major portion of the developed area will be at elevations exceeding 100 feet above sea level. This long leaching distance will reduce the likelihood of pesticides reaching groundwater, as both degradation and dispersion reduce the concentration of any pesticide which may move below the root zone.

The potential for runoff and erosion from high-slope areas is high during winter months while land-shaping operations are in progress. However, fertilizer and pesticide use will be minimal during this period. After establishment of healthy turf, runoff will be no greater than under existing pasture management and probably less, due to the absence of compaction from livestock traffic. Since the project area is a small part of a much larger watershed which will contribute runoff to Malaekehana and Kahawainui Streams, the fertilizer and pesticide chemicals which may be carried in runoff from the golf course will be highly diluted by water from surrounding areas, especially undeveloped mauka areas receiving higher rainfall. Even so, it is advisable to apply fertilizers and pesticides judiciously during the winter months when high rainfall over brief periods of time may intensify removal of recently applied chemicals in runoff.

In general, a properly developed and managed golf course should not represent a threat to the quality of either groundwater or shoreline waters in the Laie-Malaekahana area. The proposed development area is small relative to the entire watershed, thus its contribution to both groundwater and runoff will be minimal.

B. Impact on Migratory Birds and Endangered Hawaiian Waterbirds.

The fertilizers, herbicides, and fungicides used in golf course maintenance pose little or no hazard to birds frequenting the grassed areas or ponds associated with golf courses. Fertilizers are relatively non-toxic unless ingested in large amounts. All herbicides and fungicides used in golf course maintenance in Hawaii are of low to moderate toxicity (Appendix Table 1). The only chemicals used in golf course maintenance in Hawaii which are highly toxic to birds are the organic phosphate insecticides, especially chlorpyrifos.

Although chlorpyrifos is highly toxic to birds, it is strongly adsorbed on the thatch layer of turf and moves little from the site of application. One reason for its weakness in controlling soil infesting insects is the inability to get the insecticide through the thatch layer to the depth needed to contact these insects. Recent studies (Sears and Chapman, 1980; Tashiro, 1980) have shown that chlorpyrifos applied to turfgrasses does not penetrate more than 2 to 3 centimeters in the soil. In addition to resistance to movement in the soil, it has been shown that it is rapidly degraded in the soil, both by hydrolysis and microbial action (Miles et al. 1979).

Because of the adsorption of organic phosphate insecticides on organic layers in turf and their rapid break down, there is little chance of their movement from grassed areas into the ponds associated with the proposed golf course. Label instructions for application of these pesticides (which turfgrass managers are required by law to follow) specifically prohibit their direct application to streams and ponds.

The likelihood of bird injury by pesticides used in maintenance of the proposed golf course can be reduced by proper application of pesticides with reduced toxicity to birds. The attached table shows that carbaryl and trichlorfon are less toxic to birds than chlorpyrifos. In most cases these insecticides may be substituted for chlorpyrifos with little loss of effectiveness.

Golf courses are excellent habitats for birds. As far as we are aware, there have been no reported incidents of bird kill in Hawaii from chemicals applied in golf course management. Waterfowl and fish appear to thrive in ponds and water hazards on golf courses in Hawaii. Many golf courses cultivate white amur fish in the ponds to control algae. Mosquito fish are generally stocked to prevent mosquito problems. We are aware of no incidents of fish or waterfowl injury from chemicals applied to golf courses.

The labeling of herbicides and pesticides for particular uses by EPA with strict laws (enforced by the Hawaii Department of Agriculture) for their use are perhaps the best assurance of protection of humans and wildlife from their hazards. All pesticides must be applied in compliance with federal and state laws regulating their use. Hazards to both humans and wildlife are included in the decision to label a pesticide for specific uses, including use on golf courses, and in developing regulations on allowable application procedures of the pesticide for various uses.

C. Impact on Air Quality.

Most herbicides and pesticides used on golf courses are of relatively low mammalian toxicity, ranging from hundreds to several thousand mg/kg body weight (Appendix Table 1). Because they are not highly volatile and are applied in dilute sprays (50 to 100 gallons of spray solution per acre) to open areas, there is little likelihood of volatility once the pesticides are applied. The greatest danger of significant airborne concentrations of pesticides is from aerial application. Golf course pesticides are applied with ground spray equipment. Boom height of spray equipment is less than one meter. Low spray pressures (20 to 40 psi) and coarse spray droplets further reduce the hazard of airborne fine droplets. Droplets larger than 100 micrometers diameter are not highly subject to drift. Figure 1 below illustrates the effect of spray droplet size on spray drift.

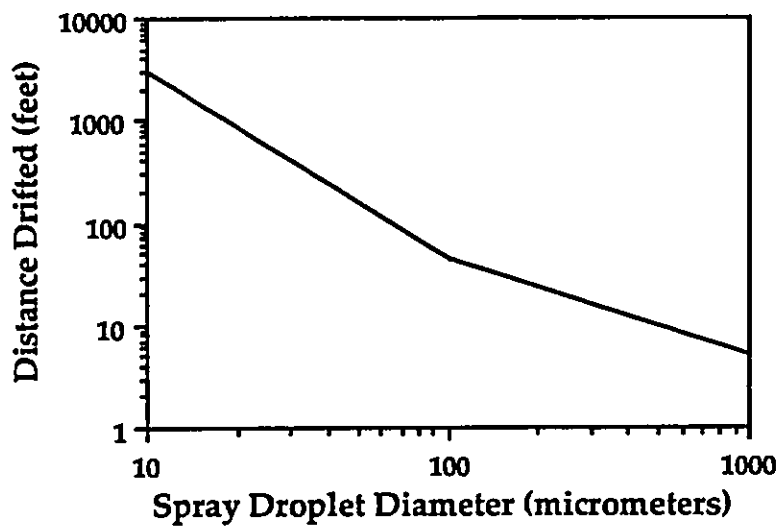

Figure 1. Relationship between spray droplet size and spray drift based on droplets falling 10 feet in a 3 MPH wind (from Hofman et al. 1986).

Most of the spray volume from typical flat-fan nozzles used in agricultural spray equipment is from droplets larger than 100 micrometers. Table 3 below shows a typical distribution of droplet sizes for a flat-fan nozzle (the type used in most golf course spray equipment).

Table 3. Droplet size range for a typical flat-fan nozzle at 20 and 40 psi. (from Hofman et al., 1986)

Droplet size range (microns)	Percent of spray volume 20 psi	40 psi
0-21	0.1	0.4
21-63	3.0	10.4
63-105	10.7	20.1
105-147	16.2	25.4
147-210	36.7	35.3
210-294	27.5	7.7
>294	5.8	0.7

At the low concentrations used in pesticide application, this would not result in significant quantities of pesticides being carried downwind. High wind speed would increase the likelihood of drift of fine spray droplets, however, because high wind speed distorts spray patterns and results in poor pesticide coverage; spraying in periods of high wind is not common practice. Table 4 below shows the percent of spray application volume deposited at 4 and 8 feet downwind and the distance downwind for the volume to drop to 1% or below for flat-fan nozzles under different conditions. Even under high wind conditions (almost 10 mph) and spraying at 40 psi, the distance downwind at which 1% or less of the total spray volume was deposited was only 17 feet.

Table 4. Percent of spray volume deposited at 4 and 8 feet downwind and the distance in feet for the volume of spray solution to drop to 1% of the total spray volume (from Hofman et al., 1986).

Nozzle ht. (in.)	Pressure (psi)	Wind speed (mph)	Percent deposited 4 ft.	Percent deposited 8 ft.	Distance to drop to 1% of volume
14	40	3.5	3.1	0.6	7.0
27	40	3.5	5.9	1.5	13.0
18	30	5.3	9.3	2.2	14.0
18	25	9.9	10.3	3.1	15.5
18	40	9.9	9.1	3.6	17.0

To facilitate spray operations and to comply with label instructions of some pesticides, spray applications are only made in late afternoon or early morning hours when golfers are not on the golf course. This reduces the risk of exposure of people to airborne spray particles. Sufficient buffer space with tall vegetation between the golf course and housing sites and facilities (such as the clubhouse) which will be used by people will further reduce the chance of exposure to airborne pesticide particles.

The greatest danger of airborne pesticides is to the applicators of pesticides themselves. Mixing of wettable powder formulations and being in close proximity to airborne spray particles, particularly when operating spray equipment in a downwind position, places spray operators in particularly vulnerable positions. EPA and OSHA have strict standards which specify that spray operators wear appropriate protective clothing and breathing apparatuses.

V. SUMMARY AND CONCLUSIONS

The proposed site for development of a golf course is situated in the foothills of the Koolau mountains near Laie. The golf course would occupy a ridge extending toward the coast from an elevation of about 375 feet at the highest point. Although about 50 percent of the land area is steeply sloping and thus would contribute substantial runoff during heavy rain storms, the areas to be treated with chemicals (fairways and greens) are generally in more level areas and thus would not likely contribute much to total runoff from the entire area. Additionally, the developed area will be a small fraction of the total watershed which will contribute runoff to local streams. Thus runoff from treated turf areas in the proposed development is not expected to adversely impact the quality of coastal waters.

Leaching of pesticide chemicals to groundwater is not expected to be a concern because of the organic carbon content (2% or greater) of the surface soils and relatively great depths to groundwater (generally more than 100 feet). Natural recharge is negligible in this area and the pesticides used are highly sorbed and/or rapidly degraded under moist soil conditions.

The chemicals applied in golf course management pose little hazard for birds or wildlife. Fertilizers are relatively non-toxic unless ingested in large amounts. With the exception of chlorpyrifos, the pesticides are of low toxicity to birds.

There will be no significant adverse effects on air quality from application of herbicides or pesticides in golf course management provided that appropriate application techniques are used. The spray equipment used in golf course maintenance is ground-operated. Nozzle heights are typically less than 2 feet. Low spray pressures and coarse nozzle openings result in relatively large droplet sizes which are not highly subject to drift.

VI. RECOMMENDATIONS

- Irrigation management is critical to the conclusions reached above. For this reason we recommend that a U. S. Weather Bureau class A evaporation pan be used to measure evaporation and schedule irrigation application in the management of the proposed golf course. Excellent discussion of irrigation scheduling can be found in the book Golf Course and Grounds Irrigation and Drainage (Jarret, 1985).

- Where grading is necessary, topsoil should be stockpiled and replaced over the areas to which chemicals will be applied; the high-organic matter containing surface soils will retard pesticide movement.

- Judicious use of fertilizers and pesticides, especially in the early establishment of turf, is essential, since pesticides and nitrogen will be more likely to move before an extensive root system and thatch layer are developed.

- As our conclusions are based on the assumption that sound management practices will be followed with regard to fertilizer and pesticide application and irrigation, we recommend that a qualified Golf Course Superintendent be given the responsibility of managing the golf course.

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APPENDIX

Appendix Table 1. Properties of pesticides used on turf in Hawaii.

Pesticide common name	Trade name (s)	Oral LD-50 (mg/kg body wt.)*	Toxicity to fish and wildlife*	Soil sorption index (Koc)**	Water solubility (mg/l)**	Half-life in soil (days)**	Surface loss potential**	Leaching potential**
I. Herbicides								
MSMA	WeedHoe etc.	1800	Low	10000	1000000	100	Large	Small
glyphosate	Roundup, Kleenup	150	Mod. to birds, none to fish	10000	1000000	30	Large	Small
metribuzin	Sencor	2200	Moderate	41	1220	30	Medium	Large
2,4-D	part of mixtures	370-700	High to fish	109	300000	10	Medium	Medium
mecoprop	ditto	700-1500	Low	3	660000	21	Small	Large
dicamba	ditto	1000-2000	Non toxic to fish	800000	800000	14	Small	Large
oryzalin	Surflan	10000	Mod. to birds, toxic to fish	2700	2.5	60	Large	Small
oxadiazon	Ronstar	8000	Toxic to fish		0.7			
propyzamide	Kerb	5620-8350	Low	990	15	30	Large	Small
simazine	Princep	>5000	Low	138	3.5	75	Medium	Large
chlorthal-dimethyl	Dacthal	>3000	Low	5000	0.5	30	Large	Small
bensulide	Betasan, Betamec	770	Mod. to fish	10000	25	60	Large	Small
parqual dichloride	Ortho Paraquat CL	150	Mod. to birds, none to fish	100000	1000000	3600	Large	Small
benfluralin	Balan	10000	Low to birds, high to fish	11000	0.1	30	Large	Small
II. Insecticides								
chloropyrofos	Dursban	135-163	High	6070	2	30	Large	Small
bendiocarb	Ficam	40-156	High					
carbaryl	Sevin	400-850	Moderate	229	40	7	Medium	Small
trichlorfon	Dylox	450-630	Moderate	2	154000	27	Small	Large
III. Fungicides								
anilazine	Dyrene	<5000	Low	3000	10	1	Small	Small
benomyl	Benlate	9590	Low	2100	2	100	Large	Small
chlorothalonil	Daconil 2787	>10000	Low to birds, mod. to fish	1380	0.6	20	Large	Small
iprodione	Chipco 26019 RP	3500	Low	500	13	20	Medium	Small
mancozeb	Dithane M-45	>8000	Low	1000	0.5	35	Large	Small
qunitozone	PCNB, Terrachlor	12000	Non-toxic	1000	0.44	21	Large	Small
thiram	Tersan	7500	Low	383	30	20	Medium	Medium
triadimefon	Bayleton	568	Low	273	260	21	Medium	Medium
metalaxyl	Subdue	669	Non-toxic	16	7100	7	Small	Medium
thiophanate-methyl	Cleary 3336	7500	Low	1000	3.5	0	Small	Small

*From: Hartley, Douglas and Hamish Kidd (Eds.) 1983. The Agrochemicals Handbook. Unwin Bros., Ltd. Old Working., Surrey, England.

**From: Wauchope, R. D. 1988. U. S. D. A.-ARS Interim Pesticide Properties Database, Version 1.0. Unpublished

Appendix Table 2. Toxicity classes of pesticides.

Class	Description	Warning Statement	Oral LD50
1	Highly Toxic	Poison, Skull & Crossbones	1-50
2	Moderately Toxic	Danger	51-500
3	Low Toxicity	Warning	500-5,000
4	Very Low Toxicity	Caution	>5,000

APPENDIX K

PUNAMANO PROJECT

KAHUKU, OAHU

BOTANICAL SURVEY

Prepared for: Group 70

By: Kenneth M. Nagata

Date: 18 March 1989

INTRODUCTION

The project site is located in the north end of Koolauloa District, Oahu in the lands of Kahuku, Punalau, Ulupehupehu, Oio and Anakaoe, mauka of Kamehameha Highway. It encompasses approximately 640 acres and is bordered by Kamehameha Highway on the makai end and abandoned sugar cane fields and secondary vegetation on the mauka side. Agricultural fields and truck farms define its boundaries along the highway. Elevation ranges from 30 to 300 feet.

The vegetation of the region has been classified into two zones by Ripperton and Hosaka (1942). The lowlands along Kamehameha Highway lie within their Zone B which is characterized by xerophytic shrubs with scattered trees in the upper part. Prominent species in this zone include lantana (*Lantana camara*), cactus (*Opuntia megacantha*), and koa-haole (*Leucaena leucocephala*) which often forms dense thickets 10-15 feet tall. Smaller shrubs and annuals such as 'ilima (*Sida fallax*), 'uhaloa (*Waltheria americana*), partridge pea (*Cassia leschenaultiana*), Spanish needle (*Bidens pilosa*), false mallow (*Malvastrum coromandelianum*) and cocklebur (*Xanthium saccharatum*) are abundant in this zone. Above this but where the annual rainfall is still less than 60 inches the vegetation grades into their Zone C, low phase which consists of mixed open forests, shrubs and grasses. Lantana and koa-haole continue to be the dominant shrubs along with guava (*Psidium guajava*) and many of the smaller shrubs common in Zone B are also common in this zone. Grasses such as Bermuda (*Cynodon dactylon*), Natal red top (*Rhyche-letrum repens*) and sourgrass (*Tricachne insularis*) are also characteristic of this zone. Spanish needle, garden spurge

(*Euphorbia hirta*), pigweed (*Portulaca oleracea*) and dandelion (*Taraxacum officinale*) proliferate in cultivated areas.

More recent botanical surveys have also documented the vegetation in the region. Nine vegetation types were identified in the Kahuku Agricultural Park and in the surrounding area which includes a portion of the present project site (State of Hawaii, 1984). The vegetation in the lowlands along Kamehameha Highway was found to consist largely of cultivated crops and stands of koa-haole, Christmas berry (*Schinus terebinthifolius*) or Java plum (*Eugenia cumini*), and Paragrass (*Brachiaria mutica*). The upland vegetation was found to be largely secondary and dominated by abandoned sugar cane fields and koa-haole. Guava, Java plum, Christmas berry, *Macaranga tanarius*, Paragrass, sourgrass and molassasgrass (*Melinis minutiflora*) were common in these uplands. Small pockets of native scrub vegetation dominated by 'ūlei (*Osteomeles anthyllidifolia*) were found on the larger ridges and knolls which had not been planted with sugar cane. Two Category 1 Endangered Species candidates were found during that survey. Several individuals of 'ili-ahi-a-lo'e (*Santalum ellipticum* var. *littorale*) were discovered on a hill just behind Kahuku Village and a single individual of *Capparis sandwichiana* var. *sandwichiana* was located on the limestone outcrops along the highway across Tanaka Store.

The lowland vegetation in the region is well-known. The lower slopes of the bluffs in the Kawela-Anakaoe area are dominated by scrubby Christmas berry, koa-haole and Guinea grass (*Panicum maximum*) (C & C of Honolulu, 1988). Near the foot of the slopes the Christmas berry and koa-haole may become extremely dense and reach heights of 20 feet and Guinea grass and Paragrass form dense mats 3-7 feet deep. The remainder of the lowlands are dominated by Johnson grass (Sorghum halepense).

METHODS

Walk-through surveys with approximately 75% coverage were conducted during the weeks of 19 December and 26 December, 1988 and single days during January and February, 1989 to determine the floristic composition of the project site. Prior to field investigations, recent aerial photographs were examined and tentative vegetation zones were delineated. Transects were established through the zones and their distribution and boundaries were confirmed by ground check. Special emphasis was given to limestone formations and to steep slopes which had not been planted in sugar cane. Collections were made of plants which could not be identified in the field for later determination in the laboratory.

RESULTS

The vegetation in the site closely resembles that described by prior surveys in the region (State of Hawaii, 1984; C & C of Honolulu, 1988). The drainages and portions of the lowlands are dominated by dense nearly uniform stands of koa-haole and the lowlands along the highway by a mixed association of Johnson grass, Paragrass and Guinea grass and shrubs. Judging by the distribution of irrigation ditches and contour furrows it seems that most of the uplands with the exception of the steepest topographic features had been planted in sugar cane at one time or another. Today except for a few remnants these cane fields have been replaced by mixed thickets of koa-haole, Christmas berry, guava and Macaranga tanarius or by

Paragrass. Several large sections of sugar cane appear to have been cleared and re-graded and put into other crops. These fields are now overgrown by various weedy species such as Guinea grass, kao-haole, *Bidens alba* var. *radiata*, virgate mimosa (*Desmanthus virgatus*) and sensitive plant (*Mimosa pudica* var. *unijuga*).

Scrub vegetation characterized by the native 'ūlei is found on ridge crests that are too narrow and steep for agriculture. The windswept conditions have resulted in a characteristic, low-statured community of 'ūlei, various grasses, and dwarfed koa-haole and Christmas berry shrubs. Slopes that are too steep for cultivation are dominated by mixed thickets of koa-haole, Christmas berry and guava or by Guinea grass. Chinese banyan (*Ficus microcarpa*) and Port Jackson fig (*Ficus rubiginosa*) which were planted in the steepest areas presumably for slope stablization have become naturalized.

Seven broad vegetation types were identified in the project site and are discussed in the following paragraphs. These are illustrated with distinct boundaries in the accompanying vegetation map but it must be noted that in nature no sharp boundaries exist. Rather, vegetation occurs as a continuum with one type grading into another.

Mixed Thickets (MT)

Most of the abandoned cane fields have been replaced by mixed thickets of koa-haole, Christmas berry, guava and *Macaranga* 10-20 feet tall. In some areas the canopy cover is dense enough to preclude the development of any significant understory. In these situations the herb and shrub layers consist of scattered koa-haole seedlings and poorly developed grasses such as Paragrass and sourgrass, and few vines of huehue-haole (Passiflora suberosa). In other areas the understory is choked with Paragrass which climbs into the koa-haole to heights of up to 10 feet. A well-developed understory situation may also involve an abundance of asystasia (Asystasia gangetica), Guinea grass, sourgrass, Bidens alba var. radiata and huehue-haole.

Dense stands of Christmas berry and ironwood are found in this community. The understory in these groves is almost non-existent. Also included in the Mixed Thickets are numerous small pockets of sugar cane that are too small to be feasibly mapped. These remnants are gnerally invaded by Paragrass or Guinea grass or by Christmas berry and guava.

Mixed Thickets are also found in the steeper slopes which have not been planted in sugar cane. Port Jackson fig, Chinese banyan and ironwood (Casuarina equisetifolia) have been planted on some of these slopes and most of the cliffs in the project site. Although canopy cover is rather dense in this vegetation type, sunny sites provided by remnant sugar cane and by roadways are also found. Common wayside species such as hairy horseweed (Erigeron bonariensis), three-flowered beggarweed (Desmodium triflorum), Bidens alba var. radiata, West Indian dropseed (Sporobolus indicus), radiate finergrass (Chloris radiata), feather fingergrass (C. virgata), Bermuda grass and partridge pea occur in these situations.

Mixed Thickets is the dominant vegetation type in the uplands and one of the two largest in the project site.

Koa-Haole Thicket (KHT)

Koa-haole Thicket represents the second of the two dominant vegetation types in the project site. It occurs in the drainages and on the gentle slopes in the east side of the site and consists of dense, closed-canopied stands of koa-haole 10-20 feet tall. Few other canopy species are associated with this vegetation type - Christmas berry is an occasional species and *Macaranga* and hau (*Hibiscus tiliaceus*) were both considered "uncommon".

The understory density varies considerably. In some areas it is very sparse and consists largely of koa-haole seedlings with a few poorly developed grasses such as sourgrass, Paragrass or Guinea grass. In other areas these grasses form a nealy complete cover and approach heights of 5-7 feet. Other species in the understory include virgate mimosa, asystasia, pluchea (*Pluchea odorata*), and yellow wood sorrel (*Oxalis corniculata*). Huehue-haole is a common vine in this community.

Numerous herbaceous species such as asystasia, 'uhaloa, virgate mimosa, and *Bidens alba* var. *radiata* are found along the roadways and in small, exposed sites. Guinea grass and sourgrass also proliferate in these situations.

Mixed Lowland Association (MLA)

This vegetation type which occurs in the lowlands along Kamehameha Highway is a mosaic of small or extensive fields of Johnson grass, Paragrass or Guinea grass or mixed grasses, with widely scattered or pure stands of koa-haole 6-15 feet tall. Along the drainageways and at the foot of the slopes koa-haole is well developed and forms dense thickets often in association with Paragrass which may become 6 feet tall or Guinea grass up to 8 feet tall.

Grasses constitute a significant component of this community.

Fields of Johnson grass occupy certain portions of the lowlands. Because this species does not form a complete cover, several herbaceous species such as virgate mimosa, sensitive plant, asystasia and Bidens alba var. radiata are found in abundance. Paragrass and Guinea grass, on the other hand, usually grow to the exclusion of other species. Paragrass forms monodominant mats 3-5 feet deep but in association with koa-haole it forms impenetrable thickets up to 10 feet tall.

Koa-haole is the dominant arborescent species. It occurs as widely scattered individuals, small groves, or extensive, nearly monodominant stands. Christmas berry and castor bean (Ricinus communis) also occur in small groves. Guava and Macaranga are found in small numbers.

Grasslands (G)

Three types of Grasslands were identified in the project site, exclusive of those in the lowlands which are included in the Mixed Lowland Association. For practicality each is mapped as a separate unit but combined as a single vegetation type (G) in the Species Checklist.

Guinea Grassland (map unit Gg)

The largest of the Grasslands is the Guinea Grassland which occupies the slopes above the lowlands in the west side of the project site. It is characterized by Guinea grass 4-8 feet tall with scatterd individuals or small groves of koa-haole and Christmas berry up to 10 feet tall. Often the Guinea grass forms a complete cover precluding the development of any of undergrowth. In other areas herbaceous species such as 'uhaloa, partridge pea, three-flowered beggarweed, virgate mimosa, pitted beardgrass

(Andropogon pertusus) and Stachytarpheta urticaefolia are common associates.

Para Grassland (map unit Gp)

Para Grassland occurs in the uplands in former agricultural fields, abandoned sugar cane fields and in areas that appear to have been bulldozed. They are usually small in size and only the largest ones have been mapped. Those too small to be feasibly mapped are included in the Mixed Thickets. Paragrass, the dominant species, grows to heights of 5-7 feet and often climbs 10 feet into the taller shrubs. In many instances it grows to the exclusion of other herbaceous species but in openings and especially where this grassland has developed in a sugar cane remnant, the cover is incomplete. Virgate mimosa, 'uhaloa, sensitive plant, Bidens alba var. radiata, Stachytarpheta urticaefolia and ricegrass (Paspalum orbiculare) are common in these exposed sites.

The most extensive example of this community type is found in the mauka portion of the project site where it appears to have developed in a bulldozed cane field. Here the Paragrass is only 2-3 feet thick. Glycine wightii is a common associate in this community and Bidens alba var. radiata is an occasional species.

Digitaria Grassland (map unit Gd)

This vegetation type occurs only in one locality on the mauka side of a hill just off the main access road. It is a man-made situation in which pangola grass (Digitria decumbens) and large crabgrass (D. ciliaris) had been used for soil erosion control in a denuded area. Although some fringe areas are now completely grassed over, much of the site still consists of bare eroding soils or small clumps of grass which appear to have not grown since they were planted. Vegetation is sparse in this community and only a few species have become established. Koa-haole has been the most successful and small shrubs are scattered in portions of the site. Ironwood is found mostly on the fringe. Sensitive plant, three-flowered beggarweed, partridge pea and 'uhaloa are among the few associated species in this community.

Exposed Scrub (ES)

The vegetation on the summits and uppermost slopes of the narrow ridges undisturbed by agriculture consist of dwarfed wind-blown shrubs and grasses. The dominant species in most of these sites is the native 'ūlei which occasionally forms mats up to 2.5 feet thick. Stachytarpheta urticaefolia and partridge pea are common in this community. Scrubby Christmas berry and koa-haole are sparsely scattered but are more abundant in protected pockets and on the fringe. Grasses which are a major component of the community, consist mostly of sourgrass and Festuca cf arundinacea. Angleton grass (Andropogon annulatus), golden beardgrass (Chrysopogon aciculatus), large crabgrass, Natal red top, pitted beardgrass, ricegrass, radiate fingergrass and Paragrass are occasional species. Generally, this community is restricted to the windswept summits and windward slopes.

Abandoned Sugar Cane Fields (ACF)

Except for the steepest slopes, all of the uplands were probably put into sugar cane at one time or another. Today, relatively little remains in the project area. Small pockets which are invaded by secondary vegetation occur in several areas and mats of dead cane can be found in portions of the Koa-Haole Thicket and the Mixed Thickets. Abandoned Sugar Cane Fields is here designated when sugar cane remains the dominant species. In instances where other species, primarily koa-haole and/or Christmas berry have become dominant, these pockets have been included in other vegetation types. Only the larger remnants have been mapped.

Most of the Abandoned Sugar CAne Fields are being invaded by Paragrass and may eventually be transformed into Para Grasslands. Individuals or small groves of guava, koa-haole and Christmas berry are found in portions of this community. In sunny, open areas, herbaceous species such as sensitive plant, partridge peas, three-flowered beggarweed, 'uhaloa, Natal red top, molassasgrass, perennial foxtail and _Bidens alba_ var. _radiata_ are common. Few other species are found in this community.

Abandoned Agricultural Fields (AAF)

Only two examples of this vegetation type are found within the project site. One community is situated in the Koa-Haole Thicket on the plateau in the _makai_ portion just above Kamehameha Highway. Here, sugar cane and koa-haole were used as windbreaks between individual fields but no evidence remains of the crops which were once cultivated. The vegetation throughout these fields consist of widely scattered koa-haole 3-6 feet tall and a dense herb layer dominated by _Bidens alba_ var. _radiata_ 2-3 feet tall. Several herbaceous species are found in this community including virgate mimosa, sensitive plant and three-flowered beggarweed but only in small to moderate numbers. Grasses such as Guinea grass and Paragrass are locally abundant and it is possible that portions of these fields may some day be converted into Grasslands.

The second community occurs in the mauka portion of the site where sections of cane fields were bulldozed and planted in _Pinus_ sp. Some of these pines have grown to 10 feet in height but most have not exceeded 6 feet. If these fields were all planted in pine the mortality rate has been very high. Relatively few individuals remain and many of these are enshrouded by *Glycine wightii*. Large portions of these fields have been invaded by Paragrass, Guinea grass, koa-haole, *Glycine*, and *Bidens alba* var. *radiata*.

NATIVE SPECIES AND NATIVE ECOSYSTEMS

Thirteen native species were observed in the project site. Nine are indigenous to Hawaii, four are endemic and all are common, widespread lowland species. 'Uhaloa, the most abundant native species occurs in all of the vegetation types in small to moderate numbers. Lauae (*Microsorium scolopendrium*) is found in five communities and huehue (*Cocculus ferrandianus*) occurs in four communities in small to moderate numbers.

No native ecosystems exist in the site. Although 'ūlei is the dominant species in the Exposed Scrub this community can in no way be considered native.

RARE AND ENDANGERED SPECIES

Two individuals of maiapilo (*Capparis sandwichiana* var. *sandwichiana*) were discovered near the project site. One was located during a previous survey (State of Hawaii, 1984) on the limestone outcrops across Tanaka Store along Kamehameha Highway and was found to be still alive. A second was found during the present survey on another limestone feature just outside the northeast portion of the site at approximately 175 feet elevation. Both plants are persisting in totally degraded habitats.

This taxon has always been considered as rare and endangered.

In the report on endangered and threatened plant species in the United States the Smithsonian Institution considered it "endangered" (Anon.,1974) and in the first formal assessment of the endangered status of Hawaiian plants it was found to be very localized in distribution and was considered "very rare" and "endangered" (ie. threatened with extinction) (Fosberg & Herbst, 1975).

In 1976, pursuant to the Endangered Species Act of 1973 it was proposed as a candidate for Endangered Species status by the U.S. Fish and Wildlife Service (Anon., 1976). It was not officially listed and under the provisions of the Act the entire candidate list was withdrawn and resubmitted in 1980. In the reproposal _Capparis_ was listed a Category 1 candidate and has retained that status in the most recent reviews (Anon., 1980, 1985). Taxa in this category include those for which the U.S. Fish and Wildlife Service has sufficient information onhand to support the appropriateness of their being listed as Endangered or Threatened.

Two varieties of _Capparis sandwichiana_ are currently recognized. Variety _zoharyi_ is an occasional shrub in the lowlands and coasts on all the main islands and a few of the Leeward Islands of Hawaii. Variety _sandwichiana_, on the other hand, is restricted to a few individuals on Oahu (St. John, 1965). In conjunction with the Bishop Museum's _Manual of the Flowering Plants of Hawaii_ project the taxonomic status of these varieties was reassessed and it was concluded that no valid reasons exist for the separation of this species into two varieties. Consequently, when the _Manual_ is published later in 1989 only _Capparis sandwichiana_ will be recognized (D. Herbst, pers. comm.). Accordingly, when the U.S. Fish and Wildlife Service publishes its revised list of candidate species for endangered status in 1989 or 1990, this taxon will be downgraded to a less critical Category 2 status (D. Herbst, pers. comm.).

POTENTIAL PROBLEMS AND MITIGATING MEASURES

Soil erosion, siltation and consequent degradation of coastal communities are major concerns whenever extensive removal of upland vegetation is involved. Irresponsible grading and construction practices can seriously affect the aquaculture operations, wildlife habitat and coastal ecosystems makai of Kamehameha Highway but if prudent measures are taken such potential difficulties can be minimized.

Many native plants will necessarily be destroyed as a result of the proposed project. All, however, are common species and no native plant communities will be affected. Two individuals of *Capparis sandwichiana* var. *sandwichiana*, a Category 1 Endangered Species candidate, are situated near the site in severely disturbed habitats. Care should be exercised during construction to avoid spillage of rubble into these sites. Leaching of chemicals such as biocides and fertilizers into these sites should also be avoided.

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SPECIES CHECKLIST

Plant families are arranged alphabetically in three groups - Pteridophytes, Gymnosperms and Angiosperms. The Angiosperms are subdivided into Monocotyledones and Dicotyledones. Genera and species are arranged alphabetically within each family. Taxonomy of the Pteridophytes follows that of Wagner's unpublished list and common names for the ferns are those which are commonly accepted. Taxonomy, common names and the status of the Gymnosperms and Angiosperms generally follow that of St. John (1973). Nagata (1985) was consulted for the native status of several species.

EXPLANATION OF SYMBOLS

Species Status:

E - Endemic to the Hawaiian Islands, ie. occuring nowhere else in the world.

I - Indigenous, ie. native to the Hawaiian Islands but also occuring naturally elsewhere.

X - Exotic (alien), ie. plants introduced after the Western discovery of the islands.

P - Polynesian introduction, plants introduced before the Western discovery of the islands.

Vegetation types:

MT - Mixed Thickets

KHT - Koa-Haole Thicket

MLA - Mixed Lowland Association

G - Grassland

ES - Exposed Scrub

ACF - Abandoned Sugar Cane Fields

AAF - Abandoned Agricultural Fields

Relative Abundance Rating:

A - Abundant, generally the major or dominant element in an area.

C - Common, generally distributed throughout a given area in large numbers.

O - Occasional, generally distributed throughout a given area in small numbers.

U - Uncommon, observed uncommonly but more than 10 times in a given area.

R - Rare, observed 2-10 times in a given area.

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE HT	KHT	HLA	G	ES	ACF	AAF
PTERIDOPHYTES									
ADIANTACEAE									
Pteris vittata L.		X	-	R	-	-	-	-	-
DAVALLIACEAE									
Nephrolepis exaltata (L.) Schott	Boston fern	I	U	-	-	-	-	R	-
POLYPODIACEAE									
Microsorium scolopendrium (Burm.) Copel.	Lauae	I	U	U	-	U	R	R	-
GYMNOSPERMS									
PINACEAE									
Pinus sp.		X	R	-	-	R	-	-	O
ANGIOSPERMS - MONOCOTYLEDONES									
COMMELINACEAE									
Commelina diffusa Burm. f.	Honohono	X	U	-	-	-	-	-	-
GRAMINEAE									
Andropogon annulatus Forsk.	Angleton grass	X	U	U	U	R	O	-	-
A. aristatus Poir.	Wilder grass	X	-	O	O	O	U	-	-
A. pertusus (L.) Willd.	Pitted beardgrass	X	-	U	-	C	O	-	-
A. sericeus R. Br.	Australian bluegrass	X	R	R	-	-	-	-	-
A. virginicus L.	Broomsedge	X	-	-	-	-	C	U	-
Axonopus affinis Chase	Narrow-leaved carpetgrass	X	-	-	-	R	-	R	U
Brachiaria mutica (Forsk.) Stapf	Paragrass	X	C	C	A	A	O	[illegible]	C
Cenchrus ciliaris L.	Buffelgrass	X	-	-	U	-	-	-	-
C. echinatus L.	Common sandbur	X	-	R	U	R	-	-	-
Chloris radiata (L.) Sw.	Radiate fingergrass	X	-	-	U	-	O	-	-
C. inflata Link	Swollen fingergrass	X	R	U	-	U	-	-	R
C. virgata Sw.	Feather fingergrass	X	R	U	U	R	-	-	R
Chrysopogon aciculatus (Retz.) Trin.	Golden beardgrass	X	-	-	-	-	O	R	-
Cynodon dactylon (L.) Pers.	Bermuda grass	X	U	U	U	U	-	R	R
Digitaria adscendens (HBK.) Henr.	Henry's crabgrass	X	-	R	-	R	R	-	-
D. ciliaris (Retz.) Koeler	Large crabgrass	X	R	U	R	C	O	U	U
D. decumbens Stent	Pangolagrass	X	-	-	-	C	-	-	-
Eleusine indica (L.) Gaertn.	Goosegrass	X	R	U	U	U	-	-	U
Festuca cf arundinacea (R.Br.) A. Camus		X	-	-	-	-	C	-	-
Melinis minutiflora Beauv.	Molassesgrass	X	U	-	R	U	-	U	O
Panicum maximum Jacq.	Guinea grass	X	C	C	O	A	U	O	O
Paspalum conjugatum Berg.	Hilo grass	X	U	U	-	-	-	U	U
P. orbiculare Forst. f.	Ricegrass	X	U	-	U	O	O	U	U
Pennisetum purpureum Schumach	Napiergrass	X	-	R	-	U	-	-	R
P. setosum (Sw.) L.C. Rich.	Feathery pennisetum	X	R	-	-	U	R	U	-
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal redtop	X	U	U	R	-	O	O	-
Saccharum officinarum L. cv	Sugar cane	X	O	-	U	U	-	A	C
Setaria geniculata (Poir.) Beauv.	Perennial foxtail	X	U	U	-	O	U	O	U
S. verticillata (L.) Beauv.	Bristly foxtail	X	R	R	-	-	-	-	-
Sorghum halepense (L.) Pers.	Johnson grass	X	-	U	C	-	-	-	R

CHECKLIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	MT	KHT	MLA	G	ES	ACF	AAF
PORTULACACEAE									
Portulaca oleracea L.	Common purslane	X	-	U	-	-	-	-	-
PRIMULACEAE									
Anagallis arvensis L.	Scarlet pimpernel	X	-	R	-	-	R	-	-
ROSACEAE									
Osteomeles anthyllidifolia Lindl.	'Ulei	E	R	R	-	-	A	-	-
RUBIACEAE									
Canthium odoratum (Forst. f.) Seem.	Alahe'e	I	R	-	-	-	-	-	-
Morinda citrifolia L.	Noni	P	-	R	-	-	-	-	-
SOLANACEAE									
Capsicum annuum L.	Red pepper	X	U	U	-	-	-	-	-
Lycopersicon pimpinellifolium Mill.	Currant tomato	X	-	-	R	-	-	-	-
Solanum nigrum L.	Popolo	I?	-	R	-	-	-	-	-
STERCULIACEAE									
Waltheria americana L.	'Uhaloa	I	U	O	U	O	O	O	U
THYMELIACEAE									
Wikstroemia oahuensis (Gray) Rock	'Akia	E	R	-	-	-	U	-	-
UMBELLIFERAE									
Centella asiatica (L.) Urban	Asiatic pennywort	X	U	-	-	U	-	-	-
VERBENACEAE									
Lantana camara L.	Lantana	X	U	U	U	U	U	U	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	X	R	U	-	U	-	-	-
S. urticaefolia (Salisb.) Sims		X	R	U	U	O	C	O	U
Verbena litoralis HBK.	Weed verbena	X	-	R	U	-	-	-	-

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	MT	KHT	MLA	G	ES	ACF	AAF
Indigofera suffruticosa Mill.	Indigo	X?	R	U	U	U	-	-	U
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X	A	A	C	O	O	O	A
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	Sensitive plant	X	O	U	C	U	U	O	O
Phaseolus lathyroides L.	Cow pea	X	-	-	U	U	-	-	R
Pueraria lobata (Willd.) Ohwi	Kudzu	X	-	R	-	-	-	-	-
MALVACEAE									
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X	R	U	U	-	-	-	-
Hibiscus tiliaceus L.	Hau	I	R	U	-	-	-	-	-
Malvastrum coromandelianum (L.) Garcke	False mallow	X	-	U	U	U	-	-	-
Sida fallax Walp.	'Ilima	I	U	U	-	-	U	-	-
S. spinosa L.	Prickly sida	X	-	U	R	R	-	U	U
MELASTOMATACEAE									
Clidemia hirta (L.) D. Don	Koster's curse	X	R	-	-	-	-	-	-
MENISPERACEAE									
Cocculus ferrandianus Gaud.	Huehue	E	U	U	-	U	U	-	-
MORACEAE									
Ficus macrophylla Desf.	Moreton Bay fig	X	R	-	-	-	-	-	-
F. microcarpa L. f.	Chinese banyan	X	U	U	-	-	R	-	U
F. rubiginosa Desf.	Port Jackson fig	X	U	-	-	-	-	-	-
MYRTACEAE									
Eugenia cumini (L.) Druce	Java plum	X	U	R	U	-	R	-	-
Psidium cattleianum Sabine	Purple strawberry guava	X	R	R	-	-	-	-	-
P. guajava L.	Guava	X	C	-	U	U	U	U	U
NYCTAGINACEAE									
Mirabilis jalapa L.	Common four o' clock	X	-	U	-	-	-	-	-
OXALIDACEAE									
Oxalis corniculata L.	Yellow wood sorrel	P?	O	O	U	-	-	-	-
O. martiana Zucc.	Pink wood sorrel	X	O	O	U	-	-	-	-
PASSIFLORACEAE									
Passiflora edulis f. flavicarpa Deg.	Yellow liliko'i	X	U	U	-	-	R	-	R
P. foetida L.	Scarlet-fruited passionflower	X	U	R	U	R	R	-	O
P. suberosa L.	Huehue-haole	X	C	C	U	U	R	-	-
PIPERACEAE									
Peperomia leptostachya H. & A.	'Ala'ala-wai-nui	I	U	R	-	-	U	-	-
PLANTAGINACEAE									
Plantago lanceolata L.	Narrow-leaved plantain	X	-	R	R	U	-	-	-
PLUMBAGINACEAE									
Plumbago zeylanica L.	'Ilie'e	I	-	R	-	-	-	-	-

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS			MT	KHT	HLA	G	ES	ACF	AAF			
					RELATIVE ABUNDANCE									
COMPOSITAE														
Ageratum conyzoides L.	Ageratum	X			-	U	-	-	-	-	-			
Bidens alba var. radiata (Schz. Bip.) Ballard ex Melchart	Spanish needle	X			O	O	A	U	O	C	A			
B. pilosa L.	Red pua-lele	X			-	U	-	-	R	-	-			
Emilia sonchifolia var. javanica (Burm. f.) Mattfeld	hairy horseweed	X			U	R	-	U	R	U	-			
Erigeron bonariensis L.	Spreading mist flower	X			U	R	-	U	U	U	R			
Eupatorium riparium Regel	Indian pluchea	X			R	-	-	-	-	-	-			
Pluchea indica (L.) Less.	Pluchea	X			U	U	U	R	-	U	-			
P. odorata (L.) Cass.	Picridium	X			U	O	U	-	-	-	-			
Reichardia picroides (L.) Roth	Sow thistle	X			-	R	-	-	-	-	-			
Sonchus oleraceus L.	Ironweed	X			-	R	U	-	-	-	R			
Vernonia cinerea (L.) Less.		X			U	U	-	-	-	-	R			
CONVOLVULACEAE														
Convolvulus arvensis L.	Field bindweed	X			U	U	O	-	-	-	R			
Ipomoea congesta R. Br.	Koali-'awahia	I			U	O	U	-	-	-	-			
I. obscura (L.) Ker-Gawl.		X			R	U	-	-	-	-	-			
Jacquemontia sandwicensis Gray	Pa'u-o-hi'iaka	E			-	R	-	-	-	-	-			
Merremia tuberosa (L.) Rendl.	Wood rose	X			-	R	-	-	-	-	-			
CUCURBITACEAE														
Momordica charantia var. pavel Crantz	Peria	X			-	U	-	-	-	-	R			
EUPHORBIACEAE														
Euphorbia geniculata Ortega	Wild spurge	X			-	-	R	-	-	-	-			
E. glomerifera (Millsp.) L.C. Wheeler		X			-	U	-	-	-	-	-			
E. hirta L.	Garden spurge	X			-	U	R	-	R	-	-			
E. prostrata Ait.	Prostrate spurge	X			-	R	-	-	-	-	-			
Macaranga tanarius (Stickm.) Muell.-Arg.		X			C	U	R	-	R	-	-			
Phyllanthus debilis Klein ex Willd.	Phyllanthus weed	X			U	O	U	U	U	R	O			
Ricinus communis L.	Castor bean	X			U	U	O	R	-	-	U			
LABIATAE														
Leonotis nepetaefolia (L.) Ait. f.	Lion's-ear	X			R	-	-	-	-	-	-			
LEGUMINOSAE														
Acacia confusa Merr.	Formosan koa	X			R	-	-	-	-	R	-			
A. farnesiana (L.) Willd.	Klu	X			-	U	U	U	U	U	-			
Canavalia cathartica Thouars	Mauna-loa	X			R	R	U	-	-	R	R			
Cassia alata L.	Candle bush	X			-	-	-	-	-	-	R			
C. leschenaultiana DC.	Partridge pea	X			O	-	-	O	C	O	O			
C. surattensis Burm. f.	Kolomona	X			U	U	-	R	-	-	R			
Crotalaria mucronata Desv.		X			-	R	-	R	R	R	-			
C. pallida Ait.		X			R	U	-	U	-	-	R			
Desmanthus virgatus (L.) Willd.	Virgate mimosa	X			U	O	C	O	-	O	O			
Desmodium canum (Gmel.) Schinz & Thell.	Spanish clover	X			U	U	R	U	R	R	U			
D. triflorum (L.) DC.	Three-flowered beggarweed	X			O	U	U	O	U	U	U			
D. uncinatum (Jacq.) DC.	Spanish clover	X			R	-	-	-	-	-	-			
Glycine wightii (Wight & Arnold) Verdc.		X			-	-	-	U	-	-	U			

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE MT	KHT	MLA	G	ES	ACF	AAF
Sporobolus indicus (L.) R. Br.	West Indian dropseed	X	U	U	-	U	-	-	R
Tricachne insularis (L.) Nees	Sourgrass	X	C	O	O	U	C	-	U
MUSACEAE									
Musa x paradisiaca cv	Banana	X	-	-	-	-	-	-	R
ORCHIDACEAE									
Spathoglottis plicata Bl.		X	-	-	-	-	R	-	-
PALMAE									
Cocos nucifera L.	Coconut	P	R	R	-	R	-	-	-
ANGIOSPERMS - DICOTYLEDONES									
ACANTHACEAE									
Asystasia gangetica (L.) T. Anders.	Asystasia	X	U	O	O	-	-	-	R
AMARANTHACEAE									
Achyranthes indica (L.) Mill.		X	R	R	R	-	-	-	R
Amaranthus spinosus L.	Spiny amaranth	X	-	-	-	-	-	-	R
APOCYNACEAE									
Thevetia peruviana (Pers.) K. Schum.	Be-still tree	X	R	-	-	-	-	-	-
ANACARDIACEAE									
Mangifera indica L.	Mango	X	R	-	-	-	-	-	-
Schinus terebinthifolius Raddi	Christmas berry	X	A	O	O	O	O	O	O
ARALIACEAE									
Brassaia actinophylla Endl.	Umbrella tree	X	R	-	-	-	-	-	-
BIGNONIACEAE									
Spathodea campanulata Beauv.	African tulip tree	X	R	-	-	-	-	-	-
BASELLACEAE									
Basella alba L.	Malabar nightshade	X	-	R	-	-	-	-	-
CACTACEAE									
Opuntia megacantha Salm-Dyck	Prickly pear	X	-	-	-	-	R	-	-
CAPPARACEAE									
Capparis sandwichiana DC. var. sandwichiana	Maiapilo	E	R	-	-	-	R	-	-
CARICACEAE									
Carica papaya L.	Papaya	X	U	U	-	-	-	-	-
CASUARINACEAE									
Casuarina equisetifolia Stickm.	Common ironwood	X	U	R	-	U	R	R	-

APPENDIX L

MALAEKAHANA PROJECT

MALAEKAHANA, OAHU

BOTANICAL SURVEY

Prepared for: Group 70

By: Kenneth M. Nagata

Date: 12 January 1989

INTRODUCTION

The project site, encumbering approximately 235 acres, is situated in the land of Malaekahana, Koolauloa District, Oahu, between 50 and 300 feet elevation with small peaks reaching 375 and 400 feet. It is surrounded on all sides by pastures and secondary vegetation.

The vegetation of the region has been characterized by Ripperton and Hosaka (1942) as open shrubs and grasses dominated by guava (Psidium guajava), lantana (Lantana camara) and koa-haole (Leucaena leucocephala). 'Ilima (Sida fallax), 'uhaloa (Waltheria americana), partridge pea (Cassia leschenaultiana), and indigo (Indigofera suffruticosa) are also common in this zone but not as abundant. In cultivated areas wayside species such as Spanish needle (Bidens pilosa), garden spurge (Euphorbia hirta), pigweed (Portulaca oleracea) and dandelion (Taraxacum officinale) are common.

Much of the land in the region had been put into sugar cane cultivation. Abandoned sugar cane fields were observed approximately a quarter mile northwest of the project site and the vegetation in the former sugar cane lands approximately two miles to the northwest was recently surveyed (State of Hawaii, 1984). Abandoned sugar cane was found to be the prevalent vegetation in the uplands of that region. Koa-haole thickets was the second most important vegetation type. Other communities included 'ūlei (Osteomeles anthyllidifolia) scrub on the ridges and knolls which had not been put into sugar cane, koa-haole-Christmas berry (Schinus terebinthifolius) scrub on the steeper, rocky slopes, mixed forests on hillsides and gulch sides, koa-haole-Paragrass (Brachiaria mutica) association in drainageways, grasslands on the hills, and cultivated areas which included active or abandoned vegetable farms, orchards, and aquaculture operations. Generally, the vegetation in the lowlands consisted of cultivated crops and that in the uplands consisted of sugar cane and secondary growth dominated by koa-haole.

METHODS

A walk-through survey was conducted during three days in December, 1988 to determine the floristic composition of the project site. Tentative vegetation types which were identified from recent aerial photographs were verified by ground checks in which transects were established through each type. Coverage was approximately 75%. Special emphasis was given to locating native ecosystems and rare and endangered species. Survey work was made more hazardous than usual and more time consuming because of the presence of cattle (including several bulls) in the *mauka* portion of the site.

RESULTS

The vegetation of the site was found to consist of grasslands, thickets, scrublands and a small abandoned banana plantation. Although several common native species and two severely degraded remnants of a native community were found, the vegetation can be generally described as secondary. Five vegetation types were recognized and are discussed in the following paragraphs. These are presented in the accompanying vegetation map with distinct boundaries but it must be understood that in nature no sharp boundaries exist. Rather, vegetation exists as a continuum with one type grading into another.

Grasslands (G)

A significant portion of the project site is occupied by Grasslands of varying origins. Some appear to have been intentionally created by bulldozing; others have developed from abandoned agricultural fields and still others are probably the result of open range grazing in forest or thickets. The entire site, in fact, appears to be open range for cattle despite the presence of fence lines and several well-maintained and well-grazed pastures (here classified as Grasslands).

Well-maintained pastures are short-cropped and dominated by Bermuda grass

(Cynodon dactylon). Other species associated with these pastures are garden spurge, Hilo grass (Paspalum conjugatum), buttonweed (Borreria laevis), synedrella (Synedrella nodiflora), Bidens alba var. radiata and Calyptocarpus vialis. Other Grasslands appear to be over-grown pastures of Guinea grass (Panicum maximum) and/or Paragrass 3-6 feet tall with emergent Christmas berry, koa-haole, pluchea (Pluchea odorata) and Macaranga tanarius. Sourgrass (Tricachne insularis), indigo, guava, lion's ear (Leonotis nepetaefolia) and Jamaica vervain (Stachytarpheta jamaicensis) are common in these over-grown fields. Guava and Christmas berry are abundant in certain portions; pluchea has invaded other portions and is transforming them into Pluchea Scrub.

Some of the Grasslands appear to be originally agricultural fields as evidenced by networks of irrigation flumes. Except for one field with remnant papaya (Carica papaya) and another with relatively intact rows of banana (Musa x paradisiaca, cv) nothing remains of the crops which were once grown. Tall thickets of koa-haole, Christmas berry and Macaranga have grown up along the flumes and Macaranga has invaded portion of these fields. Paragrass and sourgrass are the dominant species.

Mixed Thickets (MT)

This is the second of the two dominant vegetation types in the project site. It is a mosaic of dense koa-haole stands, Christmas berry stands and emergent Macaranga, Java plum (Eugenia cumini), Formosan koa (Acacia confusa) and ironwood (Casuarina equisetifolia). Typically, the koa-haole and Christmas berry stands are 10-20 feet tall but in drainage bottoms the canopy may reach 35-40 feet in height. In these dense thickets the poorly-developed understory consists largely of koa-haole seedlings, Hilo grass, sourgrass and Jamaica vervain. The understory in other portions is open and the well-developed herb layer consists of dense Paragrass and sourgrass. Common shrubs in this situation include lion's ear, indigo, burbush (Triumfetta semitriloba) and lantana.

In some sections, openings in the thickets have resulted in a proliferation of burbush, lantana, castor bean (Ricinus communis), hairy abutilon (Abutilon grandifolium), three-flowered beggarweed (Desmodium triflorum) and Paragrass. These sunny sites appear to have been caused or are being aggravated by cattle grazing.

Small pockets of other vegetation types such as Grasslands and Exposed Scrub which are too small to be feasibly mapped are included in the Mixed Thickets.

Pluchea Scrub (PS)

Pluchea Scrub is characterized by stands of pluchea 5-8 feet tall providing 60-90% canopy cover with occasional emergent guava, koa-haole and Christmas berry. Sourgrass and Paragrass are dominant in the herb layer. Other associated species include Jamaica vervain, partiridge pea, three-flowered beggarweed and lantana. In areas where cattle have not intruded recently the Pluchea Scrub is extremely dense with Paragrass which can climb 6 feet into the shrubbery. Some of the Grasslands are being invaded by pluchea and are being transformed into Pluchea Scrub.

Exposed Scrub (ES)

One of the two smallest plant communities in the project site, the Exposed Scrub is restricted to the exposed, windswept summits of two hills near the mauka boundary. It is characterized by Jamaica vervain 2 feet tall and dwarfed Christmas berry, lantana and 'ākia (Wikstroemia oahuensis) 3-4 feet tall. Taller Java plum and ironwood are scattered throughout the community. The native 'ūlei is a common species and the herb layer is dominated by golden beardgrass (Chrysopogon aciculatus). Bermuda grass, Paragrass and Natal red top (Rhynchelytrum repens) are also represented in this community.

Although moa (Psilotum nudum), 'ākia and 'ūlei are the only native species remaining in this community, it is thought to be the vestiges of an ecosystem which once prevailed on the ridges and upper slopes throughout the region.

Abandoned Banana Field (B)

An abandoned banana plantation with relatively intact rows of banana is located in the makai end of what apparantly was a large agricultural complex. Except for this remnant banana field the entire complex has been transformed into Grasslands or Mixed Thickets. The banana field is being invaded primarily by *Macaranga* which forms closed-canopied groves in some sections, Paragrass, and sourgrass. So complete is the cover provided by these species that few others are found in this community. Lion's ear is a common species here and lantana, Christmas berry, guava, rouge plant (*Rivina humilis*) and *Bidens alba* var. *radiata* are rated as "occasional". This represents the smallest of the vegetation types found within the project site.

NATIVE SPECIES AND NATIVE ECOSYSTEMS

Eleven native plant species were found in the project site. Eight are considered indigenous and three are endemic; all ar common and widespread in Hawaii. The most abundant in the site is 'uhaloa which is an occasional species in the Grasslands and Exposed Scrub and uncommon in the Mixed Thickets and Pluchea Scrub. The endemic 'ākia, the second most common native species in the site, is a common shrub in the Exposed Scrub and is occasionally found in the Mixed Thickets. Except for 'ūlei which is common in the Exposed Scrub the rest of the native species are found in very small numbers in only one or two vegetation types.

The Exposed Scrub contains elements of the ecosystem which probably once prevailed on the summits and ridges at low to medium elevations throughout the region. Despite the presence of native species, however, the Exposed Scrub is not to be considered a native community.

No rare and endangered species were observed in the project site.

POTENTIAL PROBLEMS AND MITIGATING MEASURES

Soil erosion must be a major concern in any project of this magnitude which requires extensive grading and vegetation removal. If prudent and reasonable measures are taken, however, soil loss and ocean pollution can be minimized.

No native plant communities occur in the project site and all of the native species that do occur are common in Hawaii. The integrity of the native flora will in no way be compromised by this project.

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SPECIES CHECKLIST

Plant families are arranged alphabetically in two groups - Pteridophytes and Angiosperms. The Angiosperms are subdivided into Monocotyledones and Dicotyledones. Genera and species are arranged alphabetically within each family. Taxonomy of the Pteridophytes follows that of Wagner's unpublished list and common names for the ferns are those which are commonly accepted. Taxonomy, common names and the status of the Angiosperms generally follow that of St. John (1973). Nagata (1985) was consulted for the native status of several species.

EXPLANATION OF SYMBOLS

Species Status:

E - Endemic to the Hawaiian Islands, ie. occuring naturally nowhere else in the world.

I - Indigenous, ie. native to the Hawaiian Islands but also occuring naturally elsewhere.

X - Exotic (alien), ie. plants introduced after the Western discovery of the islands.

P - Polynesian introduction, plants introduced before the Western discovery of the islands.

Vegetation types:

G - Grasslands

MT - Mixed Thickets

PS - Pluchea Scrub

ES - Exposed Scrub

B - Abandoned Banana Field

Relative Abundance Rating:

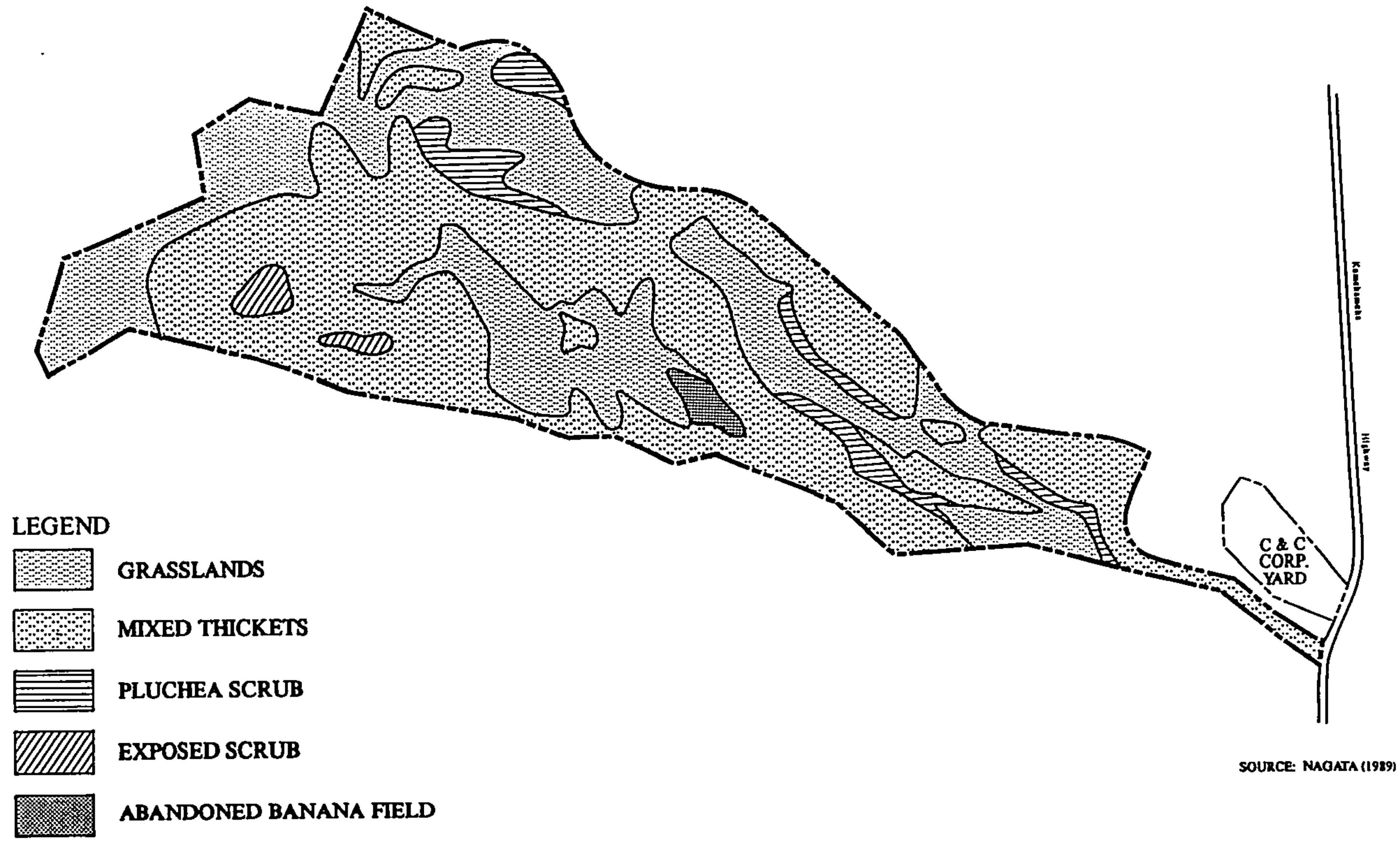
A - Abundant, generally the major or dominant element in an area.

C - Common, generally distributed throughout a given area in large numbers.

O - Occasional, generally distributed throughout a given area in small numbers.

U - Uncommon, observed uncommonly but more than 10 times in a given area.

R - Rare, observed 2-10 times in a given area.



VEGETATION COVER TYPES • MALAEKAHANA

THE COUNTRY COURSES AT KAHUKU

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	RELATIVE ABUNDANCE G	MT	PS	ES	B
PTERIDOPHYTES							
ADIANTACEAE							
Pteris vittata L.		X	-	R	-	-	-
DAVALLIACEAE							
Nephrolepis exaltata (L.) Schott	Boston fern	I	-	R	-	-	-
POLYPODIACEAE							
Microsorium scolopendrium (Burm.) Cope.	Lauae	I	-	U	-	-	-
PSILOTACEAE							
Psilotum nudum (L.) Beauv.	Moa	I	-	-	-	-	R
ANTIOSPERMS - MONOCOTYLEDONES							
AMARYLLIDACEAE							
Furcraea foetida (L.) Haw.	Mauritius hemp	X	-	R	-	-	-
ARACEAE							
Scindapsus aureus (Lind. ex Andre) Engl.	Taro vine	X	-	R	-	-	-
COMMELINACEAE							
Commelina diffusa Burm. f.	Honohono	X	R	-	-	-	R
CYPERACEAE							
Cyperus polystachyus Rottb.		I	-	-	-	R	-
C. rotundus L.	Nut grass	X	-	-	R	-	-
GRAMINEAE							
Andropogon annulatus Forsk.	Angleton grass	X	-	R	-	-	-
A. aristatus Poir.	Wilder grass	X	-	U	-	-	-
A. virginicus L.	Broomsedge	X	U	-	-	U	-
Axanopus affinis Chase	Narrow-leaved carpetgrass	X	U	U	-	-	-
Brachiaria mutica (Forsk.) Stapf	Paragrass	X	O	O	C	O	C
Chloris inflata Link	Swollen fingergrass	X	R	R	-	-	-
C. radiata (L.) Sw.	Radiate fingergrass	X	U	-	R	O	-
C. virgata Sw.	Feather fingergrass	X	R	R	-	-	-
Chrysopogon aciculatus (Retz.) Trin.	Golden beardgrass	X	U	-	-	A	-
Cynodon dactylon (L.) Pers.	Bermuda grass	X	C	U	U	O	-
Digitaria adscendens (HBK.) Henr.	Henry's crabgrass	X	-	-	-	O	-
D. ciliaris (Retz.) Koeler	Large crabgrass	X	O	C	R	R	-
Eleusine indica (L.) Gaertn.	Goosegrass	X	O	-	C	-	-
Panicum maximum Jacq.	Guinea grass	X	C	R	R	-	-
Paspalum conjugatum Berg.	Hilo grass	X	C	O	-	-	-
P. orbiculare Forst. f.	Ricegrass	X	O	U	-	U	-
Rhynchelytrum repens (Willd.) C.E. Hubb.	Natal red top	X	-	-	-	O	-
Setaria geniculata (Poir.) Beauv.	Perennial foxtail	X	C	-	R	O	-
S. glauca (L.) Beauv.	Yellow foxtail	X	U	-	U	-	-
Sporobolus indicus (L.) R. Br.	West Indian dropseed	X	U	-	C	-	-
Tricachne insularis (L.) Nees	Sourgrass	X	C	C	C	-	A

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	G	MT	PS	ES	B
EUPHORBIACEAE							
Euphorbia geniculata Ortega	Wild spurge	X	R	–	–	–	–
E. glomerifera (Millsp.) L.C. Wheeler		X	O	–	–	–	–
E. hirta L.	Garden spurge	X	O	R	U	R	–
Macaranga tanarius (Stickm.) Muell.-Arg.		X	–	C	R	–	A
Phyllanthus debilis Klein ex Willd.	Phyllanthus weed	X	R	O	–	R	–
Ricinus communis L.	Castor bean	X	R	U	R	–	U
LABIATAE							
Hyptis pectinata (L.) Poit.	Comb hyptis	X	R	R	U	–	R
Leonotis nepetaefolia (L.) Ait. f.	Lion's ear	X	O	O	–	–	C
Ocimum gratissimum L.		X	R	–	–	–	–
LEGUMINOSAE							
Acacia confusa Merr.	Formosan koa	X	R	O	–	–	–
Cassia leschenaultiana DC.	Partridge pea	X	O	–	U	C	–
C. occidentalis L.	Coffee senna	X	R	–	–	–	–
Crotalaria mucronata Desv.		X	U	–	–	–	–
Desmanthus virgatus (L.) Willd.	Virgate mimosa	X	U	–	U	–	U
Desmodium canum (Gmel.) Schinz & Thell.	Spanish clover	X	O	O	–	O	–
D. triflorum (L.) DC.	Three-flowered beggarweed	X	C	O	O	O	–
Indigofera suffruticosa Mill.	Indigo	X?	O	O	U	R	–
Leucaena leucocephala (Lam.) de Wit	Koa-haole	X	U	A	O	O	U
Medicago polymorpha L.	Bur clover	X	R	–	R	–	–
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	Sensitive plant	X	O	U	O	R	–
Phaseolus lathyroides L.	Cow pea	X	R	–	–	–	–
MALVACEAE							
Abutilon grandifolium (Willd.) Sweet	Hairy abutilon	X	O	O	–	–	–
Hibiscus tiliaceus L.	Hau	I	–	R	–	–	–
Malvastrum coromandelianum (L.) Garcke	False mallow	X	O	U	O	–	U
Sida fallax Walp.	'Ilima	I	–	R	R	–	–
S. rhombifolia L.	Cuba jute	X	O	U	U	–	–
S. spinosa L.	Prickly sida	X	–	–	U	–	–
MELASTOMATACEAE							
Clidemia hirta (L.) D. Don	Koster's curse	X	–	R	–	R	–
MENISPERMACEAE							
Cocculus ferrandianus Gaud.	Huehue	E	–	–	R	R	–
MORACEAE							
Ficus microcarpa L. f.	Chinese banyan	X	–	U	–	–	–
F. rubiginosa Desf.	Port Jackson fig	X	–	R	–	–	–
MYRTACEAE							
Eugenia cumini (L.) Druce	Java plum	X	U	O	–	O	–
Psidium cattleianum Sabine	Purple strawberry guava	X	R	U	–	O	–
P. guajava L.	Guava	X	O	O	R	O	O

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	G	MT	PS	ES	B
LILIACEAE							
Cordyline terminalis (L.) Kunth	Ti	P	–	R	–	R	–
MUSACEAE							
Musa x paradisiaca L. cv	Banana	X	–	–	–	–	A
ANGIOSPERMS – DICOTYLEDONES							
ACANTHACEAE							
Asystasia gangetica (L.) T. Anders.	Asystasia	X	U	U	–	–	–
AMARANTHACEAE							
Achyranthes indica (L.) Mill.		X	R	–	U	–	U
Amaranthus spinosus L.	Spiny amaranth	X	U	–	R	–	–
ANACARDIACEAE							
Schinus terebinthifolius Raddi	Christmas berry	X	O	A	U	C	O
BIGNONIACEAE							
Spathodea campanulata Beauv.	African tulip tree	X	–	U	R	–	–
CARICACEAE							
Carica papaya L.	Papaya	X	U	–	–	–	–
CASUARINACEAE							
Casuarina equisetifolia Stickm.	Common ironwood	X	–	U	U	–	–
COMPOSITAE							
Ageratum conyzoides L.	Ageratum	X	R	–	–	–	–
Bidens alba var. radiata (Schz. Bip.) Ballard ex Melchart		X	O	O	U	O	O
B. pilosa L.	Spanish needle	X	R	–	–	–	–
Calyptocarpus vialis Less.		X	O	R	U	–	–
Emilia sonchifolia (L.) DC. var. sonchifolia	Lilac pua-lele	X	–	–	–	R	–
E. sonchifolia var. javanica (Burm. f.) Mattfeld	Red pua-lele	X	O	–	–	O	–
Erigeron bonariensis L.	Hairy horseweed	X	U	–	R	R	–
Galinsoga parviflora Cav.	Galinsoga	X	–	U	–	–	–
Pluchea indica (L.) Less.	Indian pluchea	X	–	–	R	–	–
P. odorata (L.) Cass.	Pluchea	X	O	C	A	–	–
Synedrella nodiflora (L.) Gaertn.	Synedrella	X	O	R	R	–	–
Verbesina encelioides (Cav.) B. & H. ex Gray	Golden crown-beard	X	R	–	–	–	–
Vernonia cinerea (L.) Less.	Ironweed	X	U	R	R	O	–
Xanthium saccharatum Wallr.	Cocklebur	X	U	–	U	–	–
CONVOLVULACEAE							
Convolvulus arvensis L.	Field bindweed	X	O	–	R	–	R
CUCURBITACEAE							
Momordica charantia var. pavel Crantz	Peria	X	R	–	–	–	R

CHECK LIST OF PLANTS

SCIENTIFIC NAME	COMMON NAME	STATUS	G	MT	PS	ES	B
OXALIDACEAE							
Oxalis corniculata L.	Yellow wood sorrel	P?	U	O	U	U	–
O. martiana Zucc.	Pink wood sorrel	X	–	O	–	–	–
PASSIFLORACEAE							
Passiflora edulis f. flavicarpa Deg.	Yellow liliko'i	X	–	O	–	–	–
P. foetida L.	Scarlet-fruited passionflower	X	R	–	–	R	–
P. suberosa L.	Huehue-haole	X	O	O	–	R	–
PHYTOLACCACEAE							
Rivina humilis L.	Rouge plant	X	–	O	–	–	O
PIPERACEAE							
Peperomia leptostachya H. & A.	'Ala'ala-wai-nui	I	–	U	–	–	–
PLANTAGINACEAE							
Plantago lanceolata L.	Narrow-leaved plantain	X	–	–	R	–	–
PRIMULACEAE							
Anagallis arvensis L.	Scarlet pimpernel	X	–	–	R	–	–
ROSACEAE							
Osteomeles anthyllidifolia Lindl.	'Ulei	E	–	–	–	C	–
RUBIACEAE							
Borreria laevis (Lam.) Griseb.	Buttonweed	X	O	O	–	–	–
Morinda citrifolia L.	Noni	P	–	R	–	R	–
SOLANACEAE							
Capsicum annuum L.	Red pepper	X	–	R	–	–	–
Solanum sodomeum L.	Apple of Sodom	X	U	–	R	–	–
STERCULIACEAE							
Waltheria americana L.	'Uhaloa	I	O	U	U	O	–
THYMELIACEAE							
Wikstroemia oahuensis (Gray) Rock	'Ākia	E	–	O	–	C	–
TILIACEAE							
Triumfetta semitriloba (L.) Jacq.	Burbush	X	R	O	R	–	–
UMBELLIFERAE							
Centella asiatica (L.) Urban	Asiatic pennywort	X	–	R	–	–	–
VERBENACEAE							
Lantana camara L.	Lantana	X	U	O	O	C	O
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	X	O	O	O	A	–
S. urticaefolia (Salisb.) Sims		X	O	–	O	–	–
Verbena litoralis HBK.	Weed verbena	X	U	U	U	–	U

APPENDIX M

Terrestrial Vertebrate Animals of the
"Country Golf Courses at Kahuku"
Punamano and Malaekahana

By Andrew J. Berger

Thie report was prepared upon instructions received from Mr. Jeffrey Overton of Group 70, Honolulu. Mr. Overton and Mr. Ralph Portmore escorted me and several other consultants on a thorough site visit of all four sites on December 21, 1988. I made additional field studies on December 28, 1988.

The Habitat

The entire region has been greatly altered for more than 100 years. There is no semblance of any endemic or native ecosystem anywhere near the site of the proposed golf courses. Nearly all plants in the four areas are introduced or alien plant species. St. John (1973) discussed more than 4,500 alien plants that have been introduced to the Hawaiian Islands. The dominant plants in all areas consist of koa haole (Leucaena glauca) and several species of grasses. Subdominant plants include Christmasberry tree (Schinus terebinthifolius) and Hialoa (Waltheria americana), a shrubby plant introduced from tropical America. Other shrubs and vines also grow in the area. A complete listing will be given by the botany consultant.

Amphibians and Reptiles

There are no endemic amphibians or land reptiles in the Hawaiian Islands. All, therefore, have been introduced by man and none are endangered or threatened species.

I. Amphibians

1. Giant Neotropical Toad (Bufo marinus). This toad was first introduced to the Hawaiian Islands in 1932 "when Dr. C. E. Pemberton brought 148 adult toads from Puerto Rico. Eighty of these were liberated in a taro patch near Waipio, Oahu, and 68 were released in a swampy part of Manoa Valley" (Oliver and Shaw, 1953:77). The toads were successful, and "in a little over two years more than 100,000 descendents of the original stock were distributed through Dr. Pemberton's activities throughout the islands." Hunsaker and Breese (1967) wrote that this toad was the "commonest species of amphibian in Hawaii." The neotropical toad is found throughout the general area, but they must return to lower elevations where there is water for their breeding activities.

2. Gold and Black Poison Frog (Dendrobates auratus).

This frog was introduced to Oahu to "assist in the control of insect pests." Oliver and Shaw state that the species was released in upper Manoa Valley in 1932. Hunsaker and Breese (1967) wrote that "additional plantings with subsequent establishment have been made in Waiahole Valley, and the population has been observed to fluctuate in size at this locality again according to the amount of water available." McKeown (1978) said that this frog is found in well-foliated. moist valleys on both Leeward and Windward Oahu." He added that, in summer and fall, "these frogs spend their time in moist places such as under debris, logs, stones, tangled root systems or under elevated valley homes." I did not see any of these frogs and

I believe that the ridges are too dry to sustain a population of this frog.

3. American Bullfrog (Rana catesbeiana).

"This was probably one of the first species of amphibians to be introduced into the Hawaiian Islands and may have been one of the frogs that was imported prior to 1867" (Oliver and Shaw, 1953). The frogs were abundant enough to be harvested commercially by 1900. Tinker (1941) wrote that "the University of Hawaii has organized 'frog clubs' to encourage the production of frogs for food." The species is not nearly so common now, presumably because of the draining of so many wetland areas and, perhaps also, because of the widespread use of pesticides during recent decades. There is no habitat for this water dependent frog in the project area.

4. Wrinkled Frog (Rana rugosa)

This frog was introduced to Hawaii from Japan in 1896 (McKeown, 1978). It is most common in mountain streams, although Shallenberger (1977: 245) found this species at Punahoolapa Pond on the north shore of Oahu. McKeown noted that the wrinkled frog and the bullfrog rarely are found together because the latter species is such an aggressive feeder. There is no subitable habitat for the wrinkled frog in the Project area.

II. Reptiles

1. Blind Snake (Typhlops braminus).

"This small, secretive snake was apparently introduced from the Philippines in the dirt surrounding plants that were brought in for landscaping the campus of the Kamehameha Boys School in Honolulu. It was first found there in January of 1930" (Oliver and Shaw, 1953). By 1967, Hunsaker and Breese (1967) write that "it now appears to occupy the lowland areas over the entire island." These blind, worm-like snakes are rarely seen until they are flooded from their underground burrows by heavy rains or unless one looks for them under branches and other debris on the ground. I did not search for these snakes because they are of no significance for an impact assessment.

2. Skinks and Geckos. Eleven species of skinks and geckos occur on Oahu. All are foreign to the islands, all are insect eaters, and all adapt well to both urban and rural habitats. Their presence is irrelevant to an impact assessment.

a. Family Iguanidae

1- green iguana (_Iguana iguana_)

2- green anole lizard (_Anolis carolinensis porcatus_)

b. Family Chamaeleonidae

3- Jackson's chameleon (_Chamaeleo jacksoni_)

c. Family Gekkonidae

4- mourning gecko (_Lepidodactylus lugubris_)

5- stump-toes gecko (_Gehyra mutilata_)

6- tree gecko (_Hemiphyllodactylus typus_)

7- Indo-Pacific gecko (_Hemidactylus garnoti_)

8- house gecko (_Hemidactylus frenatus_)

d. Family Scincidae

9- metallic skink (Leiolopisma metallicum)

10- snake-eyed skink (Cryptoblepharus boutoni)

11- moth skink (Lipinia noctua)

The Birds

Three groups of birds are found in the Hawaiian Islands: I. Introduced or exotic, II. indigenous or native, and III. endemic. All of the birds that are found within the boundaries of the project site are introduced species.

I. Introduced Birds

More than 170 species of alien birds have been intentionlly introduced to the Hawaiian Islands (Berger, 1981). I found the following species on the project sites or on lands adjacent to it. I include birds seen "on lands adjacent to the site" for several reasons. First, the sites are surrounded by areas of other land uses; secondly, my studies were conducted on only two days in late December; and, thirdly, some of the bird species seen adjacent to the project sites undoubtedly visit it from time to time and certainly will move in when the golf courses are built.

Family Ardeidae, Herons and Egrets

1. Cattle Egret (Bubulcus ibis)

This species was imported to Hawaii from Florida to aid "in the battle to control house flies, horn flies, and other flies that damage hides and cause lower weight gains in cattle" (Breese, 1959). A number of birds were released on Oahu in 1959 and 22 additional birds were released during July 1961. Thistle (1962) reported that the population of cattle egrets on Oahu exceeded 150 birds by July 1962. The population has increased greatly since that time. Personnel of the State Division of Forestry and Wildlife counted 621 egrets on Oahu during their January 1986 census (Walker, et al., 1986), and Pyle (1988) reported that 1009 egrets were counted just in the area covered by the Audubon Society Chrismas Count on December 27, 1987. The first active rookery was found near Kahuku in 1960 (Elepaio, 21:39-40). I found cattle egrets along the road leading up to the military training area, as well as in flight near the proposed Malaekahana golf course area. There were literally hundreds of egrets along the ponds at the shrimp farm on the makai side of the highway.

Family Columbidae, Pigeons and Doves

2. Spotted or Chinese Dove (Streptopelia c. chinensis)

This Asian dove was introduced to the Hawaiian Islands at an early date; the exact date is unknown, but the birds are said to have been very common on Oahu by 1879. The species is now very common on all of the major islands and is classified as a game bird in Hawaii.

This dove also is called the lace-necked dove because of the conspicuous bands of white spots on the back of the neck. Although this species does occur where the rainfall exceeds 100 inches per year, the highest densities are found in drier areas where the introduced kiawe or mesquite (Prosopis pallida) is one of the dominant plants. Schwartz and Schwartz (1949), for example, reported densities as high as 100 birds per square mile in dry areas on Molokai. This dove is common on the project site and in all surrounding areas where the vegetation is not too dense.

3. Barred Dove or Zebra Dove (*Geopelia striata*)

This species is called the zebra dove in its native habitat in the Orient and Australia. This species is said to have been introduced to Hawaii sometime after 1922 (Bryan, 1958). It now is common to abundant on all of the islands. This dove also prefers the drier areas, and Schwartz and Schwartz (1949) reported densities as high as 400 to 800 birds per square mile in some areas on Oahu (e.g., Barber's Point to Makaha).

The zebra dove also is classified as a game bird in Hawaii, but, because of its small size, few birds have been shot in recent years (Saito and Walker, 1984). For example, 6,963 zebra doves were shot by hunters during the 1969-1970 game bird season; only one bird was reported during the 1983-1984 season.

One study of the food habits of the barred dove in Hawaii revealed that the diet consists of 97 percent seeds and other plant materials; the 3 percent animal matter included several species of beetles, weevils, and wireworm larvāe. Kocan and Banko (1974) reported on barred doves from the Big Island that were infected with trichomonas; this parasite has "catastrophic" effects on doves in North America. The zebra dove is common throughout the project site and adjacent areas.

Family Tytonidae, Barn Owls

4. Barn Owl (Tyto alba pratincola)

The first barn owls were imported from California and released on Hawaii island during April 1958. Barn owls were released at Hauula, Oahu, on two different occasions. Seven birds were imported from the San Diego Zoo and released during September 1959; 11 additional birds were imported from the San Antonio Zoo, Texas, and released at Hauula during October 1959 (Tomich, 1962). As with the mongoose much earlier, the barn owls were introduced in the hopes that they would prey upon the abundant rats in the sugarcane fields. No long-term food habits study has been conducted in Hawaii, but on Hawaii island Tomich (1971) found that almost 90 percent of the barn owl pellets that he examined contained only the remains of house mice. He commented that, although the barn owl sometimes feeds on rats, it is not likely a significant fact in the economic control of rats in Hawaii. Moreover, Byrd and Telfer (1980) reported that barn owls on Kauai and Kaula Island had killed more than 100 seabirds and their chicks. On Oahu, a barn owl killed six white terns (Gygis alba) in Kapiolani Park (Elepaio, 46, 1986:175).

No study of the spread of the barn owl from Hauula region since 1960 has been made, but the birds have been seen and found injured or dead on both leeward and windward sides of the island. The barn owl also has been seen in the ironwood (Casuarina) habitat makai of the highway. Barn owls are nocturnal in habits and I did not see any during my field studies. It is reasonable to assume, however, that one or more birds forages over the project site for food.

The remaining introduced birds belong to the order Passeriformes, which includes all of the socalled songbirds.

Family Timaliidae, Babblers and Laughing-thrushes

5. Melodious Laughing-thrush (Garrulax canorus)

Although long called the Chinese thrush in Hawaii, this species is a babbler and not a member of the thrush family (family Turdidae). The Chinese name is Hwa-mei. It was introduced to the islands many years ago as a favorite cage bird. "A number obtained their freedom at the time of the great fire in the Oriental quarter of Honolulu in 1900, and took to the hills behind the city" (Caum, 1933).

This babbler is now found in both the Koolau and the Waianae mountains. It seems to prefer wetter areas where there are thickets and clumps of dense vegetation. The birds have a loud, attractive song and more often are heard rather than seen. It is widespread in the project area.

Family Pycnonotidae, Bulbuls

6. Red-vented Bulbul (Pycnonotus cafer)

Although all members of this family are listed as "prohibited entry" by the State Quarantine Division of the Department of Agriculture, two species are now well established on Oahu. The history of the spread of the red-vented bulbul since the mid-1960s has been discussed by Berger (1975, 1981).

Bulbuls are a scourge to both fruit and flower growers because they eat not only ripe fruits and peppers but also buds and flowers. This bulbul has now reached the North Shore and is a very conspicuous bird through the project sites and the surrounding areas.

Family Turdidae, Thrushes and Solitaires

7. White-rumped Shama (Copsychus malabaricus)

According to Caum (1933), this attractive thrush was first released on Oahu by the Hui Manu in 1932. Bryan (1958) said that this species was released on Kauai in 1931 and that it was established on that island and in the Tantalus region of Oahu. Shama is the Indian name for this thrush, which is native to India, Nepal, Burma, Malaysia, and throughout the Indochina area.

The Shama is now a common bird on both leeward and windward sides of Oahu. The birds prefer lush vegetation, and they typically are noted because of their loud and attractive song. They were singing during late December 1988 and were found throughout the project areas.

Family Sylviidae, Old-world Warblers

8. Japanese Bush Warbler (Horeites cantans)

This warbler, which is native to Japan and Formosa, was first released on Oahu in 1929 (Caum, 1933). The Japanese name is Uguisu. Berger (1975b) summarized our knowledge of the distribution of this species on Oahu. These are shy and secretive birds, typically occuring in habitats with dense underbrush. Their song period lasts from mid-December to mid-July, and they were singing during my December field studies.

Family Zosteropidae, White-eyes and Silver-eyes.

9. Japanese White-eye (Zosterops japonicus)

Long a favorite cage bird in the Orient, this white-eye was first imported from Japan to Oahu by the Territorial Board of Agriculture and Forestry in 1929 (Caum, 1933). Later importations were made by the Hui Manu. The Japanese name is Mejiro, amd Mejiro Clubs held singing contests with these birds.

The Japanese white-eye rivals the House Sparrow and the European starling in North America as a successful alien species, and it now undoubtedly is the most abundant song bird in the Hawaiian Islands. It occurs from sea level to 10,000 feet elevation on Maui and Hawaii, and it occurs in near desert areas and those with an annual rainfall exceeding 300 inches. It is found in all habitats of the project sites and the adjacent areas.

Family Sturnidae, Mynas and Starlings.

10. Common Indian Myna (Acridotheres tristis)

This myna is native to Sri Lanka, India. Nepal, and adjacent regions. It "was introduced from India in 1865 by Dr. William Hillebrand to combat the plague of army worms that was ravaging the pasture lands of the islands. . . . . reported to be abundant in Honolulu by 1879. it now is extremely common throughout the Territory" (Caum, 1933). The myna continues to be abundant on Oahu, and it occurs both in the vicinity of buildings, on golf courses, in rural and residential areas. It is a common species throughout the Kuilima region.

Family Ploceidae, Weaverbirds and Their Allies

a. Subfamily Estrildinae, Waxbills

11. Common Waxbill (Estrilda astrild)

When this African species was introduced to Oahu appears to be unknown, but the species is widely distributed now. It seems probable that it was released during the mid-1960s. It also sometimes is called the St. Helena waxbill (Goodwin, 1982; Falkenmayer, 1988). Although I did not see this species on the project sites, I did see a flock of 37 birds feeding on grass seeds on the other side (makai) of Kamehameha Highway.

12, Spotted Munia or Ricebird (Lonchura punctulata)

This munia has a wide distribution in Sri Lanka, India, Nepal, Burma, and southward into Malaysia and the Indo-Chinese subregion, and in the Philippines. The species was introduced to Hawaii about 1865 by Dr. William Hillebrand. Caum wrote that this species "feeds on the seeds of weeds and grasses and does considerable damage to green rice." Although rice is no longer grown in Hawaii, the birds have continued to be destructful to certain crops (see explanation under house finch). Ricebirds are highly gregarious and flocks of 100 or more birds are not uncommon at certain times of the year. It is a prolific species that nests throughout the year. They are not inhabitants of dense thickets or forests, but occur wherever there are open spaces, for example, golf courses, along dirt roads, and residential areas. The ricebird is common through the project region.

b. Subfamily Passerinae, Sparrow Weavers

13. House Sparrow (Passer domesticus)

Incorrectly sometimes called the English Sparrow (it has a wide distribution in Europe and Asia), this sparrow was first imported to Hawaii in 1871, when nine birds were brought to Oahu from New Zealand (where they previously had been introduced from England). Caum (1933) wrote that "the species was reported to be numerous in Honolulu in 1879." The house sparrow became a serious pest in North America and many thousands of dollars were spent in attempting to control the population. It is omnivorous in diet, eating weed seeds as well as insects and their larvae. In India, as well as in North America, the house sparrow causes "collosal damage to the food-grains in standing crops and storages" (Rana and Idris, 1986; Dearborn, 1912).

The house sparrow typically is found in the vicinity of man and his buildings but they also forage in outlying areas and I found them generally distributed in and around the project sites.

Family Fringillidae, American Sparrows and Their Allies

a. Subfamily Emberizinae

14. Red-Crested Cardinal (Paroaria coronata)

This species was long called the Brazilian cardinal in Hawaii, but the native range of this South American species includes Uruguay, Paraguay, Brazil, and parts of Bolivia and Argentina. The species was released several times between 1928 and 1931 (Caum, 1933). This cardinal is a very common species on Oahu and it is found in residential and rural areas. It occurs throughout the Kuilima and the project sites.

b. Subfamily Cardinalinae

15. Cardinal (Cardinalis cardinalis)

This North American bird is known as the Kentucky cardinal, Virginia cardinal, and the Kentucky redbird. Its native range is the eastern part of North America east of the plains and northward into Ontario. The cardinal was released on Oahu several times between 1929 and 1931 (Caum, 1933). It now is a common species in residential and rural areas. It is generally distributed in the project area.

c. Subfamily Carduelinae

16. House Finch (Carpodacus mexicanus frontalis)

This finch was introduced to Hawaii from California "prior to 1870, probably from San Francisco" (Caum, 1933). The house finch now is an abundant species on all of the islands, and probably is the second most common song bird in the islands. Although house finches sometimes eat ripe fruit, especially papaya (hence the vernacular name of Papayabird), the species is predominantly a seed eater. House finches and ricebirds caused great damage to experimental sorghum crops on Kauai and Hawaii during 1971 and 1972. A report by the Senate Committee on Ecology, Environment, and Recreation said that "ricebirds and linnets [equals house finch] caused a 30 to 50 percent loss in the sorghum fields at Kiluea on Kauai last year . . . . seed-eating birds at Kohala are 50 tons of sorghum grain in a 30-acre experimental field that was supposed to produce 60 tons" (Honolulu Advertiser, March 14, 1972, page B-2). The house finch also is common throughout the proposed project sites.

II. Indigenous Birds

These are species that occur naturally in Hawaii and also in other parts of the Pacific Basin. These birds are native to the Hawaiian Islands but are not unique to them. In this category are 22 species of sea birds, the Hawaiian black-crowned night heron, and a number of migratory species that spend their winter or non-breeding season in the islands.

There is no habitat for the sea birds in the project region, although I did see three great frigatebirds (*Fregata minor palmerstoni*) soaring high over the lower portion of the Malaekahana area.

There is no habitat for the black-crowned night heron (*Nycticorax n. hoactli*) in the project areas. but the species is very common at the waste stabilization pond and in the Punahoolapa marsh area.

Bruner (1978: Table 2) reported seven species of wintering ducks and shorebirds at the Kuilima and Punahoolapa pond areas on the makai side of Kamehameha Highway. For the project sites, however, I would expect to find only one species: the lesser golden plover (Pluvialis dominica fulva). In Hawaii these birds winter from sea level to 10,000 feet elevation on Maui and Hawaii. The birds frequent lawns in residential areas, golf courses, weedy pastures, open areas in the mountains, and mud flats along the beaches. They are common winter residents in the Kuilima region and I found them along the dirt roads in the project areas as well as on eroded land in the hills.

III. Endemic Birds

These are birds that are unique to the Hawaiian Islands; they occur naturally nowhere else in the world. Many of these endemic birds are classified as threatened or endangered by the U.S. Fish & Wildlife Service and the State Division of Forestry and Wildlife. Most of these endangered birds, however, are forest birds and there is no suitable habitat for them on Oahu for many miles from the project sites. Nor is there any habitat for the four endangered Hawaiian waterbirds on the project sites, although these birds are found in the Punahoolapa marsh region and on the James Campbell National Wildlife Refuge. These four species are: 1. Koloa or Hawaiian duck (Anas wyvilliana), Hawaiian gallinule or 'Alae 'Ula (Gallinula chloropus sandvicensis), Hawaiian coot or 'Alae Ke'oke'O (Fulica americana alai), and the Hawaiian stilt or Ae'O (Himantopus mexicanus knudseni).

There is one endangered Hawaiian bird that could occupy the general region: the Hawaiian owl or Pueo (Asio flammeus sandwichensis). This subspecies of the North American short-eared owl is considered to be endangered on Oahu by the State Division of Forestry and Wildlife but not by the U. S. Fish & Wildlife Service. This owl differs from most other owls in that it is diurnal in habits, so that, where present, it typically is seen soaring either high or low over the ground as it searches for prey. I did not see any Pueo during my field studies nor have I ever seen it in this region during past field work there. I do not know of any published reports of its occurrence in the area.

Mammals

I. Endemic Mammals

The only endemic land mammal is the Hawaiian bat (*Lasiurus cinereus semotus*), a subspecies of the North American hoary bat. The Hawaiian bat is found primarily on Kauai and Hawaii (Kramer, 1971; Tomich, 1986). I know of no evience that there is a resident population of bats on the island of Oahu.

II. Introduced Mammals

All of the introduced species of mammals have proven highly detrimental to man, his buildings, agricultural crops, and/or to the native forests and their animal life. None is an endangered species and none is of concern as far as detrimental effects resulting from a change in land use. It would, in fact, be a great boon to the-islands if it were possible to exterminate all of them.

With the possible exception of the house mouse (*Mus musculus*) all of the smaller introduced mammals prey on birds, their eggs, and young. These small mammals include the roof rat (*Rattus rattus*), Polynesian rat (*Rattus exulans*), Norway rat (*Rattus norvegicus*), small Indian mongoose (*Herpestes auropunctatus*), feral cat (*Felis catus*), and feral dog (*Canis familiaris*). Because all of these mammals are serious pests, I did not set traplines in order to sample the population, It is reasonable to assume that all of the rodents occur in the project areas (Kramer, 1971; Tomich, 1986). The diurnal mongoose was seen on a number of occasions as it ran across the dirt roads.

Summary and Conclusions

1. The vast majority of the plants in the project areas are introduced or alien species, some of which are pest species. There is no semblance of any native ecosystem anywhere near the project areas. The change in land use, therefore, will have no adverse effects on any native ecosystem.

2. Because there are no endemic amphibians or land reptiles in the Hawaiian Islands, all of those that are present are alien or introduced species. Some (e.g., the bullfrog) pose a threat to the endangered Hawaiian waterbirds; they prey on the downy young of the Koloa and probably on the young of the other marsh birds. The neotropical toad has poison glands that are a threat to dogs and to young children. All of these introduced animals are irrelevant to an environmental impact assessment.

3. None of the 16 species of introduced birds discussed in this report is an endangered species and a number have proven to be serious pests to agriculture in Hawaii. The destruction

to sorghum crops by the ricebird and the house finch has been discussed above. The two species of doves and the myna have been implicated in the spread of such noxious plants as Lantana camara. The Japanese white-eye and the red-vented bulbul cause considerable damage to ornamental flowers and to fruit crops (see Keffer, et al., 1976). The barn owl has been reported to kill seabirds and their chicks on Kauai and the white tern on Oahu. It seems reasonable to conclude, therefore, that these alien bird species are of no concern in an environmental impact assessment. In fact, the construction of golf courses would improve the habitat for a number of these species.

4. There is no habitat for the Hawaiian black-crowned night heron on any of the proposed project sites. For the following reasons, however, their occurrence at the Punahoolapa marsh area and at the nearby shrimp farms is entirely irrelevant to an impact assessment of the project sites. First, although these herons feed primarily on aquatic insects, fish, frogs, and mice, they also sometimes prey on the downy young of terns and undoubtedly on the downy young of the endangered Hawaiian waterbirds. Secondly, they also have a liking for prawns and the State Land Board gave prawn producers a "120-day permit to destroy black-crowned night herons which have been causing economic havoc at Oahu's Kahuku prawn farm as well as other aquaculture farms statewide" (Honolulu Star-Bulletin, October 26, page A-8 and October 30, 1985, front page).

5. Clearing of the sites to build greens and fairways for the golf courses would actually provide more habitat for the wintering golden plovers.

6. Changes in the land use will have absolutely no effect on any of the Hawaiian seabirds.

7. Although the Pueo or Hawaiian owl does occur on Oahu, it is an uncommon species there, and I know of no records of its being seen in the vicinity of the project sites. Scott, et al. (1986) wrote that the Pueo "was most often seen in grasslands, shrublands, and montane park-lands" on Maui and Hawaii.

8. The only endemic land mammal in Hawaii is the Hawaiian bat, now classified as an endangered mammal. However, I know of no evidence that there is a resident population on the island of Oahu (Kramer, 1971; Tomich, 1986).

9. All of the remaining mammals in the project region are introduced or alien mammals and all are serious pests to man, his buildings, products, agriculture, and to the native forests and their animal life. The three species of rats prey on the nests of ground-nesting birds and even some tree-nesting birds. The mouse and the rats cause great damage to homes, businesses, and agriculture. The very common diurnal mongoose is a serious predator on some of the endangered waterbirds as well as on poultry and other domestic birds. If it were possible to exterminate all of these alien mammals, it would be a great

benefit to the Hawaiian Islands. There presence, therefore, in and adjacent to the project sites is irrelevant to an impact assessment.

10. In view of the above summary, I can see no biological reason for not changing the land use for the project sites.

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APPENDIX N

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

Report 483-040489

ARCHAEOLOGICAL INVENTORY SURVEY
PUNAMANO AND MALAEKAHANA GOLF COURSES

Lands of Ulupehupehu, Punaluu, Kahuku, Malaekahana, and Laie
Koolauloa District, Island of Oahu

by

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Prepared for

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April 1989

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SUMMARY

At the request of Mr. Ralph Portmore of Group 70, for their client, Kuilima Resort Company, Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed an archaeological inventory survey of the proposed Punamano and Malaekahana Golf Courses project area, which comprises c. 866 acres in the Koolauloa District on the Island of Oahu. The field work was conducted December 19, 1988 through January 25, 1989, and involved a variable coverage (partial to 100%), variable intensity surface reconnaissance survey of the project area. The objectives of the survey were to (a) identify all sites and site complexes present within the project area, (b) evaluate the potential significance of all identified archaeological remains, (c) determine the possible impacts of the proposed golf course development upon the identified remains, and (d) define the general scope of any subsequent archaeological work that might be deemed necessary or appropriate.

A total of 26 archaeological sites containing 45 component features have been identified within the 866-acre project area. Formal feature types present at the sites include caves, overhangs, walls, terraces and platforms, enclosures, isolated midden deposits, and historic components including WWII II emplacements, historic dumps, roads, and agricultural ditches. Functional types present include habitation, burial, historic agriculture, and WWII II activities.

Of the total 26 sites situated within the project area, 23 are assessed as significant solely for information content. For 13 of the 23 sites, no further work is recommended. For the remaining 10 of the 23 sites, further data collection is recommended. Of the remaining three of the total 26 sites, two are assessed as significant for information content and cultural value. For these two sites, further data collection is recommended. The remaining one site is assessed as significant for information content and as an excellent example of a site type. For this site, further data collection followed by preservation "as is" is recommended.

483-040489

INTRODUCTION

BACKGROUND

At the request of Mr. Ralph Portmore of Group 70, for their client, Kuilima Resort Company, Paul H. Rosendahl, Ph.D., Inc. (PHRI) completed an archaeological inventory survey of the proposed Punamano and Malaekahana Golf Courses project areas in the Koolauloa District on the Island of Oahu. Comprising a total of c. 866 acres, the project area consists of three courses at Punamano, near the existing Kuilima Resort in the Lands of Ulupehupehu, Punalau, and Kahuku, and a fourth course near Laie Town in the Lands of Malaekahana and Laie. The basic objective of this survey has been to provide information appropriate to and sufficient for the preparation of an Environmental Impact Statement (EIS) being prepared in conjunction with a Land Use Boundary Amendment petition to be submitted to the State Land Use Commission and a Development Plan Change application to be submitted to the City and County of Honolulu (CCHONO).

The survey was conducted December 19, 1988, through January 25, 1989, under the supervision of PHRI Supervisory Archaeologist Bert Rader and Associate Senior Archaeologist Dr. Peter M. Jensen, assisted by PHRI Field Archaeologists Brad Dilli, Gerald Doty, Mike Fager, Jack Harris, and Hoski Schaafsma. Approximately 839 man-hours of labor were expended conducting the survey field work.

The present report comprises the final report of the current project. The report includes a scope of work, a detailed description of the project area, a discussion of previous archaeological investigations including a brief overview of areal prehistory, historical documentary research, a section on field methods and procedures, and site descriptions. The report concludes with evaluations and recommended treatments for all sites.

SCOPE OF WORK

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

The project area inventory survey was carried out in accordance with the standards for inventory-level survey recommended by the Hawaii State Department of Land and Natural Resources-Historic Sites Section/State Historic Preservation Office (DLNR-HSS/SHPO). These standards are currently being used by the City and County of Honolulu as guidelines for the review and evaluation of archaeological reconnaissance survey reports submitted in conjunction with various development permit applications.

The specific objectives of the present inventory survey were four-fold: (a) to identify (find and locate) all sites and features present within the project area (including any previously identified and as yet unidentified sites and features), (b) to evaluate the potential general significance of all identified archaeological remains, (c) to determine the possible impacts of any proposed development upon the identified remains, and (d) to define the scope of any subsequent intensive data collection and/or other mitigation work that might be necessary or appropriate.

Based on a review of readily available background literature, basic familiarity with the general project area, extensive familiarity with the current requirements of pertinent review authorities, and discussions with Mr. Portmore of Group 70 and with Dr. Joyce Bath—staff archaeologist for the Island of Oahu with the Hawaii State Department of Land and Natural Resources-Historic Sites Section/State Historic Preservation Office (DLNR-HSS/SHPO), the following specific tasks were determined to constitute an adequate and appropriate scope of work for the proposed inventory survey:

1. Conduct limited archaeological and historical documentary background research involving review and evaluation of readily available archaeological and historical literature, historic documents and records, and cartographic sources relevant to the immediate project area. In addition, assess the potential utility of more detailed historical research that might be appropriate in connection with any subsequent archaeological work;

2. Conduct a variable coverage (partial to 100%), variable intensity surface reconnaissance survey of the project area, with (a) relatively higher intensity coverage being given non-cultivated and otherwise minimally modified lands, and (b) relatively lower intensity coverage to areas extensively modified by historic period and/or recent cultivation;

3. Conduct limited subsurface testing of selected locations within the project area by means of mechanical backhoe to determine the presence or absence of potentially significant buried cultural features or deposits; conduct limited subsurface testing within archaeological deposits in order to recover appropriate dating samples; and

4. Analyze background and field data, and prepare appropriate reports. The Final Report to include (a) a full descriptive account of survey findings, (b) interpretation and evaluation of the findings, and (c) specific recommendations for any further archaeological work that might be appropriate and/or required.

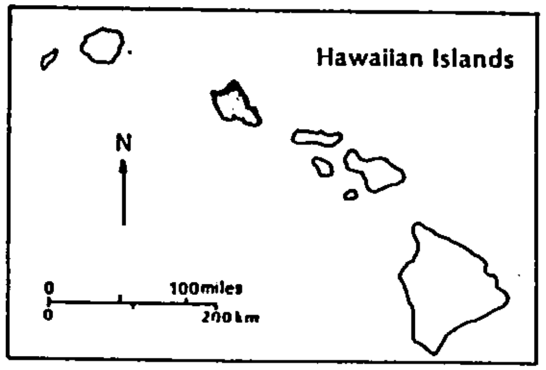
The inventory survey was carried out in accordance with the standards for inventory-level survey recommended by DLNR-HSS/SHPO. The significance of all archaeological remains identified within the project area was assessed in terms of (a) the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60), and (b) the criteria for evaluation of traditional cultural values prepared by the national Advisory Council on Historic Preservation. DLNR-HHS/SHPO uses these criteria to evaluate eligibility for both the Hawaii State and National Register of Historic Places.

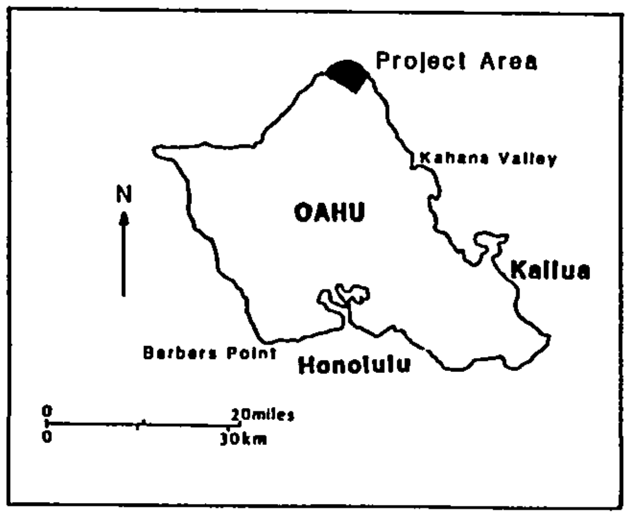
To further facilitate management decisions regarding the subsequent treatment of resources, the general significance of all identified archaeological remains was also evaluated in terms of potential scientific research, interpretive, and/or cultural values. Scientific research value refers to the potential 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.

PROJECT AREA DESCRIPTION

The Punamano and Malaekahana Golf Courses are situated immediately inland from the coast and Kahuku Point, within the Lands of Ulupehupehu, Punalau, Kahuku (Punamano Golf Courses, three in number), and Malaekahana and Laie (Malaekahana Golf Course), Koolauloa District, Island of Oahu. (Figure 1).

The Punamano project area encompasses approximately 638 acres, or nearly 74% of the c. 866 acres comprising the entire land area examined as part of the present project. The three golf courses to be constructed on these lands are bounded on the north by Kamehameha Highway, and on the east, south, and west by private lands owned by Campbell Estates.





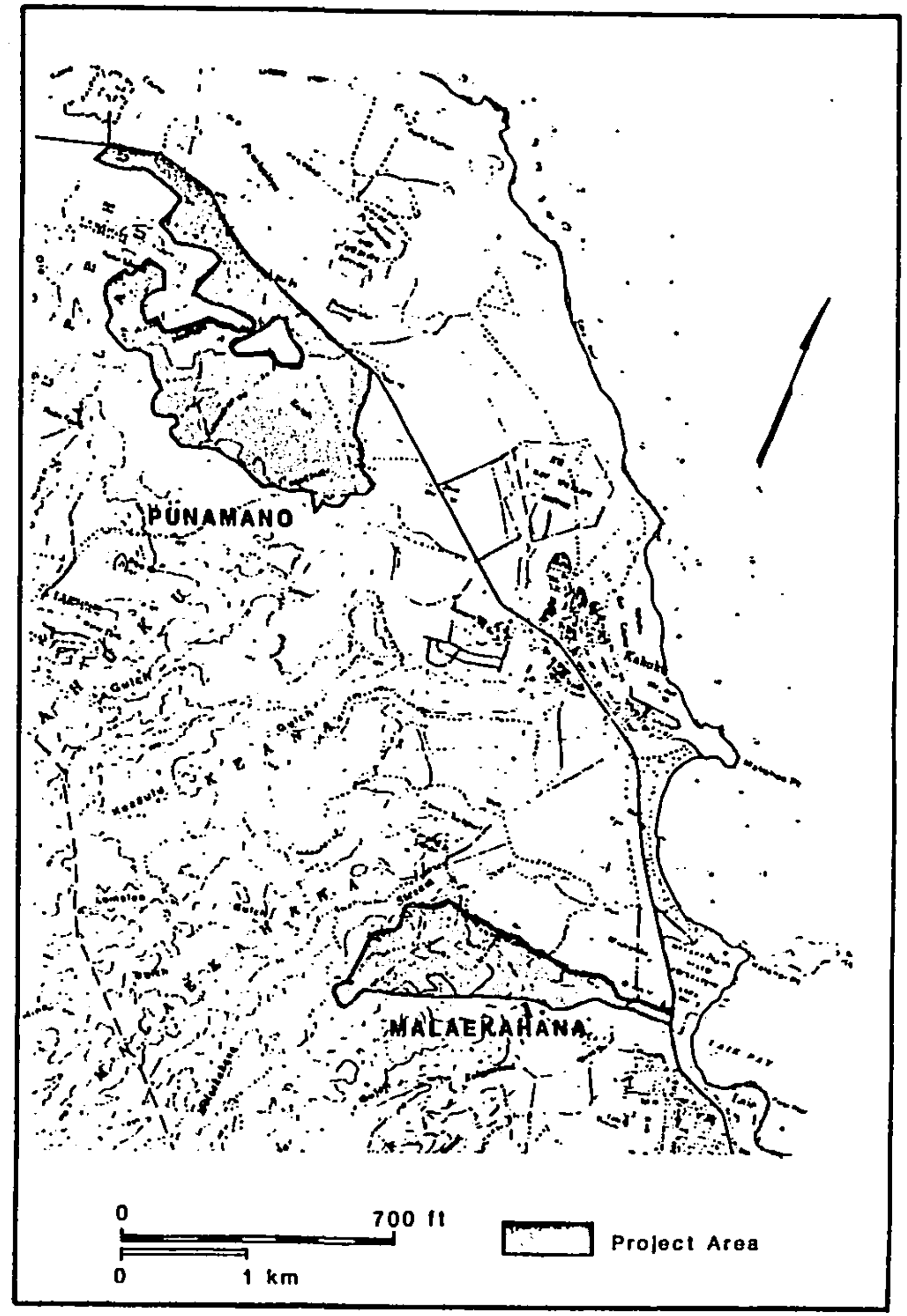


Figure 1. PROJECT AREA LOCATION MAP

ARCHAEOLOGICAL INVENTORY SURVEY
PUNAMANO AND MALAEKAHANA GOLF COURSES
Lands of Ulupehupehu, Punalau, Kahuku, Malaekahana, and Laie

Koolauloa District, Island of Oahu

PHRI Report 483-040489 April 1989

The Malaekahana Golf Course, to be located between approximately 0.50 and 1.25 miles northwest of Laie Town, represents a linear segment of land encompassing approximately 228 acres (c. 26% of the overall project survey area). This parcel is narrowest at its eastern end where it is bordered by Kamehameha Highway; the parcel expands in width as it proceeds c. 7,500 ft (nearly 2,500 m) eastward from the highway.

Both of the parcels affect lands located between one and two miles inland from the coast at elevations ranging from 20 to 260 ft above mean sea level (AMSL) at Punamano, and from 20 to nearly 400 ft AMSL at Malaekahana. Both parcels are generally exposed to the prevailing northeasterly winds which cross the coastline at average speeds of 18-20 knots. Temperature in the coastline area ranges between 65-85 degrees F, and slightly lower at the highest points within the two project areas (Armstrong 1983:64-65). Both parcels receive approximately 40-60 inches of rainfall per year (concentrated between late November through February). Although a moderately dissected region dissected by several gulches, neither parcel contains a permanent water source, although such sources are available nearby. The Punamano Spring complex is located immediately north of the east end of the Punamano project area, while Kahawainui Stream flows adjacent to the east end of the Malaekahana project area at a distance of c. 300 meters to the south.

Both project areas are relatively diverse in terms of topography, soils and dominant vegetation. The low, nearly flat coastal plain extends into the northern portion of the Punamano project area and the easternmost portion of the Malaekahana project area. Historically cleared of natural vegetation and planted in sugar cane, the abandoned fields within these low areas now support dense stands of immature koa-haole (Leucaena glauca [L.] Benth.), and other introduced species which thrive in disturbed soils, including ironwood (Casuarina equisetifolia L.), Christmas-berry (Schinus terebinthifolus Raddi), and tree heliotrope (Messerchimidia argentea [L.f.] Johnston). Soils in these low lying areas are dominated by silty clays, primarily of the Lahaina Series (Foote et al. 1972).

The uplands in both project areas, separated from the narrow littoral plain by an escarpment averaging 100 m high, support scattered ironwood (Casuarina equisetifolia [L.]), occasional dense stands of eucalyptus trees, open pasture, and a variety of grasses and 'uhaloa (Waltheria americana [L.]). Vegetation along the several upland gulches which dissect both project areas is generally comprised of strawberry guava (Psidium cattleianum Sabine), Christmas-berry (Schinus terebinthifolius Raddi), Java plum (Eugenia javanica Lamb.), ironwood, grasses, and 'uhaloa. Within these upland areas, soils are dominated by stony clays, primarily of the Kaena Series (Foote et al. 1972).

Lastly, both project areas contain significant plateau areas comprised of exposed coral reef escarpments capped with silty clays or a thin layer of friable, red soil concentrated in cracks, crevices, and depressions. These formations represent between 20 and 25% of the Punamano project area, and approximately 10% of the Malaekahana project area. Where present within the two project areas, these plateaus tend to be covered with dense stands of koa-haole. Erosion around the exposed perimeters of these coral outcrops has created small overhangs and caves which provided suitable locales for prehistoric and historic occupation and other activities (primarily burial). Since these areas were generally not subjected to agriculture or other historic developments, these areas retain the highest percentage of intact cultural resources located within the project area.

PREVIOUS ARCHAEOLOGICAL WORK

Previous archaeological work within the immediate and general vicinity of the present project area consists primarily of reconnaissance research, although several subsurface testing and data recovery projects have also been completed at the nearby Kuilima Resort and on Kahuku Point.

The earliest documented archaeological research is the 1930 survey of Oahu by McAllister (1933). McAllister's work adjacent to the present project area resulted in identifying one site, Kukio Pond. Located near Kahuku Point, the pond was described as "...a natural basin filled with brackish water, located about 300 feet from the sea, Kahuku Point." Formerly much larger and containing several varieties of fish, McAllister suggested that the pond system was undoubtedly associated with a large Hawaiian settlement. Mrs. John Kaleo, interviewed by McAllister, indicated that she had friends and relatives buried in shallow graves in the sand between the pond and the sea. She also recounted that trees, now found only on the mountains to the south, once covered the Kahuku plain (McAllister 1933:153). The entire Kukio Pond system was destroyed during the construction of Kahuku Air Base.

During the 1970's and early 1980's, a number of reconnaissance surveys were conducted in the general vicinity of Kahuku Point (Barrera 1979, 1981, 1984; Clark 1978; Davis 1981, 1982; Rogers-Jourdane 1982; Schilt 1979; and Sinoto 1981). An historical account of the Kahuku area was also prepared at this time (Nakamura 1981). Collectively, these various projects resulted in expanding the information base regarding the number and types of prehistoric and historic site types present along the northernmost shores of Oahu.

Of particular relevance to the present project area is Davis' 1981 Kahuku Wind Farm project area survey (Davis 1981). Only four cultural sites were located during an examination of c. 100 acres of land located between about 150 and 250 m above mean sea level. Three of the sites, including two small habitation sites and a probable religious structure, were presumed to be prehistoric, all of which were situated in a protected upland swale. Davis interpreted the sites as representative of an aboriginal response to conditions of persistent wind, high annual rainfall, and low topographic relief lacking developed stream channels. Citing historic records which emphasized extensive native use and occupation within the Kahuku area, Davis' own field work produced contrasting results. In effect, Davis' findings highlight the negative impact on prehistoric resources which have accompanied historic agriculture. Similar results were expected within the present project area, most of which involves lands which have been extensively cultivated since the latter part of the 19th century.

Concurrently with some of the survey projects identified above, subsurface evaluation of select deposits was also being undertaken. In August of 1977, Dye (1977) examined the western portion of Site 2911 and discovered that it represented an extension of previously recorded Site 50-Oa-F4-14. To further evaluate the subsurface deposits within Site F4-14, Dye excavated a 1.0 sq m test unit to 100 cm below surface, revealing two occupation layers. The upper layer (III) appeared transitional, from prehistoric and/or protohistoric to historic; the lower layer (IV) appeared to be fully prehistoric. Site F4-14 was evaluated as containing potentially valuable prehistoric cultural deposits, and additional data recovery was recommended.

The eastern portion of Site 2911 was designated Site T-6 during a 1984 subsurface reconnaissance survey by Bath (1984). Subsequently, Bath's Site T-6 was combined with previously recorded Site F4-14, and both were redesignated Site 50-OA-2911, "Kahuku Point Archaeological Area." This complex was later determined by SHPO to be eligible for inclusion on the National Register of Historic Places (letter of Aug. 13, 1986, from Susumu Ono, state historic preservation officer/Board of Land and Natural Resources chairperson, to Everett A. Flanders, chief, Construction-Operations Division, Operations Branch, U.S. Army Engineer District, Honolulu).

In May of 1984, SHPO Staff Archaeologist Earl Neller conducted a limited reconnaissance survey along the eastern portion of Kahuku Point. During his inspection of a sand dune, Neller discovered several burial pits which had been excavated into an older midden deposit that contained charcoal and marine shell. Laboratory analysis of the burial remains resulted in the identification of three individuals, and provided some additional insight into the relationship between late prehistoric and early historic use/occupation within the area.

During a 1986 subsurface reconnaissance of the Kahuku Point Archaeological Area (Survey Area 6 [Site F4-14] and Survey Area 7 [Kahuku Point, east side]), PHRI (Walker and Haun 1986) excavated 18 auger units, two face-section shovel units, and 3.0 sq m of sand near the human remains earlier identified by Neller (1984). The research in Survey Area 6 (Site F4-14) revealed three cultural layers, each c. 12-19 cm thick. Two layers (III, IV) appeared to correspond with cultural layers which had earlier been identified by Dye (1977). A dating sample (PHRI No. RC-157) from Layer IV yielded a calendric age of 165 BC-AD 210 (calibrated according to Klein et al. 1982). The research in Survey Area 7 (Kahuku Point, east side) revealed two subsurface cultural layers, each c. 20-30 cm thick.

The upper layer contained human skeletal remains and appeared to be associated with those skeletal remains earlier uncovered by Neller (1984). A single dating sample (PHRI No. RC-156) was recovered from Layer II in TU-34, which yielded a calendric calibrated age of AD 1655-1950.

Based on these findings, Site 2911 was evaluated as having potentially high scientific research value, and appropriate further archaeological work was recommended (Bath 1984:53). The recommendations were implemented by PHRI in April of 1986, and involved excavation of 105 auger cores and 28 test units at Site 2911. This research defined the spatial extent of archaeological remains representing prehistoric, protohistoric/early historic, and recent historic-period occupation at Site 2911. Additional age determinations on volcanic glass and radiocarbon samples yielded an overall maximum age range of AD 1065 to AD 1950 for Site 2911.

There were several implications of the Kahuku Point research for the present project. First, although Kahuku Point has yielded little or no evidence of significant occupation prior to about 1,000 years ago, the present project area contained an important site type not represented on the narrow coastal plain. Specifically, numerous caves were believed to exist around the margins of the coral escarpment located just inland from the Kamehameha Highway within the present project area; it was expected that such sites might contain evidence of earlier prehistoric use and occupation. Second, the PHRI research (as well as Davis' earlier upland survey work) had documented the effects of agricultural practices and WWII II construction activities on archaeological sites. The implications for the present project were that many of the area's archaeological sites were undoubtedly obliterated as historic agricultural fields were cleared, "chained," and cultivated year after year. Site complexes, and remnants of such complexes, were expected to be most frequently encountered within agriculturally marginal areas, such as steep terrain associated with gulches, and along the margins of the elevated limestone escarpment fronting much of the Punamano project area.

Finally, a substantial archaeological excavation program was undertaken during the late 1970's at Malaekahana State Recreation Area (Yent and Estioko-Griffin 1980). The research involved reconnaissance, testing and mitigative-level excavations at several sites located in the extensive dune formation fronting Malaekahana and Laie Bays. The excavations revealed three major cultural occupations dating to the late prehistoric period (between c. AD 1600 and 1780). Each of the three occupations was stratigraphically and temporally distinct, and suggested an increase in the local population and expansion in the subsistence base over time. In addition, the presence of terrestrial products coupled with certain changes in settlement pattern indicated greater reliance on inland products concomitantly with increased sedentism through time. These findings generally support those from nearby Kahuku Point, although for the latter area an earlier period of initial occupation coupled with a larger prehistoric population is indicated.

HISTORICAL DOCUMENTARY RESEARCH

Historical documentary research was conducted by historical researcher Helen Wong Smith, B.A., who examined and analyzed readily available archaeological and historical literature, and other documentary resources relating to the project area. Potential sources of information for the project area included early historical accounts by native and foreign residents of the Hawaiian kingdom, written descriptions by visitors, land records, and historic maps. The following summarizes only the most relevant of Ms. Smith's findings (relevant in terms of the specific project area). Ms. Smith's research is presented in its entirety in Appendix A of this report.

According to Handy and Handy (1972:271), the windward coast of Oahu, extending from Laie to Kahana, was densely settled and populated during the Pre-Contact and early Post-Contact periods. At Laie, agriculture was extensive; the lo'i *system of* wetland taro production (at Laie involving spring irrigation) was most intensive. In Malaekahana, agricultural terraces existed in association with both streams and springs; there is an old terrace system concentrated along the lower reaches of Kahawainui Stream which was called Waieli, but the crops were irrigated with water from a spring. According to Handy (1940:89), at one time such agricultural terraces must have been encountered throughout the general Laie area; much of the terracing was later disturbed or destroyed by sugarcane cultivation.

In 1846, prior to the distribution of lands known as the Mahele, R. Moffitt gained control of the konohiki land in Kahuku. Moffitt raised cattle and sheep on the land, eventually selling the land to Charles Hopkins, who established Kahuku Ranch.

By 1865, the Mormon Church had extended its initial holdings in Laie by purchasing approximately 6,000 additional acres of land (Cummings 1965). An 1884 map by Jackson shows sugarcane fields throughout much of the Laie area. As the rest of the area was still a part of the extensive Kahuku Ranch, it is assumed that these fields belonged to the Mormons. In 1867, parts of Malaekahana, Laie, and Kahuku were conveyed to Herman Widemann, who by 1873 was the sole owner of Kahuku Ranch, which at that time totalled approximately 15,000 acres. In 1874, Kahuku Ranch was renamed the Kahuku and Malaekahana Ranch and was sold to Julius Richardson. James Campbell bought the ranch from Richardson in 1876. In 1889, Campbell leased portions of Malaekahana and Kahuku to Ben Dillingham. Dillingham subsequently subleased some of the lands to the Oahu Railway and Land Co. (leased for 49 years and eleven months beginning January 1, 1890). Included in the lease were sugar lands in Kahuku and surrounding areas.

On January 30, 1890, with James B. Castle as the first president, the Kahuku Plantation Co. was incorporated (Yent and Estioko-Griffin 1980). In 1902, the Koolau Railway Co. was formed, and tracks were built from

Kahuku through Malaekahana; the tracks ran past the north edge of the present project area. The railroad ceased common carrier service in 1931, when it merged with Koolau Plantation Company. The railway remained in operation through the 1950s, transporting sugarcane to local mills.

In 1917, pineapple cultivation was initiated within the project area. The Kahuku Plantation Co. leased 171 acres to C. Okayama for this purpose. During the 1920s and 1930s, Oahu Railway and Land Co. subleased parcels in Malaekahana for the same purpose. In 1971, the Kahuku Plantation Company closed after 80 years of sugar cultivation and processing. In 1975, the State of Hawaii purchased makai acreage in Malaekahana from Campbell Estate in order to establish the Malaekahana State Park. The mauka acreage remains under the control of the Campbell Estate and is still being used as ranch land.

FIELD METHODS AND PROCEDURES

Field work was conducted December 19 through January 25, 1989, under the supervision of PHRI Supervisory Archaeologist Bert Rader, assisted by PHRI Field Archaeologists Brad Dilli, Gerald Doty, Mike Fager, Jack Harris, and Hoski Schaafsma. The field work consisted of an inventory survey, detailed recording of sites and features, and evaluation of subsurface components.

Inventory Survey and Recording

Survey transects across c. 75% of both the Punamano and Malaekahana parcels involved high-intensity pedestrian sweeps, with the distance between sweeping crew members maintained at 10-15 meters, depending on vegetation cover, terrain, and extent of ground disturbance encountered. Survey transects across c. 25% of both parcels involved low-intensity cursory examination, with the distance between sweeping crew members maintained at 60-80 meters.

Ground surface visibility ranged from poor to excellent. In some areas, particularly sugarcane fields which have been abandoned in excess of 10 years, koa-haole has matured sufficiently so as to create a low but closed canopy, effectively choking out sunlight and ground-level vegetation, resulting in improved ground surface visibility. In other areas, relatively recent abandonment of agricultural fields has been followed by the appearance of dense, shoulder-high grass.

Detailed recording was completed for all sites encountered; the recording included site and feature dimensions, delineation of surface and subsurface midden deposits, and preparation of scaled maps and drawings of individual features. Sites were described on standard PHRI site and feature record forms, and distinctive features were mapped to scale and were photographed using 35 mm black-and-white film (PHRI Roll Nos. 88-483:1-4).

Once identified and recorded, the locations of all archaeological sites and features were determined using a combination of aerial photographs and metric tape and compass, and the locations were then plotted onto a master project area map. Each recorded site and/or the primary feature within each site complex was marked with pink and blue flagging tape, as well as an aluminum tag bearing the site number, date, the letters "PHRI," and the PHRI project number (88-483). PHRI temporary site numbers (prefixed by "T-") were assigned to all recorded sites located within the two project parcels.

At the time of site recording, one site was subsumed as a feature of an adjacent recorded site, and several of the identified sites were deleted because (1) they were found to be recent bulldozer push mounds, (b) they were found to be parts of essentially modern irrigation systems, (3) upon closer inspection they were discovered to be non-cultural, and/or (4) they were found to be located outside of the project boundaries. The following is a list of deleted and subsumed T-sites:

	Originally-Assigned T- number	Deleted, or subsumed under:
PUNAMANO	T-6	Determined non-cultural feature
	T-8	Determined part of modern ditch system
	T-10	Determined to be unutilized cave
	T-12	Determined part of modern ditch system
	T-13	Rock pile, bulldozer push
	T-14	Rock pile, bulldozer push
	T-18	Rock pile, bulldozer push
	T-23	Now Feature B of Site T-22
MALAEKAHANA	T-2	Determined part of modern ditch system
	T-4	Rock pile, bulldozer push
	T-5	Rock pile, bulldozer push
	T-9	Wall/terrace, outside project area
	T-10	Two overhangs, outside project area
	T-11	Rock pile, bulldozer push

Subsequently, all T- sites were assigned the following permanent State Inventory of Historic Places (SIHP) site numbers prefixed by 50-80-02 (50=State of Hawaii, 80=Island of Oahu, 02=USGS 7.5' series quad map [Kahuku]):

PUNAMANO SITES: T-1 (4068), T-2 (4069), T-3 (4070), T-4 (4071), T-5 (4072), T-7 (4073), T-9 (4074), T-11 (4075), T-15 (4076), T-16 (4077), T-17 (4078), T-19 (4079), T-20 (4080), T-21 (4081), T-22 (4082), T-24 (4083), T-25 (4084), T-26 (4085), T-27 (4086), T-28 (4087);

MALAEKAHANA SITES: T-1 (4088), T-3 (4089), T-6 (4090), T-7 (4091), T-8 (4092), T-12 (4093).

Evaluation of Subsurface Components

Limited subsurface excavation was to be undertaken in order to evaluate midden content and depth at select sites/features, if appropriate deposits were encountered. Test units would be excavated by cultural/natural stratigraphic layers utilizing arbitrary 5 or 10 cm levels, depending on specific site conditions. All cultural material recovered during such excavation would undergo laboratory analysis, which would include cleaning, sorting, photographing, sketching and classification as to type and material, weighing, and characterization in terms of metric attributes.

Backhoe Test Trenching of Select Punamano Project Areas

Excavation of exploratory trenches was accomplished at Punamano using a tractor-mounted backhoe. A total of 32 trenches was excavated along 5 separate transect corridors. The transect corridors were established at 30 m intervals along the Kamehameha Highway, each of which proceeded perpendicular to the highway so as to expose the coastal plain deposits from the highway back (south) to the intersection of the coastal plain with the limestone escarpment. From four to eight individual 4 m-long exploratory trenches were excavated at 20 m intervals along each of the ?? transect corridors. The objective was to evaluate coastal plain deposits for evidence of buried agricultural field deposits, or other cultural features. Stratigraphic levels in the trenches were recorded, and representative cross-section drawings of stratigraphies were prepared. Soil samples were collected from two of the exploratory trenches. At present, analytical results of the samples are unavailable.

FINDINGS

A total of 26 archaeological sites containing 45 component features has been located within the 866-acre project area. Formal feature types present at the sites include caves, overhangs, walls, terraces and platforms, enclosures, one isolated midden deposit, and historic components including WWII gun emplacements, an historic dump, roads, and agricultural ditches. Functional types present include habitation, burial, historic agriculture, and WWII activities.

Twenty of the 26 recorded sites are located within the Punamano Project Area, and six are located within the Malaekahana Project Area (Figures 2 and 3). Table 1 provides the following specific information for each of the recorded sites and features: "T-" number assigned, feature designation (where appropriate), site type, presumed function, integrity, and a brief comment concerning any residual information value at the site.

PORTABLE REMAINS

Prehistoric artifact types were observed at nine of the 26 recorded sites—Sites 4068, 4070, 4072, 4076, 4078, 4082 and 4087 at Punamano, and Sites 4089 and 4090 at Malaekahana. The prehistoric artifacts include small utilized pieces of coral (abrader fragments), interior (non-cortical) flakes of volcanic glass and basalt, polished adze fragments, and the partial remains of a burial canoe (a portion of an a'ama brace). No basalt or obsidian cores were observed at any of the sites, and it is possible, though not yet demonstrated, that core reduction of this material occurred elsewhere.

Historic-era artifacts were observed at six of the 26 recorded sites. The artifacts include milled boards (primarily 1" by 12"), both cut and wire nails, glass insulators, bottle glass, plate glass, tin cans with and without soldered seams, porcelain plate and bowl fragments, leather fragments, and concrete blocks and foundation anchor bolts. The concrete blocks and foundation anchor bolts were observed at the WWII gun emplacement Site 4075 (Punamano). Punamano sites containing pre-WW II historic artifacts include 4073 (an overhang with several concentrations of broken bottles and Chinese-decorated porcelain fragments), 4080 (an historic-era dump site), and 4082 (especially Features B, C, D, and G, from which historic burials had been removed). At Malaekahana, historic artifacts were observed at Sites 4089 (an overhang which contained a few bottle glass fragments) and 4093 (a turn-of-the-century irrigation ditch system with associated tunnel and concrete flume).

Both prehistoric as well as historic-era artifacts were observed at two of the sites identified above—Site 4082 at Punamano, the cave complex which appears to have been utilized initially for prehistoric occupation and subsequently for historic burials, and Site 4089 at Malaekahana, a large limestone cave in which the prehistoric midden deposit has been covered with a light scattering of both early historic as well as much more recent (i.e., 1970-80s) artifacts.

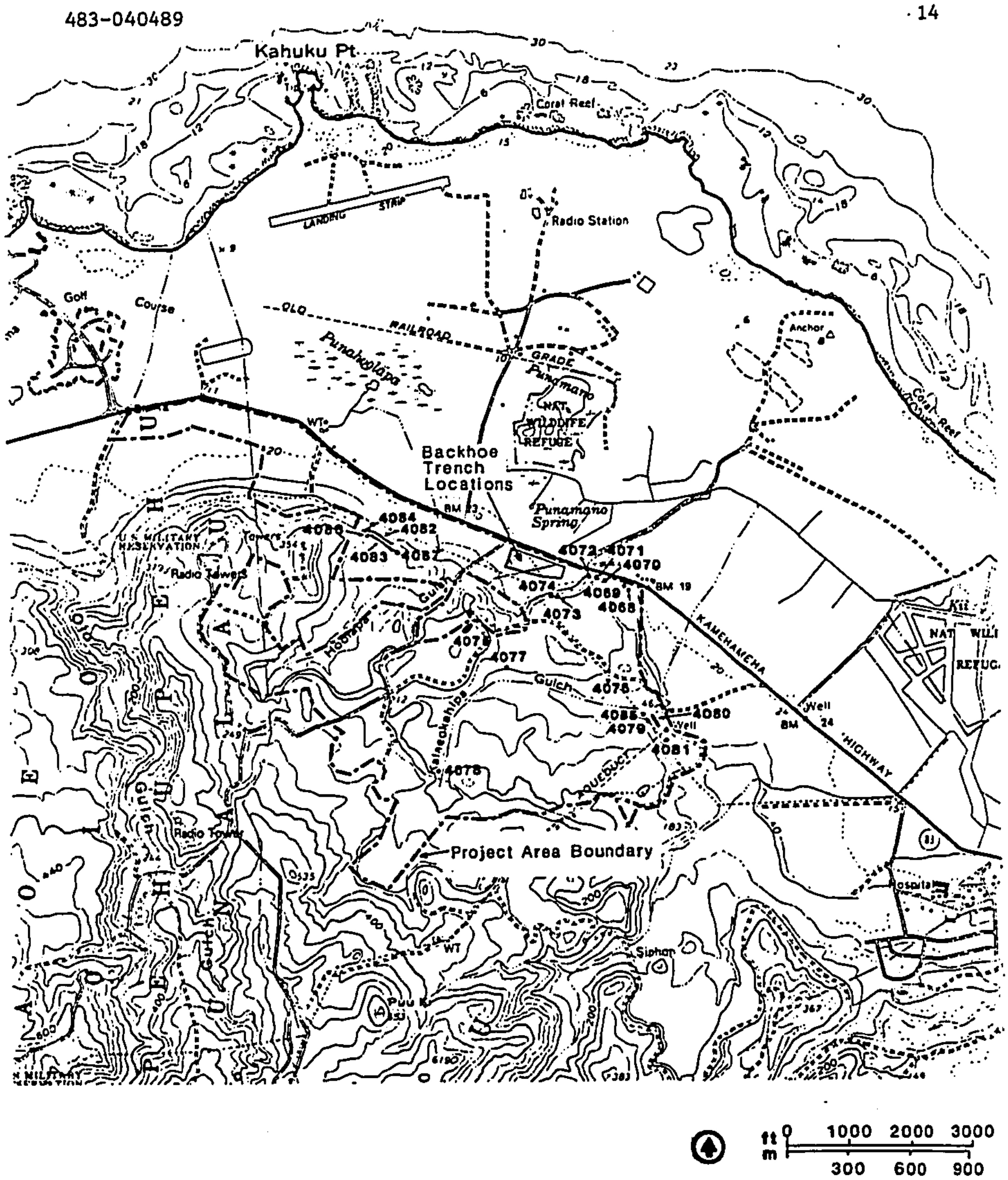


FIGURE 2. Puanamano Site Location Map

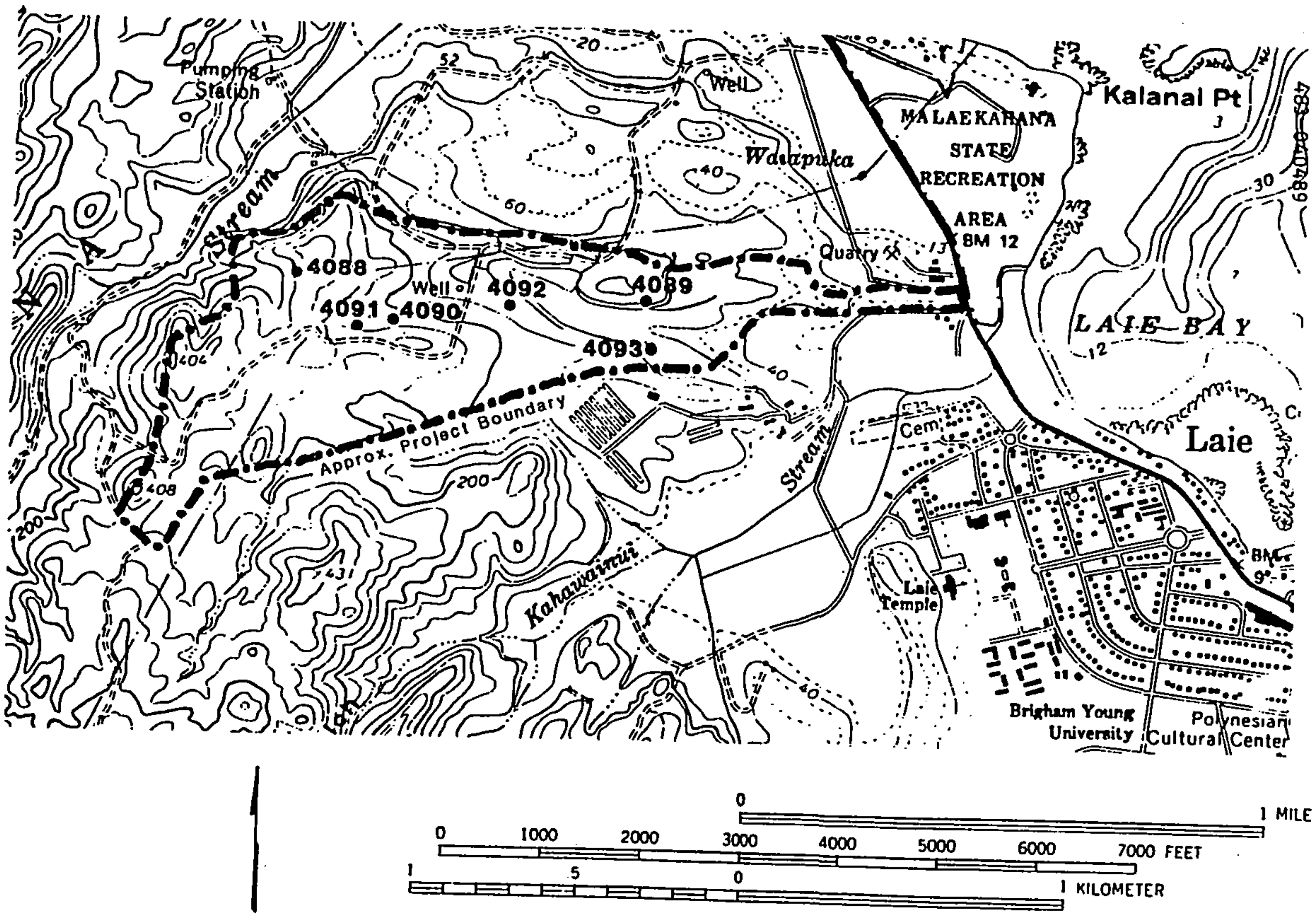


FIGURE 3. Malaekahana Site Location Map

Table 1: Site Summary for Punamano and Malaekahana

Site #	Feature	Type	Function	Integrity and Comments re. Residual Info./Cult. Value
Punamano				
T-1	A	Overhang	Habitation	Fair to good, residual deposit should be evaluated
	B	Overhang	Habitation	Poor to fair, no sig. deposit remaining
	C	Overhang	Habitation	Poor to fair, no sig. deposit remaining
T-2		Wall	Ranching?	Poor to fair, no sig. deposit remaining
T-3	A	Overhang	Habitation	Good, residual deposit warrants further evaluation
	B	Overhang	Habitation	Poor to fair, warrants surface collection
T-4	A	Short wall	Ranching?	Good, but no residual info. in the form of deposits
	B	Overhang	Habitation	Fair, contains some deposit and should be evaluated
T-5		Overhang	Habitation	Fair to poor, should be subjected to surface collection
T-7		Overhang	Habitation	Fair to poor, historic deposits should be evaluated
T-9		Overhang	Habitation	Poor, no significant deposit, does not warrant evaluation
T-11	A	WW II	Gun emplacement	Poor, most of the original features no longer exist
	B	WW II	Gun emplacement	Poor, most of the original features no longer exist
	C	WW II	Gun emplacement	Poor, most of the original features no longer exist
	D	WW II	Bunker (2 units)	Poor, most of the original features no longer exist
T-15		Overhang	Habitation	Good, contains deposit and should be evaluated
T-16		Terrace, wall	Ag. Terrace?	Fair, but no residual info. in the form of deposits
T-17		Overhang	Habitation	Fair, some deposit remains which should be evaluated
T-19		Walls (2)	Ag.? Ranching?	Good, but no residual information value
T-20		Historic Dump	Habitation	Fair, but deposits mixed through modern use
T-21		Overhang	Habitation	Poor, but no residual info. in the form of deposits
T-22	A	Overhang	Habitation	Good, contains potentially significant deposit
	B	Overhang	Burial crypts (7)	Poor, recover and re-bury any human remains
	C	Overhang	Burial crypt (1)	Poor, recover and re-bury any human remains
	D	Overhang	Burial crypt (1)	Poor, recover and re-bury any human remains
	E	Overhang	Habitation	Good, contains deposit, and should be further evaluated
	F	Midden pocket	Habitation	Good, appears to contain some deposit, should be tested
	G	Overhang	Burial crypt (1)	Poor, recover and re-bury any human remains
	H	Overhang	Habitation	Fair, contains deposit which should be evaluated
	I	Overhang	Habitation	Poor, does not contain a significant, intact deposit
	J	Overhang	Habitation	Poor, does not contain a significant, intact deposit
	K	Overhang	Habitation	Poor, does not contain a significant, intact deposit
T-24		Graded road	Agriculture	Poor, no residual information value
T-25		Terrace/Mnd.	Ag., road clearing	Poor, no residual information value
T-26	A	Enclosure	Agriculture?	Fair to good, no residual information value as no deposit
	B	Wall	Agriculture?	Fair, but no residual info. value in the form of deposits
T-27		Wall/pile	Ag.?. Clear field?	Fair, but no residual info. value in the form of deposits
T-28		Overhang	Habitation	Good, contains some deposit and should be evaluated
Malaekahana				
T-1		Platform	Possible Burial	Fair, should be evaluated through partial dismantling
T-3		Cave, large	Habitation	Good, with substantial deposit, should be evaluated
T-6	A	Overhang	Habitation	Fair, some deposit which should be evaluated
	B	Overhang	Habitation	Fair, some deposit which should be evaluated
T-7		Overhang	Habitation	Fair to poor, no residual info. value in form of deposit
T-8		Cave	Habitation	Good, but no residual info. value in form of a deposit
T-12		Ditch/Tunnel	Agriculture	Fair to good, with historic documentary research value

(For correlation of site numbers see page 11.)

BACKHOE TEST TRENCH EXCAVATIONS

Excavation of exploratory trenches was accomplished at Punamano using a tractor-mounted backhoe. The north-central portion of the Punamano project area contains lands likely to have been intensively utilized during late prehistoric times for agricultural purposes, and within which one kuleana holding had been tentatively identified during pre-fieldwork research (LCA 4422:2). The objective of trenching was to evaluate the subsurface deposits within this area for possible evidence of buried agricultural field deposits, field walls, or other cultural features.

Ten transect corridors were established at 30 m intervals along the Kamehameha Highway, beginning immediately west of the prominent limestone cliff formation above Tanaka Store and proceeding westerly along Kamehameha Highway (Figure 4). The transects, numbered 1 through 10 from west to east, were established perpendicular to the highway so as to dissect the coastal plain deposits from the highway to a point c. 150 meters south of the highway.

Excavation of 23 trenches along three of the corridors (#s 1-3) failed to produce any evidence of buried agricultural fields or other cultural deposits or features. The decision was made to expand the distance between the excavated trenches by skipping some of the flagged transect corridors. Nine additional trenches were then excavated along transect #s 6 and 9. The results were also negative with respect to identifying buried agricultural fields, cultural deposits, or features. In all, 32 4-meter-long by 3-meter-deep backhoe trenches were excavated along 5 separate transects.

Stratigraphic levels in all 32 trenches were recorded, and representative stratigraphic drawings were prepared. Soil samples were collected from two of the exploratory trenches (trench B and C) along transect #9, although analytical results are not yet available.

Figure 5 depicts the general stratigraphy observed along transects 1-3, and transects 6 and 9. In both instances, Layer I (ranging from the surface to between 40 and 70 cm below the surface) consists of a granular, reddish to dark-brown soil containing numerous rootlets (particularly near the surface) and other indications of agricultural activities. This layer has been interpreted as the agricultural "plow zone" resulting from sugarcane cultivation during the past three-quarters of a century. Layer I may also incorporate some imported fill, particularly at the low, eastern end of the study area closest to the limestone cliff formation and Tanaka Store (i.e., as depicted in transects 6 and 9). Layer II consists of a finer-grained, dark brown to grey clay soil which is believed to represent the pre-modern subsurface matrix. Layer II grades into the coarser, reddish Layer I soil along the southern portion of the study area—as one proceeds south toward the steeper slopes associated with the limestone escarpment.

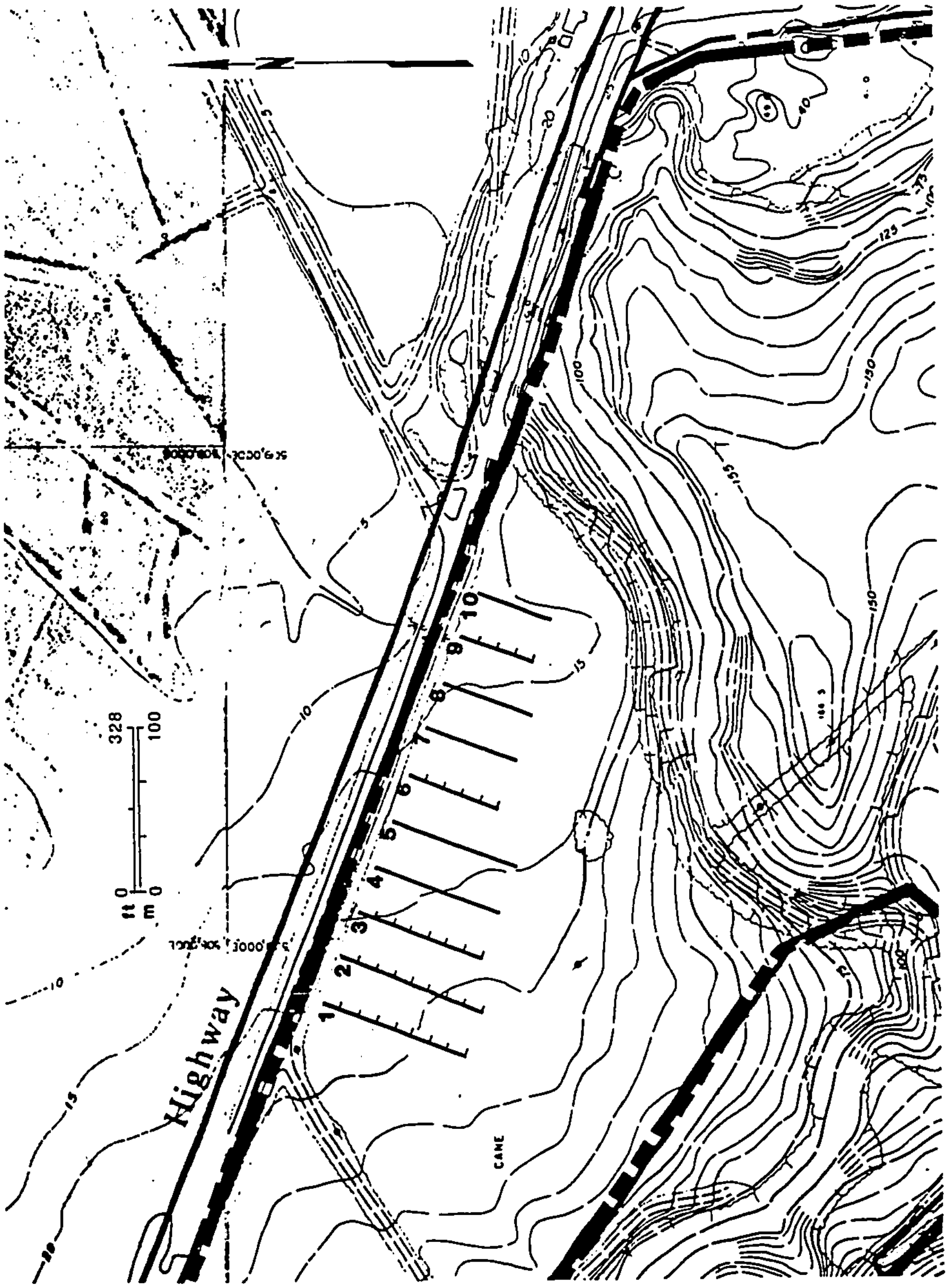


FIGURE 4. Backhoe Trench Location Map

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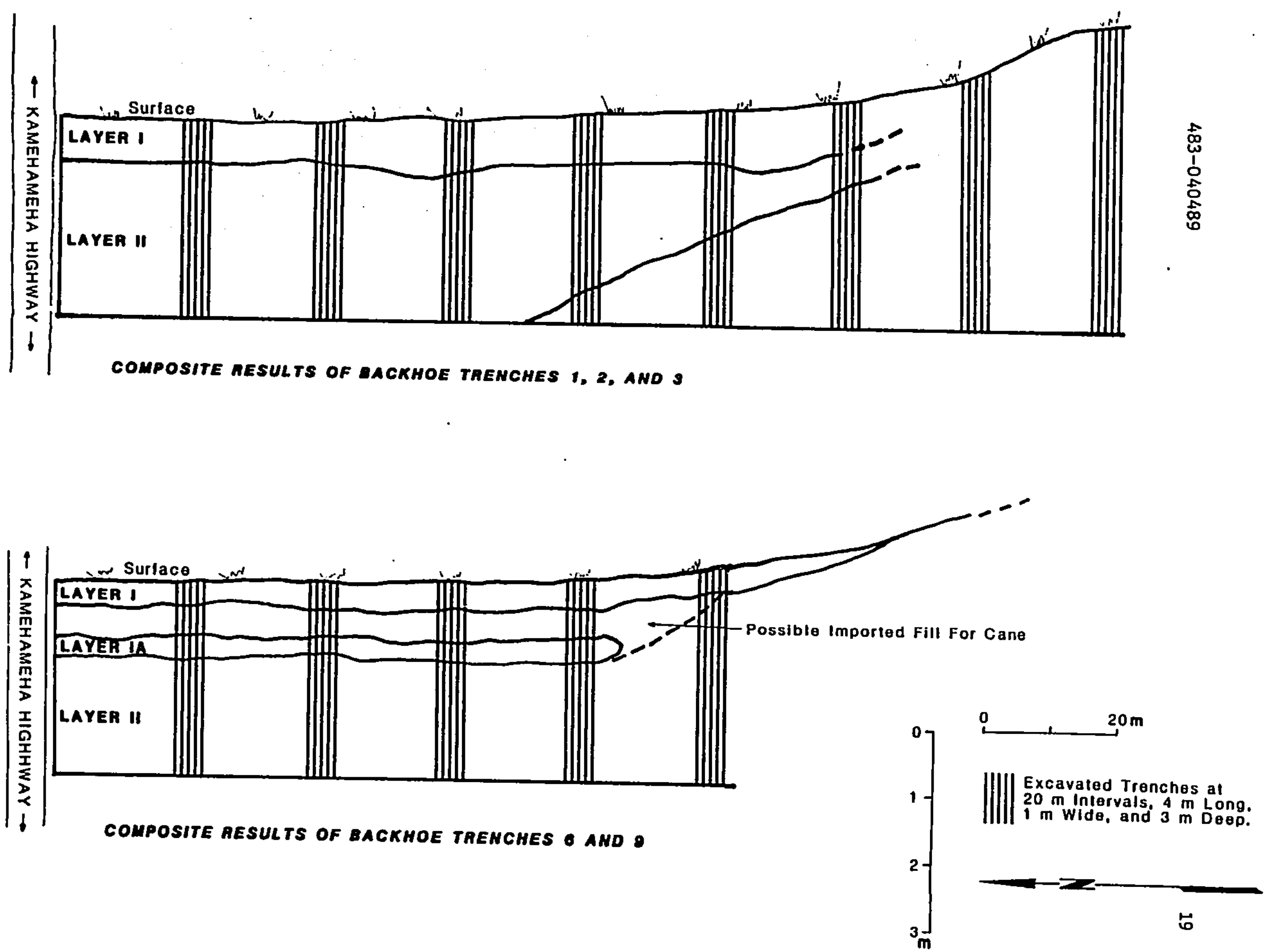

FIGURE 5. Composite Results of Backhoe Tenches 1, 2, 3, 6, and 9

In transect #9, a Layer IA was observed and defined on the basis of a dense concentration of vegetal matter, presumably roots and entangled stem fragments. This layer is believed to represent an earlier exposed ground surface which was covered with imported fill or with soil bladed from adjacent portions of the parcel in order to fill a low, wet area. The fill apparently effectively capped the original surface vegetation and preserved the material under essentially anaerobic conditions. A sample of this material was recovered from excavation trenches B and C of transect #9, although macro-fossil identifications have not been completed as of this writing.

The gleyed, mottled, charcoal-bearing deposits typically associated with buried agricultural fields were not encountered in any of the excavated trenches, nor were loose basalt or coral cobbles or any other indications of buried cultural features. Such features dating to prehistoric times may well have been present within this area, but appear to have been completed or nearly completely obliterated by subsequent clearing associated with modern agriculture.

SITE DESCRIPTIONS - PUNAMANO SITES

Site 4068 - Three Overhang Shelters (Features A, B, and C)

Site 4068 consists of three overhang shelters located along the northern-most portion of limestone cliff descending to the Kamehameha Highway and overlooking the coastal plain behind Kahuku Point (Figure 6). Feature A overhang, situated under a prominent circular outcrop, extends along the exposed limestone face for c. 15 meters north-south and averages 5 meters in depth. However, only the southern 1/3 of the overhang possesses sufficient headroom and a floor area suitable for habitation. This habitable space measures approximately four by five meters, and contains an accumulation of midden composed of marine shell fragments, basalt flakes, at least one basalt adze fragment, cut and unmodified faunal bone, and a dark, ashy soil matrix which appears to reach a maximum depth of 60 cm. A 40 cm-square area of this midden was excavated during the present project in order to recover a bulk dating sample (Field Accession Sample #24).

Features B and C are located approximately 30 m northwest of Feature A. Feature B consists of a 3 by 6.5 m sheltered area formed under the eroded lower portion of the limestone cliff. Interior rock rubble has been piled in front (north) of the overhang, while a small scatter of contemporary bottles is located immediately northwest of the rubble pile. The interior of the shelter is "stepped," providing two potential habitation/work/use areas.

Feature C is a small overhang situated 3 meters east of Feature B, and consists of a protected/habitable area which measures 3 meters wide at the opening (parallel with the cliff face), and proceeds back under the cliff a maximum of 4 meters.

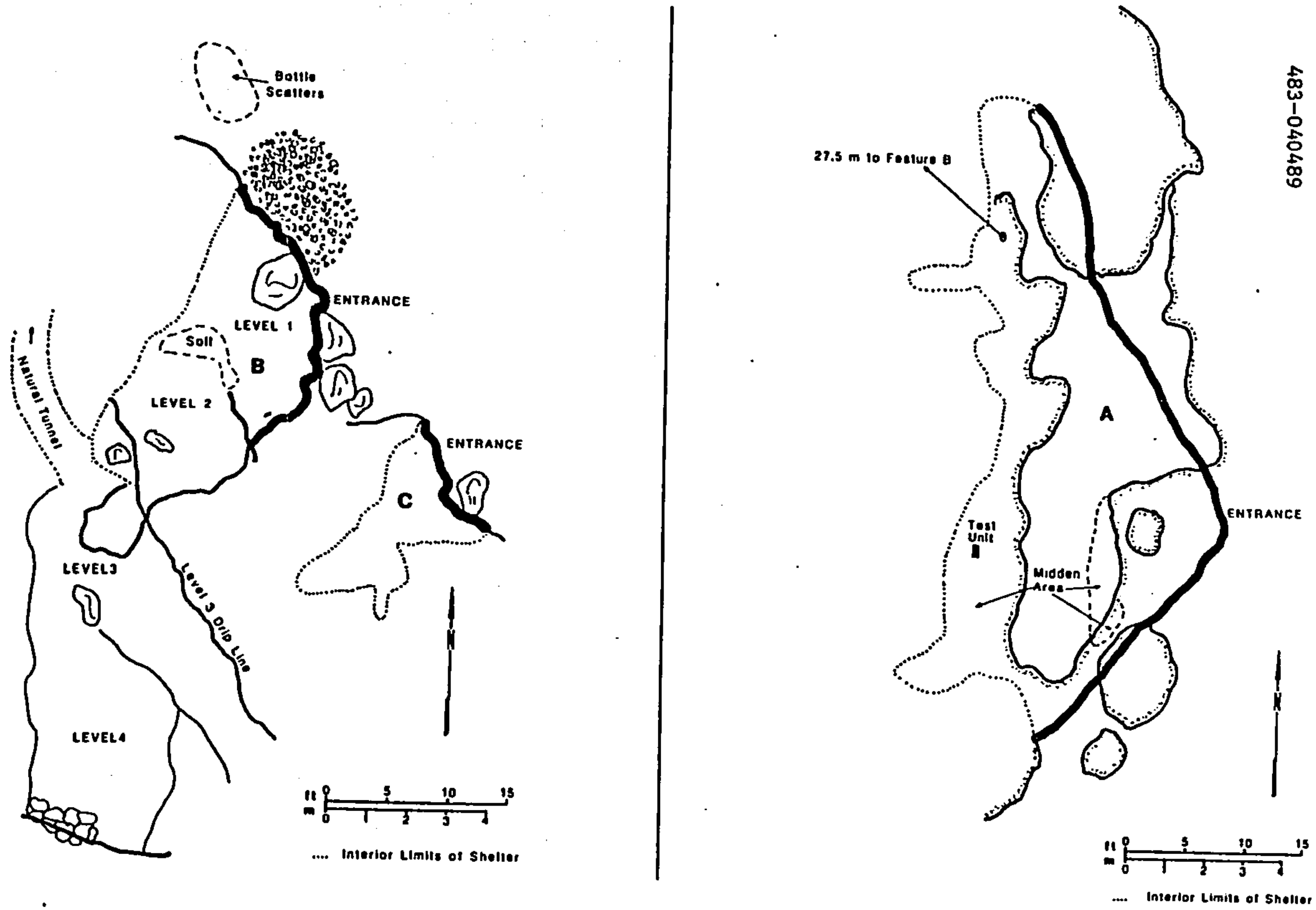

FIGURE 6. Site 4068

No midden or portable artifacts were observed in association with either Feature B or Feature C. Potential prehistoric and/or historic use was indicated for these two features, not on the basis of habitation debris, but on the basis of piles of rubble at and around the features which indicated that the interiors had been modified for use.

Two additional flat surfaces are accessible from both Features B and C by following a natural crack or "tunnel" upward above Feature B. However, no clearing debris or other rubble piles were observed at either one of these small areas, and neither was thus recorded.

Although located within about 50 meters of the highway and clearly subjected to past disturbances, the midden deposit at Feature A is largely concealed and not easily accessible. Apparently for this reason it has been moderately well-preserved.

A single charcoal dating sample was recovered from Site 4068 between 5 and 10 cm below the surface within the midden area (BETA 29701). Unfortunately, the sample was contaminated with bomb C-14 and could not be used for evaluation of the time period of occupation.

Site 4069 - Short Wall Segment

Site 4069 is located adjacent to the cliff face overlooking the coastal plain, the Kamehameha Highway, and Kahuku Point. The site consists of a short segment of wall constructed from 1 to 2 meters in front of the cliff face. Measuring 9 m in length and averaging .85-1.0 m in height, the feature is not associated with portable remains or midden and may well date to the historic era and have been constructed in support of ranching needs.

Site 4070 - Two Overhangs (Features A and B)

Site 4070 consists of two small overhangs overlooking the coastal plain and Kahuku Point. Feature A overhang extends east-west along (parallel with) the limestone cliff face for a total distance of 18 m, providing a sheltered (covered) area which averages 2.75 m in depth. Several slabs of roof have fallen into the interior and disrupted the otherwise flat floor of the overhang's interior. A pocket of habitation midden has accumulated within an area measuring c. 1.5 m in diameter at the eastern end of the shelter. In the extreme east-end corner of the shelter, c. 7 fragmentary pieces of human bone were observed (including pelvic and long bone fragments). It could not be determined during the present project whether these human remains represent a disturbed primary interment, or rather bones which might have been scavenged from some other location along the cliff and then deposited here later in time. Although some disturbance is in evidence at this feature (as attested by the presence of contemporary trash), the small midden deposit does not appear to have been excavated or otherwise significantly disturbed.

Feature B consists of a small overhang situated within an area of lithified aeolian sandstone. The floor of the overhang forms a flat U-shaped, gently-sloping bench which occupies c. 30 square meters of surface area. A thin scattering of cultural material (between 10 and 15 basalt waste flakes, kukui nut shell fragments, and occasional marine shell fragments) was observed at several locations on the surface of the sheltered area. Although no formed artifacts or potential dating samples are visible on the surface, a shallow subsurface deposit may exist which would warrant further evaluation prior to any project-related disturbances.

A review of Sterling and Summers (1978:151-152) indicates that McAllister had recorded a cave site along the northwest face of the limestone cliff overlooking Kahuku Point. Three lines of evidence were utilized in an attempt to determine whether or not Site 4070 is in fact McAllister's Site 267. First, several observers in Sterling and Summers concur that the cave is located on the northwest side of the "rocky brow of Kalaeokahipa...", a location which corresponds generally with the location of Site 2070. Second, the published descriptions refer to two "stalactites" resembling the breasts of a woman which "formerly hung..." within the cave; another description also indicates that at least one of these features has been broken off. Several of the caves located along the cliff face witin this area, including Site 4070, contain small stalactites. Third, one of the descriptions indicates that close to the cave is "...a small round opening into a secret cave..." As noted in the general description of the project area, numerous small caves exist around the cliff face overlooking Kahúku Point. However, many do not contain cultural material or other clear indications of past use, and such caves were therefore not recorded. One of these small unoccupied caves located within the immediate vicinity of the recorded cave features could represent the "secret cave" being referenced in the desciption of Site 267.

While the collective evidence suggests that Site 4070 may perhaps represent McCallister's Site 267, the same possibility exists for a number of the other caves also recored along the cliff face. The problem of identification is compounded by the lack of specificity in the original site description provided by McAllister.

Site 4071 - Short Segment of Wall (Feature A) and Overhang (Feature B)

Site 4071 is a dual component site located at the base of the limestone cliff overlooking the Kahuku coastal plain and Punamano Spring. The site area has been the focus of fairly recent activity which resulted in depositing a number of contemporary plastic and other artifacts about the surface.

Feature A consists of a short segment of unfaced wall constructed by piling limestone cobbles from three to four courses high and from one to three courses wide. The resultant wall, which abuts bedrock outcrops at both ends, is 2.5 m in length and averages 0.8 m in height and 0.40 m in width. Light brown to ashy-colored soil has accumulated on the east side of the wall; however, partial trowel scraping of this area to a depth between 2 and 5 cm below the surface failed to reveal midden, artifacts or other evidence of accumulated cultural material.

Feature B is located approximately 25 meters to the west of Feature A, and consists of a large cliff boulder, one end of which has been undercut. This end forms an overhang sheltered area measuring approximately 3 meters in diameter, within which occupational midden appears to have accumulated. A 0.5 m-square pit has recently been excavated within the midden, exposing at least one thin charcoal lens. The extent of disturbance to this site could not be determined on the basis of the limited data collected during the present inventory survey.

Site 4072 - Overhang

Site 4072 is a single component site located at the base of the limestone cliff overlooking the Kahuku coastal plain and Punamano Spring. As with Site 4071, the area around Site 4072 has been the focus of fairly recent activity (marijuana cultivation?), and a large number of koa haole trees have been cut and piled within the general vicinity. The site was established in a collapsed section of cliff face. A large section of limestone detached unevenly from the cliff face, forming in the process a narrow overhang and a short, incompletely detached lower ("floor") section suitable for habitation. The protected area under the overhang averages 1.5 m deep and extends along (parallel with) the cliff face for approximately 22 meters. At the northeast end, a crack has developed between the cliff face and a segment of original cliff rock, forming a cave which measures c. 1.5-2 m in width, 2-3 m in height, and which extends back into the cliff for a maximum distance of 4 meters. Habitation midden containing small quantities of kukui nut shell and cut faunal bone (esp. bird bone) has accumulated within a small portion of this area near the cave's entrance. Two isolated basalt flakes were observed on the surface at the opposite (southwest) end of the overhang.

Site 4073 - Overhang

Site 4073 is a single component site consisting of an overhang located at the base of a limestone cliff overlooking the Kahuku coastal plain and Punamano Spring (Figure 7). The protected area within the natural cave formation measures 10.0 m wide by 8.0 m deep (maximum) by 1.0 m high. A talus composed of cultural debris, cobbles, and dirt has accumulated in front of the cave, effectively extending the habitation area by 3 additional meters in front of the cave for the full width of the cave opening. Historic-era cultural material litters the surface of the cave and the talus in front. This material consists of a pile of broken bottles containing c. 50 variable-colored glass fragments, a Chinese porcelain bowl fragment, and approximately 15 fragmentary metal objects (including possible cast iron stove fragments). Three wood-framed beehive comb supports have been discarded on the surface at the east end of the talus.

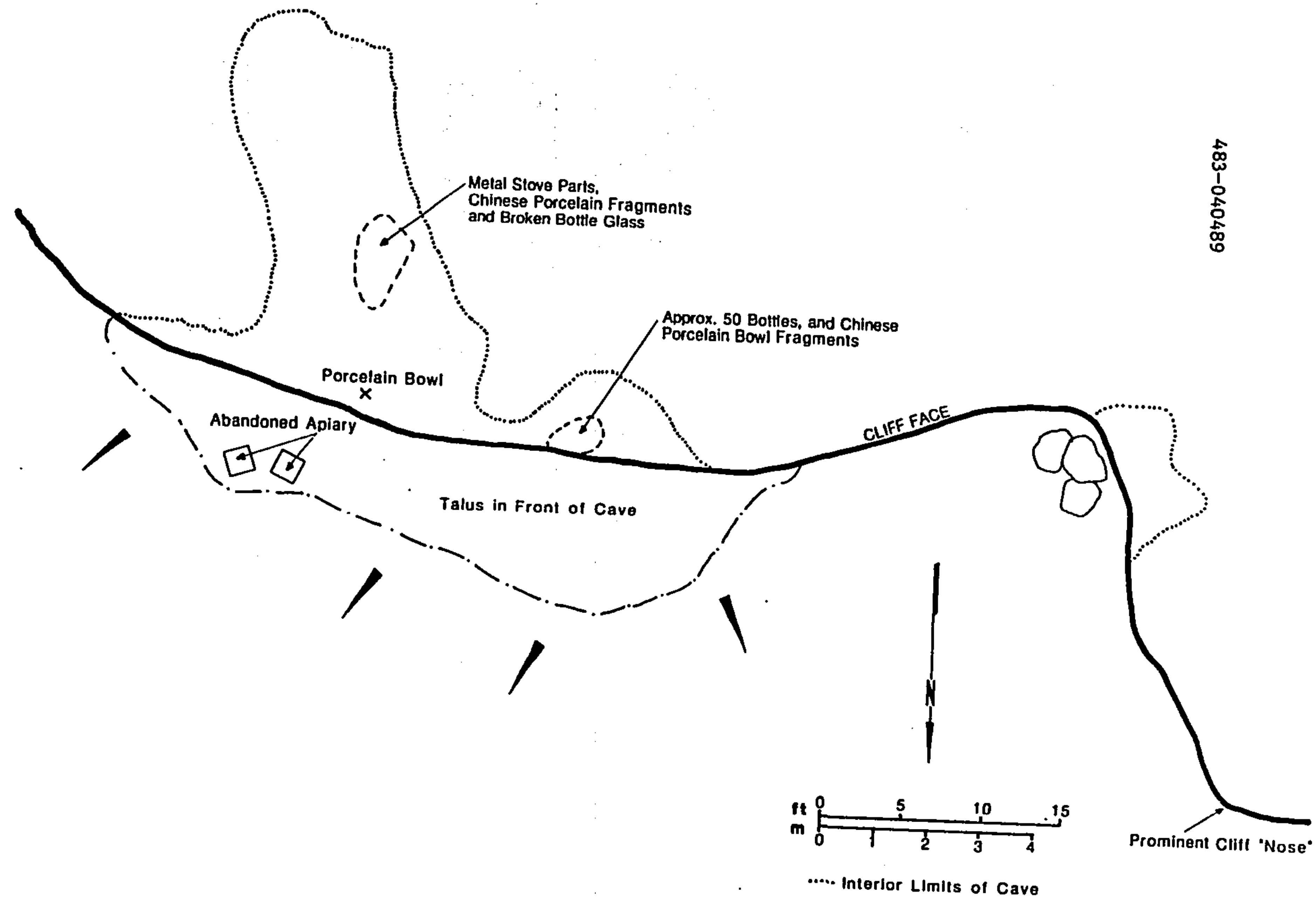

FIGURE 7. Site 4073

An occupational midden of prehistoric materials may have accumulated not only on the floor of the cave, but may also exist intermixed within the talus debris in front of the cave.

Site 4074 - Overhang

Site 4074 is an overhang which has formed under the undercut end of a large boulder which detached from the cliff face. A small sheltered area measures approximately 6 m wide by 1.5 m deep (maximum) and 0.75 m high. No portable artifacts, features or evidence of accumulated habitation debris were observed on the surface, and relatively recent disturbance was observed in the form of contemporary fire rings and minor "excavation" within the site. In view of the proximity of a contemporary "camp" (containing automobile parts, mattresses, etc.), the disturbances to this site may well have occurred no more than 1 to 3 years ago.

Site 4075

Site 4075 is composed of four separately designated features defining a series of WWII gun emplacements and associated bunkers, located within the eastern portion of the project area and distributed over an area measuring 35 by 220 meters.

Features A, B and C consist of gun emplacements, each with nearly identical dimensions and attributes. The overall diameter of each of the emplacements is 11.65 meters, allocated as follows:

(a) center core of concrete, poured in two separate levels on a radius of 1.5 meters. This center core provided the footing for mounting the primary hardware and receiver.

(b) central flattened area, without concrete, occupying the space between 1.5 m and 5.0 m from the center of the feature;

(c) outer (tracking) ring of concrete, poured in a single level, attached to the center of which is a carbon steel track for mounting and pivoting the barrel. The outer ring begins at a point located 10.65 m from the center of the feature, and terminates at 11.65 m from the center. No portable artifacts were observed within the vicinity of any of these foundation remains.

Feature D consists of two bunkers which were constructed within 7.5 m of one another. The most northerly of the two consists of a square, above-ground concrete room measuring 3.5 m on a side, connected with a smaller rectangular room on top of which 2-3 meters of fill had been placed. The second bunker consists of a semi-subterranean U-shaped concrete structure, each end of which connects with a concrete staircase leading up 7 steps to the outside. The two entrances are located 6.5 m from one another, and measure c. 1.5 m in width. The distance between the current ground surface and the floor of the bunker varies between about 2.25 and 3.00 meters. Except for isolated concrete "chunks" and "road base" gravel piles, no portable artifacts or other features were observed in association with the bunkers.

Site 4076 - Overhang

Site 4076 is a substantial overhang shelter formed along an eroded section of fossil sea bluff exposed in a small gulch in the eastern portion of the project area (Figure 8). The overhang extends for a total distance of 19 meters parallel with the exposed bedrock (east-west), and protrudes under the bedrock for an average of 2.75 m (north-south). A small pile of rocks is located at the eastern end of the shelter area, marking a possible fire hearth. Dark, ashy-colored midden covers the entire interior living surface, and appears to have accumulated to at least 30-40 cm depth (as determined from examination of two exposed areas within the deposit). A basalt adze and a drilled bivalve shell were observed on and recovered from the surface (provenience of these two collected artifacts is indicated on the site map, Figure 2). Two additional artifacts, both basalt flakes, were not collected.

A gentle slope has been established in front of the cave opening by constructing a terrace which extends for a distance of c. 8 m parallel with, and which begins at a point c. 5 m in front of, the cave opening. This upper terrace may conceal a rock retaining wall buried beneath the loose soil fill. A second parallel terrace, definitely supported by a rock (limestone slab and boulder) retaining wall, was established at c. 10 meters in front of the cave. Immediately below the lower terrace retaining wall is a narrow and shallow ditch segment. Cultural material, consisting of portable artifacts and buried pockets of midden, may well have accumulated in portions of these two terraced areas in front of the overhang.

This site may possess a substantial subsurface midden deposit, located both within, as well as in front of, the overhang shelter. There are no surface indications of significant past looting or other disturbances.

Site 4077 - Terrace

Site 4077 is a short segment of "retaining wall" constructed from tabular sandstone slabs piled from three to four courses high and from one to two courses thick. The wall, located on a side hill above an isolated field near the center of the project area, measures only 2.6 m in length, 0.5 m in width, and 0.8 m high. No additional features, or other evidence of prehistoric or early historic use or occupation, were observed in association with the wall or within the nearby area. Additional features may have existed prior to the extensive cultivation to which the Punamano project area has been subjected over the past 100 years.

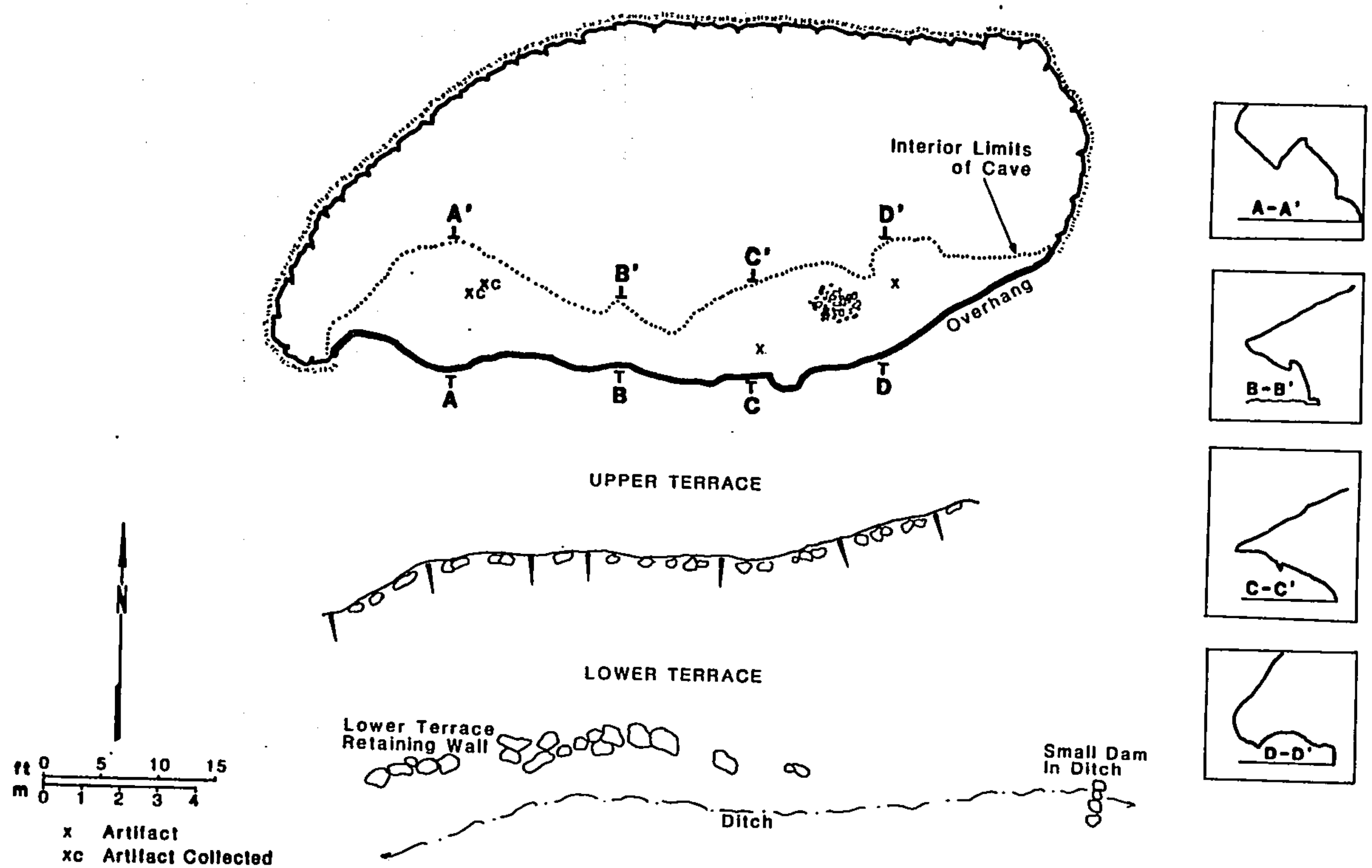

FIGURE 8. Site 4076

Site 4078 - Overhang

Site 4078 is a small overhang, with the available living surface extended by constructing two short segments of rubble wall near the entrance. The site, located adjacent to a large cultivated field within the south-central portion of the project area, has been formed by erosion of a portion of exposed limestone, creating an overhanging shelter which measures 4.5 meters north-south (wide) by 2.75 meters deep (east-west). The opening is oriented to the east. Two short sections of low wall have been constructed at the south end of the opening, effectively blocking a portion of the opening and simultaneously extending the habitable space at and around the shelter.

A few milled board fragments were observed within the immediate vicinity of the shelter, indicating contemporary use. Although no native cultural materials were observed on the surface, the wall may nevertheless represent Native construction and cultural materials may have accumulated within the dark brown soil located at and around the feature.

Site 4079 - Short Wall Segments

Site 4079, located at the base of a limestone outcrop near the eastern edge of the project area, consists of two short segments of wall constructed between natural rock outcrops, effectively completing a small U-shaped enclosure. One of the wall sections measures 2.9 m in length, is 0.75 m in width, and 0.80 m in height; the second wall is 3.8 m in length, 0.45 m in width, and 0.80 m in height. These features are probably historic in age and may relate to stock raising. No additional features, either prehistoric or historic, were observed in association or within the general vicinity.

Site 4080 - Historic Trash Dump and Bottle Scatter

Site 4080 is located at the base of an exposed section of fossil sea bluff within the eastern portion of the project area. Dirt roads providing access to upland agricultural fields pass by the dump at two different locations and at distances which vary between 1 and 10 meters. The site extends roughly north-south along the base of the "cliff" for a distance of c. 50 meters, occupying the space (which varies from 15 to 25 meters in width) between the dirt road and the cliff face. Containing mostly seamed glass bottles with occasional milled boards fastened with wire nails, several bottle fragments with applied tops were also observed, indicating use at least as early as c. turn-of-the-century. Very recent use is also indicated, however, as "Vicks" "Vap-O-Rub" bottles, plastic items, and assorted metal objects, including at least one 4 ft by 8 ft sheet of galvanized tin roofing, were observed. The absence of explicitly household artifact types suggests that the dump was not created in conjunction with historic habitation.

Site 4081 - Overhang

Site 4081, located near the extreme southeast corner of the project area, consists of a single overhang shelter. The opening of the overhang measures 3 meters wide (parallel with the cliff face), and extends into the cliff a maximum of 1.75 m. A cobble and boulder wall has been constructed adjacent to the 3 meter-wide opening, leaving a narrow access opening at the south end of the feature.

Potential prehistoric and/or historic use was indicated, not on the basis of habitation debris (midden or portable artifacts), but on the basis of the enclosing wall which indicated modification for use.

Site 4082 - Complex, Burial and Habitation Caves and Overhangs along Cliff Face

This site is located along the base of a prominent limestone bluff formed at the intersection of the existing broad coastal plain and an uplifted fossil sea bed (Figure 9). The bluff, which overlooks the coastal plain and Kahuku Point within Kahuku ahupua'a, extends roughly 340 meters east-west. Approximately 280 meters of the 340 m-long formation (c. 82% of its total length) has been eroded along its base, forming a series of interconnected, or closely spaced cave chambers and overhangs. These features encompass anywhere from 1-2 to over 50 square meters of surface area, with several of the larger examples being suitable for habitation. Other chambers were too small for habitation, but with minor excavation and other modifications (construction of short wall segments, removal of small overhanging projections, etc.) could be and were in fact used as burial crypts. It is estimated that up to 25 separate burials have been placed within the series of chambers and overhangs along this cliff. No intact examples were observed during the present project, and in fact all of the observed burials, as well as most of the midden associated with the habitation areas, have been extensively looted. That such looting is at least in part a recent activity is documented by the presence of a well-preserved wood-framed 1/8" mesh screen still present at one of the habitation areas.

Two temporary site designations were originally assigned to this series of chambers (Sites T-22 and T-23). However, upon closer inspection during detailed recording, it was clear that the chambers were nearly continuously distributed along the bluff. For this reason, the decision was made to include all of the features within a single site designation containing eleven separately described feature areas.

Feature A is a moderate-sized overhang which represents the easternmost of the series of chambers and which appears to have been utilized exclusively for habitation. The protected (habitable) area under the overhang measures 15 meters in length (east-west) by 3 m in width (north-south), and is open to the north. A midden deposit, containing ashy-colored soil, small faunal bone fragments and occasional kukui nut shells, is distributed throughout the entire floor area of the cave. Two

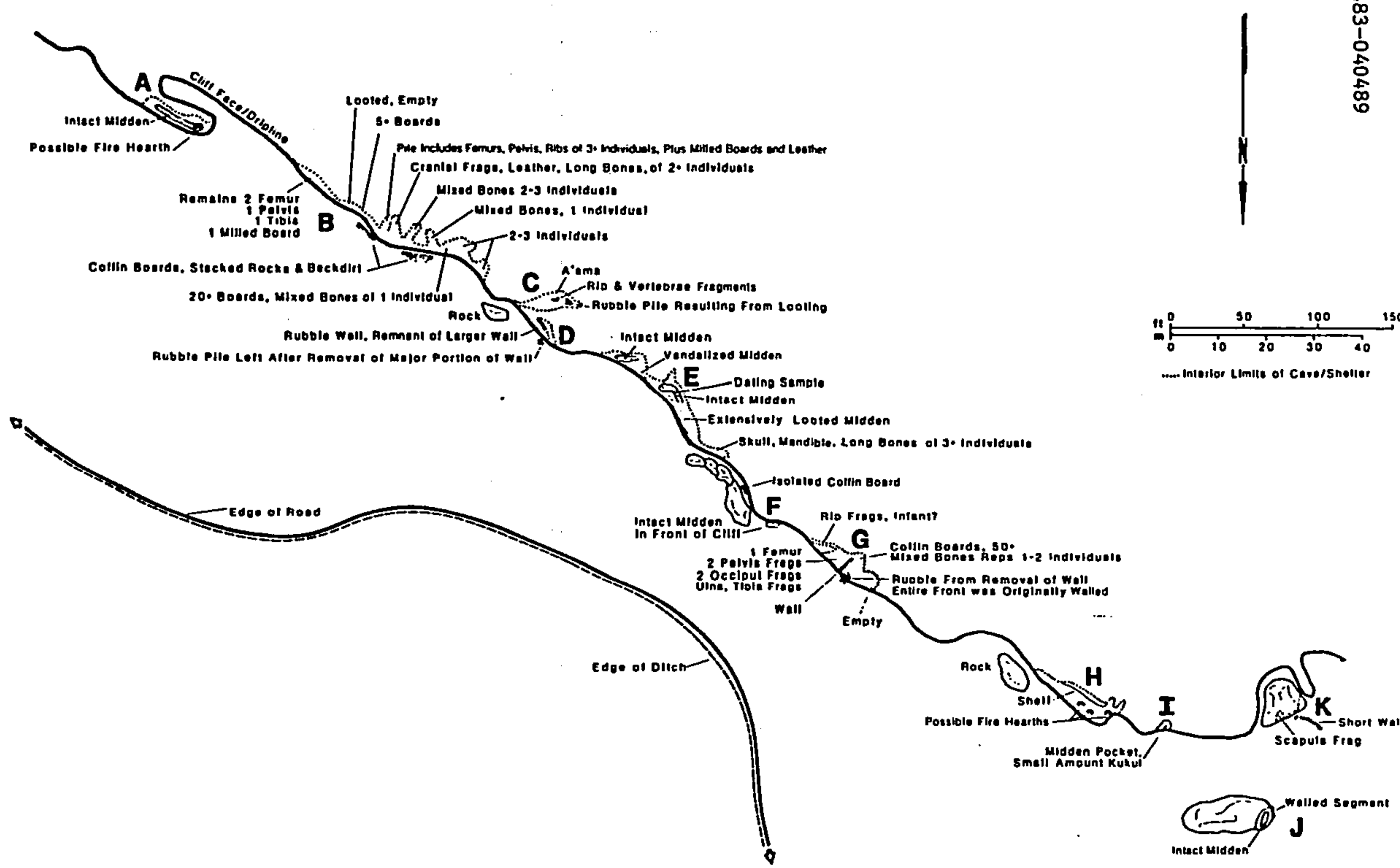

FIGURE 9. Site 4082

possible fire hearth areas were observed, but no human bones or formed artifacts were noted on the surface. This represents one of the few features at this site which does not appear to have been extensively vandalized, perhaps due to the presence of a large beehive.

Feature B consists of a nearly continuous and interconnected series of low chambers formed at the contact between the limestone cliff and the soil zone. Seven primary chambers or alcoves are distributed along the cliff for a total distance of 45 meters. The two easterly chambers are low and shallow, protruding into the cliff formation no more than 1-2 meters. The remaining five primary chambers have long axes which run perpendicular to (rather than parallel with) the cliff. These five chambers penetrate the cliff an average of four meters. All seven chambers appear to have been artificially enlarged, but subsequent disturbance has modified the chambers and openings substantially so that it is virtually impossible to segregate original from more recent modifications. Based on the rubble piles located in front of various chamber openings, it appears that all may have been walled-in along the cliff face prior to vandalism at the site.

Each of the seven chambers appears to have contained from 1-3 burials, most or all of which had been placed in wooden coffins constructed from milled lumber. Milled 1" by 12" boards were observed scattered both within and outside of four of the seven chamber entrances. Extensive corrosion on the few nails observed in the coffin boards prevented determining whether they were "cut" or drawn-wire fasteners.

Skeletal material was not removed or otherwise disturbed during the present inventory survey. Clearly, however, skulls and mandibular elements are underrepresented, and were most likely removed by looters.

Feature C consists of a chamber formed by a crack in a portion of the limestone cliff. The entrance angles upward at c. 2-3 degrees, proceeding above the cliff/soil contact zone and back into the cliff for a total distance of 14 meters. Average width of the crack is 1-2 meters. The fact that the chamber originally contained at least one burial is attested by the presence of two shallow excavated pits or depressions in the floor, one of which is associated with rock rubble, one a'ama pole from a burial canoe, and several rib and vertebrae fragments observed at several locations within the feature's interior.

Feature D is a small chamber (measuring 1.5 m wide and 4 m deep) formed at the cliff/soil contact zone. A portion of a low rock wall remains intact along the cliff face, although adjacent rock rubble documents that most of the original concealment has been removed to access the contents of the chamber. No human remains have been left inside.

Feature E is a habitation area created by a 30 m-long overhang at the contact between the cliff face and the soil zone. The width of the overhang shelter ranges from 3-4 meters, while the height (headroom) averages c 1.5 meters. Midden has accumulated along the entire length of the overhang, and has been extensively looted at the west end. Nevertheless, intact midden, representing perhaps 20-30% of the original deposited material, is present at two locations.

At the extreme west end of the feature, within a small side chamber, four skull fragments, a mandible, two femurs, two fibulae, and 5+ rib bone fragments were observed. It is not clear whether these bones were originally recovered from this portion of the cave, or whether they were transported and deposited here during lotting.

Feature F consists of a small pocket of what appears to represent habitation midden (ashy-colored soil associated with a small quantity of *kukui* nut shell). The deposit has accumulated adjacent to the face of the cliff, rather than under an overhang or within an otherwise protected area.

Feature G is a moderate-sized, low overhang which was used for the placement of from 2-3 coffin burials. The primary chamber measures 12 meters in length (east-west) and averages 3.5 meters in width (north-south). A low rubble wall was constructed perpendicular to the cliff face, effectively creating two separate burial crypts; within each, from 40 to 60 bones were observed associated with 5 to 7 coffin board fragments.

Feature H is a habitation area created by an 18 m-long overhang at the contact between the cliff face and the soil zone. The width of the overhang ranges from 2-4 meters, while the height (headroom) averages c 1.75 meters. A narrow rock shelf exists along the back of the shelter, and some midden has accumulated on top of this feature. Midden has also accumulated elsewhere within the overhang, with moderate vandalism in evidence at the feature's west end. Despite past looting, intact midden is present over c. 35% of the habitable floor area. Lastly, three possible fire hearths are present within the western half of the feature, although one or more of these may relate at least partially to use of the feature by vandals.

Feature I is a very small overhang or cave which shelters a floor area measuring approximately four square meters. A small area of midden, defined by the presence of ashy-colored deposits and occasional *kukui* nut shell fragments, has accumulated near the center of this feature.

Feature J consists of a small overhang which has formed under the west end of a large boulder which has broken away from the bluff above. The habitable space measures approximately 2 by 4 meters, with midden accumulated throughout most of the floor space. A low wall segment was constructed by arranging a single course of waterworn basalt cobbles along a portion of the shelter's exposed perimeter.

Feature K consists of a small overhang which has formed under the west end of a large boulder which has broken off the face of the adjacent cliff formation. The habitable space measures approximately 1 meter wide by 4 meters in length. A low wall, constructed by arranging a single course of waterworn basalt cobbles, was observed along a portion of the exposed segment of shelter; the wall apparently helped retain soil within the shelter area and/or deflected runoff water away from the area.

A bulk dating sample was recovered from between 5 and 10 cm below the surface within the midden accumulation area of Feature E (BETA 29700). At two sigmas, the calendric range of the date is AD 1327-1617, indicating a fairly early period of use of these caves. Whether or not occupation continued more or less uninterrupted through subsequent centuries cannot be determined on the basis of the limited data collected during the present project. It does appear, however, that these caves may have been abandoned for habitation use in late prehistoric times, and then were utilized again during the historic period, this times as burial crypts.

Site 4083 - Abandoned Agricultural Access Road

Site 4083 represents an abandoned sugar cane haul, or irrigation access road which parallels, and is located on top of, the exposed limestone cliff within the west-central portion of the project area (above Site 4082). The alignment, overgrown with koa-haole, could be followed for only c. 155 meters across the top and near the north edge of the elevated sea bed plateau. Average width of the alignment is 0.90 m. No features were observed along the road itself, although Site 4084, consisting of two rock rubble piles, may in fact have been created during initial construction, or later re-grading, of this access road.

Site 4084 - Rock Rubble Piles (2)

Site 4084 is located c. 30 meters from the west end of Site 4083 access road, on top of the limestone plateau but within 20 meters of the Plateau's northern edge. The site consists of two rock "piles" or mounds, each representing a more or less random assortment of small-, medium- and large-sized cobbles and boulders. One of the piles measures 12 m in length by 3 m in width by 0.5 m in height; the other measures 3.5 m in length, 1.6 m in width, and 0.55 m in height. Both appear to be related to 20th century agricultural activities within this area, most likely field clearing or access/haul road construction/grading.

Site 4085 - Rock Enclosure (Feature A) and Low Rubble, Partially Stacked Wall (Feature B)

Site 4085 consists of a small rock enclosure and a partially stacked rock wall located within the eastern portion of the project area. Feature A rock enclosure is oval in plan view, measures approximately 3 meters in diameter (long axis), and was constructed by stacking limestone and basalt boulders and slabs from 1-2 courses wide and from 4 to 6 courses high. The perimeter length of the wall is 9.5 meters, which averages 0.35 m in width and 1.0 m in height. No portable artifacts or other features were observed in direct association, so that it is not possible to determine the feature's cultural affiliation. However, it seems likely that the feature was associated with late 19th or early 20th century sheep or cattle grazing operations within the project vicinity.

Feature B is located approximately 23 meters to the north of Feature A, and consists of a bulldozer-pushed rock rubble wall, oriented approximately east-west, which measures 4.0 m in length, 2.4 m in width, and 0.6 m in height. At the east end of the "pushed" section of wall, and articulated with it, is a short section of stacked wall which extends the overall length of the wall by 1.6 m. This stacked section of wall is slightly less wide than the pushed section, ranging from 1.5-1.75 m, but is c. 0.75 m higher than the pushed portion. The stacked section of wall was clearly constructed subsequent to the bulldozed section, and is therefore not prehistoric or early historic. The stacked section appears to represent the need to establish a square corner, most likely for erecting a stock gate. No additional features or portable artifacts were observed in association with this pushed/stacked rock wall.

Site 4086 - Low Rubble Wall

Site 4086 is a linear alignment of limestone and basalt boulders and cobbles which proceeds roughly east-west for c. 36 meters across the top of the limestone plateau within the northwestern portion of the project area. The alignment, which averages 2 m in width and ranges from 0.3 to 0.8 m above the surrounding ground surface, does not represent a hand-constructed boulder-lined cobble/core filled wall. Rather, significant soil was deposited in several areas in conjunction with deposition of the cobbles, suggesting bulldozed field clearing debris; at other places, no soil accumulated, indicating possible sledding of field stones during agricultural field clearing. Although no additional features were observed along or near the rock rubble, the linear alignment suggests the possibility that one side or the other may at one time have marked the edge of a field access road.

Site 4087 - Overhang

Site 4087 is an overhang shelter located along the base of a prominent limestone bluff formed at the intersection of the existing broad coastal plain and an uplifted fossil sea bed. The bluff, which overlooks the coastal plain and Kahuku Point, extends roughly 340 meters east-west. Approximately 280 meters of the 340 m-long formation (c. 82% of the bluff's total length) was recorded as Site 4082. The present site (4087) is located approximately 40 meters to the east of Feature A of Site 4082.

The overhang extends along the bottom of the cliff for a total distance of 26 meters; the average depth of the overhang is 2.5 meters, with height ("headroom") under the overhang ranging from 0.5 to slightly over 1.5 meters. Habitation debris and cultural midden has accumulated at several locations, and may represent at least a thin veneer throughout the entire sheltered area. Although no portable artifacts were observed during the present recording, such items may well exist below the surface within the midden. Several exposed boulder piles (possible circular alignments) suggest possible fire hearth locations.

SITE DESCRIPTIONS - MALAEKAHANA SITES

Site 4088 - Platform/Mound

Site 4088 is a small platform, or mound, located near the northwestern corner of the Malaekahana project area. The feature was constructed of large waterworn boulders stacked adjacent to a shallow ravine. The feature measures 4.5 m long (parallel with elevation contours), 3 m in width (perpendicular to elevation contours), and reaches a maximum height of 1.35 meters along the front face above the ravine. The surface of the mound is slightly dome-shaped, and has been "paved" with small basalt cobbles and pebbles. No additional features, and no midden accumulation or portable artifacts, were observed within the vicinity of the feature. The feature may represent the remnants of a larger complex of habitation features, or could mark a prehistoric or historic burial, essentially isolated from other cultural elements. This latter determination should be made on the basis of partial dismantling of the feature.

Site 4089 - Cave

Site 4089 is a relatively large cave which has formed in an exposed coral reef (limestone) formation located within the east-central portion of the project area. The cave entrance is located on the south side of a low hill, and measures approximately 5 meters in width and 2.5 meters in height. The entrance slopes downward and proceeds north for approximately 5 meters, at which point the primary cave chamber is reached. The primary chamber, covered with stalactites ranging in length from a few centimeters to nearly 1 m, extends 6 meters north-south by 14 meters east-west (see Figure 10). The chamber, which averages 3 meters in height but achieves a maximum height at the west end of c. 5 meters, has been divided essentially in half by construction of a north-to-south-oriented retaining wall. The wall ensured that a level living and working space would be maintained within the eastern half of the primary chamber. This latter consideration was necessary as the only available source of light inside the cave is that which enters through the east-end entrance.

The east (habitable) half of the chamber contains two cleared terraces, one of which (lower) measures approximately 2 meters in diameter, with the second (upper) measuring c. 1.5 m in diameter. Associated with the upper terrace is an accumulation of midden, containing marine shell fragments, cut and unmodified pieces of faunal bone, and occasional small basalt waste flakes. Midden appears also to be associated with the lower terrace, along with a possible fire hearth, as evidenced by the presence of a white, ashy deposit exposed on a portion of the surface. A small dating sample of this ashy deposit was recovered during the present project (PHRI Field Sample Numbers 18 and 19).

The floor of the west half of the primary cave chamber is situated c. 0.6 m below the lowest portion of the east-half floor. No cultural deposits have accumulated within the west chamber area, presumably due to

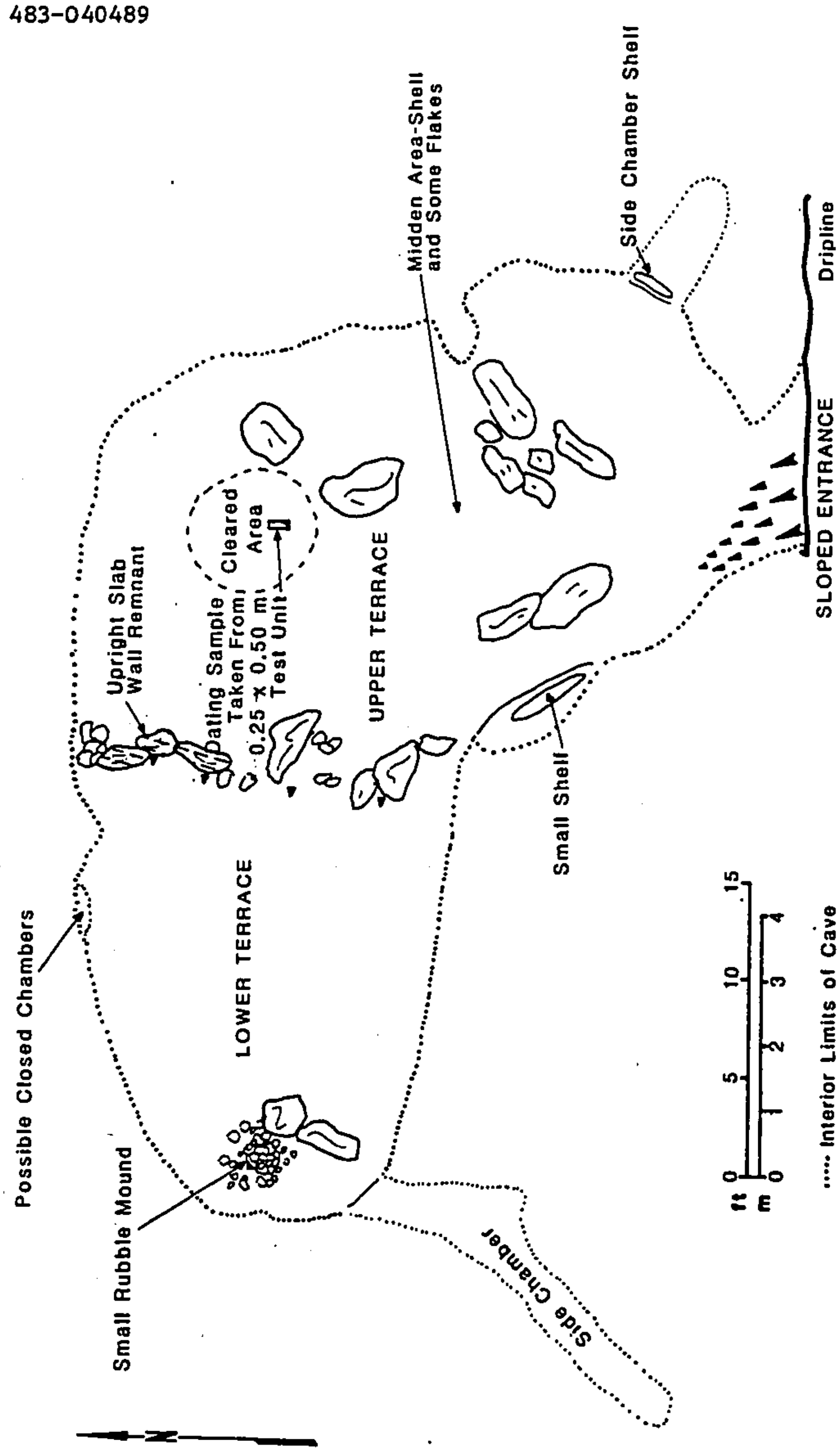

FIGURE 10. Site 4089

the absence of suitable light. A narrow side tube chamber extends 3.8 m southwest from the west end of the west chamber; no burials or other cultural materials were observed within this tube.

This site is very well preserved. Several additional attributes of the site warrant its consideration as an excellent example of a site type and possible preservation "as is": (1) The site has apparently not been subjected to significant looting or other disturbance, (2) it may contain a deep and relatively old cultural deposit, and (3) the feature is unique in configuration among the inventory of sites recorded during the present project.

Two bulk dating samples were recovered from Site 4089, one from between 35 and 40 cm below surface, and the second from between 55 and 58 cm below surface (BETA 29698 and 29699, respectively). The former, suggesting occupation between AD 1600 and 1955, was contaminated with bomb C-14. The latter date, however, was uncontaminated and indicates use of the site between AD 1010 and 1375. This range, combined with that indicated for Site 4082, implies that the two sites combined may contain a record of regional prehistory spanning nearly 600 years—c. AD 1000-1300 for Site 4089 and AD 1300-1600 for Site 4082.

Site 4090 - Overhang (Features A and B)

Site 4090 consists of two overhang shelters which have formed in an area of exposed limestone outcrop on the north side of a low hill near the center of the project area. Feature A overhang extends for a total of 10.5 meters along the outcrop, and protrudes an average of 2.5 meters under (perpendicular to) the outcrop. Height of (headroom within) the sheltered area averages 0.75 m. A pile of rock rubble is located in front of the overhang at the eastern 1/3 of the feature, and may represent clearing debris from inside the overhang. Although no formed artifacts or interior features were observed within the feature, one basalt core and one basalt flake suggest the possibility that additional cultural materials remain buried below the surface.

Feature B overhang is located c. 7 meters to the west of Feature A. Feature B overhang extends c. 5 meters along the exposed section of outcrop, and varies from 0.5 to 1.25 m deep. Two natural cupboards are located within the feature, one near the center, and one at the feature's west end. Although no portable artifacts or other interior features were observed within the overhang, a light brown to grey habitation midden appears to have accumulated to at least a few centimeters depth throughout most of interior. The tentative conclusion that the majority of any deposit is probably quite shallow is based on the observation at several locations of exposed bedrock "floor".

Site 4091 - Overhang

Site 4091 consists of a single overhang shelter located on the north side of a low hill near the center of the project area. The overhang extends approximately 9 meters north-south along the exposed limestone outcrop, and averages 1.25 m deep. A short (2 m n-s by 0.9 m e-w by 0.25 m high) alignment of stacked limestone slabs is located just outside of the overhang interior near the north end of the feature. A 2 meter-square "room" occurs at the south end of the feature, within which all of the observed cultural debris was noted (including five waterworn pebbles/cobbles, two basalt flakes, a contemporary glass jar fragment, and a light-colored and probably shallow deposit of cultural midden (faunal bone and possibly marine shell fragments).

Site 4092 - Cave

Site 4092 is a small single-chamber cave located in an exposed section of bedrock on a north-facing hill within the north-central portion of the project area. In plan view, the interior chamber is long and narrow, extending 13 meters east-west but averaging only 1.2 meters in width. Average height inside the chamber is 1.0 m from the entrance to a point about 4 meters west of the entrance, and from that point to the end of the feature height decreases by about 10 cm per linear meter. A non-cultural rock rubble pile partially blocks the entrance to the cave. No portable artifacts, interior construction modifications, or midden accumulations were observed during the present recording. The only evidence of prehistoric or historic use/occupation exists in the form of a few kukui nut shell fragments scattered about the rock rubble in front of the cave opening.

Site 4093 - Agricultural Ditch and Associated Tunnel

Site 4093 is a fairly substantial irrigation ditch which proceeds approximately 198 degrees az until it intersects a hillside. At this point, a 46.5 meter-long tunnel, averaging 1.5 meters in diameter and 1.75 meters high, was drilled and blasted through the sandstone substrate. To prevent erosion of the floor and sides of the tunnel, the ditch was concrete-lined through the tunnel. The concrete portion of ditch is 0.6 m wide and 0.35 m deep. At the tunnel outlet, the concrete-lined ditch continues on a new bearing (260 degrees az) for 21.4 meters past the tunnel, at which point the system disappears under a major dirt access road and could not be relocated on the other side of the road. Apparently, subsequent sugar cane operations have obliterated the continuation of the original ditch, perhaps replacing the earlier feature with buried pipe.

Except for some of the original form/shoring boards and chunks of concrete, no portable artifacts or other features were observed in association with the tunnel, which probably dates to around the turn-of-the-century. The current access road blocks the outlet of the ditch just past the point at which the ditch exits the tunnel, and it does not appear that the ditch has been utilized for a considerable period of time.

CONCLUSION

DISCUSSION

During the combined surface and subsurface inventory survey of the Punamano and Malaekahana new golf course project areas, 26 sites were identified and recorded, 32 backhoe trenches were excavated, and hand-trowel probes were conducted at three overhang shelters. The 26 sites are comprised of 45 component features representing 11 feature types and four primary functional types. Table 2 summarizes the findings by segregating prehistoric from early historic components, and displaying the distribution of the various functional feature types in terms of their frequency and percentage of occurrence within the two project areas.

Table 2.

DISTRIBUTION OF SITE FUNCTIONAL TYPES BY PROJECT AREA

	Punamano		Malaekahana	
	#	%	#	%
Single-Component Sites	14	70	5	83
Dual or Multi-Component Sites	6	30	1	17
Total # of Sites	**20**		**6**	
Distribution of Component Features				
Prehistoric Components				
Caves	0	0	2	33
Overhangs (habitation)	19	70	3	50
Overhangs (burial)	4	15	0	0
Terraces/Plat/Mounds	2	7	1	17
Enclosure	1	4	0	0
Isolated Midden Deposits	1	4	0	0
Sub-total Prehistoric:	**27**	**100**	**6**	**100**
Historic Components				
WWII Artillery	4	36	0	0
Historic Bottle Dump	1	9.5	0	0
Early Road Alignment	1	9.5	0	0
Early Ditch w/Tunnel	0	0	1	100
Walls	5	45	0	0
Sub-total Historic:	**11**	**199**	**1**	**100**

As can be seen from an examination of Table 2, caves and overhangs are by far the most prominent feature type represented at both Punamano and Malaekahana, representing 85% and 83%, respectively for the two project areas, of all prehistoric components recorded; caves and overhangs are represented by 23 (c. 60%) of the total of 38 individual components recorded at Punamano, and by five (c. 71%) of the total of seven individual components recorded at Malaekahana.

For Punamano, two periods of occupation appear to be represented by the 23 overhangs. A prehistoric and/or protohistoric period is indicated for all of the inhabited overhangs, based on the presence of prehistoric artifact types such as abraders and abrader fragments, adze fragments, at least one drilled shell, and basalt flakes and cores and volcanic glass flakes, associated with typical midden deposits which include marine shell fragments, kukui nut, and faunal bone (especially avian species). Except for a possible single "isolated" midden pocket observed adjacent to the cliff face among the complex of overhangs at Site 4082, all observations of such prehistoric material (artifacts and midden) were in the context of occupied overhangs. In no case did prehistoric material appear mixed with early historic artifacts, although at most of the overhangs recent trash was observed on top of the earlier cultural deposits.

Within several of the occupied overhangs, and in adjacent uninhabitable (very small) overhangs, historic-era burials have been identified. All have been looted, presumably for skulls, mandibles and formed artifacts as such elements are clearly underrepresented among the estimated 25 individual burials observed. In all instances where sufficient debris was left for estimating the age of the burials, an historic time period seems to be indicated, with interments having begun near the end of the 19th century and to have continued through perhaps the first decade of the twentieth century. This inference is based on the presence of milled coffin boards and the generally good preservation of the wood and other perishable materials observed in association with the looted burials. That all of the individuals were of Hawaiian cultural affiliation is suggested by the presence of traditional Hawaiian artifacts or artifact fragments at all features where identifiable artifacts were observed. Finally, the looting of these burials may have begun early in this century, but seems most likely to have begun in more recent times: an intact, 1/8" mesh, wood-framed sifting screen was observed on the surface at Site 4082.

For Malaekahana, there is no evidence of use/occupation of the two caves and three overhangs during historic time periods (excluding modern times), nor use of these features as burial crypts. Based on the observation of typical Hawaiian artifact types and midden deposits, the primary use of these features appears to have occurred during the prehistoric or protohistoric time periods. Considerable antiquity may also be indicated for initial occupation at one of the caves. Based on extrapolations involving the slope of the cave floor, coupled with examination of a portion of the subsurface soil profile which was exposed while removing a bulk dating sample, the midden at Malaekahana's Site 4089 may in fact exceed 0.75 meters in depth. Whether or not this apparent substantial accumulation also signals significant time depth must await dating results on the sample recovered during the present project as well as further data recovery.

Two terrace/platform/mound features were recorded within the Punamano project area. Both ends of Site 4077 "terrace/wall" segment appear to have collapsed and to be "incomplete," suggesting that the present feature, now only 2.5 m in length, may once have articulated with a larger system. Based on an extrapolation from the existing alignment, the hypothesized larger system would have been constructed along a natural contour above a shallow swale, in such a way as to have protected the land above from sheet-wash on the adjacent lower ground. Such terraces would have been integral components of an agricultural system which focused on the sheltered, well-watered and well-drained soils along upland swales, as Davis suggests may have been the case at nearby 'Opana <u>ahupua'a</u> (Davis 1981). Unfortunately, it cannot be determined on the basis of present evidence what proportion, if any, of the original Site 4077 wall was lost to subsequent historic agricultural activities. The second terrace/mound site located within Punamano (Site 4084) was clearly the result of essentially modern agricultural activities.

At Malaekahana, a well-constructed terrace (Site 4088) was recorded on a low hill overlooking a swale. In consideration of the obvious care exercised during construction, and on the basis of the slightly mounded and narrow "floor" area available, a religious function has been inferred. The feature may contain one or more burials.

A single rock enclosure was encountered during the course of the project. Recorded as Punamano Site 4085A, neither the cultural affiliation nor age of the feature can be realistically estimated on the basis of present evidence. For convenience, the site is listed in Table 2 among the "prehistoric" sites.

Historic components listed in Table 2 are believed to relate to three basic activities/time periods, as follows:

(1) WWII coastal defenses. Punamano Site 4075 contains three gun emplacements and two bunkers, most likely constructed during or just prior to WWII. Although the physical remains do not warrant further data recovery and no additional work has been recommended, further historical documentary research could provide insight into the exact period of construction and abandonment of these features.

(2) Early historic cattle and sheep ranching in the project area. Historical background research for this project indicated that a substantial effort was expended prior to the turn-of-the-century in developing cattle and sheep ranching operations within and near the two project areas (see Appendix A). Punamano wall sites 4069, 4071, and 4079 are believed to relate to these activities. In the absence of additional associated features or accumulations of other cultural material, however, these sites retain minimal information value.

(3) Late 19th and early- to mid-20th century sugarcane operations. Punamano Site 4080 is an historic dump containing numerous bottles and other fragmentary artifacts, including contemporary items of galvanized steel, plastic and aluminum. The dump does not appear to be associated with known historic habitation areas, which has led to the suggestion that it may represent the accumulated refuse of cane field workers. While the earliest period of use appears to date back perhaps 80-90 years, grading of adjacent access roads has destroyed much of the material originally deposited. In addition, the site appears to have been both "picked through" as well as continuously utilized through modern times, thus rendering less reliable any provenience information which might accompany a formal data recovery program.

Site 4083 is believed to represent the alignment of an agricultural access road, and is without additional associated features or artifact concentrations. Sites 4085B and 4086 represent field/road clearing piles of rock and dirt. Lastly, Malaekahana Site 4093 is a concrete-lined ditch with an associated tunnel. The tunnel was obviously excavated in order to dramatically shorten the length of ditch required to service a number of nearby sugarcane fields. While the physical remains do not appear unique nor do they contain significant residual information value, additional historic documentary research could confirm the exact dates of ditch and tunnel construction. This information could, in turn, prove helpful in accounting for some of the other features which have been observed within the project area.

EVALUATIONS

Significance categories used in the evaluation process for the present project area sites follow definitions derived from the National Register criteria for evaluation, as outlined in the Code of Federal Regulations (36 CFR Part 60). The Hawaii State Historic Preservation Office also employs these criteria for evaluating cultural resources. Sites determined here to be potentially significant for information content (Category A in Table 3) are assessed under Criterion D, which defines significant resources as those which "have yielded, or may be likely to yield, information important in prehistory or history" (36 CFR Sec. 60.4). Sites determined to be potentially significant as excellent examples of site types (Category B) are assessed under Criterion C, which defines significant resources as those which "embody the distinctive characteristics of a type, period, or method of construction...or that represent a significant and distinguishable entity whose components may lack individual distinction" (36 CFR Sec. 60.4).

Sites determined to be (potentially) culturally significant (Category C) are assessed under guidelines prepared by the Advisory Council on Historic Preservation, entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (Draft Report, August 1985). Cultural value is defined in the guidelines as

Table 3.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS PUNAMANO AND MALAEKAHANA GOLF COURSES

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
4069	-	+	-	-	-	+	-	-
4074	-	+	-	-	-	+	-	-
4075	-	+	-	-	-	+	-	-
4077	-	+	-	-	-	+	-	-
4079	-	+	-	-	-	+	-	-
4080	-	+	-	-	-	+	-	-
4081	-	+	-	-	-	+	-	-
4083	-	+	-	-	-	+	-	-
4084	-	+	-	-	-	+	-	-
4085	-	+	-	-	-	+	-	-
4086	-	+	-	-	-	+	-	-
4091	-	+	-	-	-	+	-	-
4092	-	+	-	-	-	+	-	-
Subtotal:	0	13	0	0	0	13	0	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, DLNR-HSS=not significant);
B=Excellent example of site type at local, region, island, State, or National level (PHRI=interpretive value); and
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;
PID=Preservation with some level of interpretive development recommended (including appropriate related data recovery work); and
PAI=Preservation "as is," with minimal further work (and possible inclusion into landscaping), or appropriate data recovery/disinterments.

Table 3. (Cont.)

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
4068	+	–	–	–	+	–	–	–
4070	+	–	–	–	+	–	–	–
4071	+	–	–	–	+	–	–	–
4072	+	–	–	–	+	–	–	–
4073	+	–	–	–	+	–	–	–
4076	+	–	–	–	+	–	–	–
4078	+	–	–	–	+	–	–	–
4087	+	–	–	–	+	–	–	–
4090	+	–	–	–	+	–	–	–
4093	+	–	–	–	+	–	–	–
Subtotal:	10	0	0	0	10	0	0	0
4082	+	–	–	+	+	–	–	–
4088	+	–	–	+	+	–	–	–
Subtotal:	2	0	0	2	2	0	0	0
4089	+	–	+	–	+	–	–	+
Subtotal:	1	0	1	0	1	0	0	1
Total:	13	13	1	2	13	13	0	1

"...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" (1985:1). The guidelines specify that, "A property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value" (1985:7). Both religious and non-religious cultural values are specified, and examples include burial sites, loci of traditional economic activities, and loci that are symbolic of a group's identity or history (1985:11).

To further facilitate client management decisions regarding the subsequent treatment of resources, the general significance of all archaeological remains identified during the present survey was evaluated in terms of potential scientific research, interpretive, and/or cultural values. Scientific 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.

In evaluating information content (Category A) (Scientific research value), all of the sites located within the project area were examined in light of several major research issues identified during background research. These issues revolved around general questions of chronology, settlement and exploitative patterns, site and assemblage variability, material culture and technology, diet and economy, and socio-religious patterns.

Chronology - Determining the period of use for sites within the project area is contingent upon recovery and assay of datable materials, such as volcanic glass and charcoal. A number of sites located within both project areas have already been demonstrated as containing, or are believed to contain, volcanic glass and/or charcoal in contexts suitable for stratigraphic dating of midden deposits (Punamano Sites 4068, 4070A, 4071B, 4072, 4073, 4076, 4078, 4082A,E,F,H, and 4087, and Malaekahana Sites 4089, 4090A,B, and 4092).

Two sites in particular—Punamano Site 4076 and Malaekahana Site 4089—possess attributes which could render them especially suited to the evaluation of existing hypotheses concerning the early prehistoric occupation of Oahu. These attributes consist of deep, possibly stratified and apparently undisturbed midden deposits. That it will be possible to secure dates for Site 4089 has already been demonstrated by observing several charcoal lenses during excavation for bulk dating samples; moreover, there is a high probability that the substantial nature of the deposits at both sites conceal undisturbed fire hearths.

At the most general level, additional information from these various caves and overhangs could not only provide new information on the earliest use of the area, but also whether the Punamano Site 4082 overhangs were first used for occupation and only subsequently as burial sites, or whether these two functions might have been more or less coeval. The association of faunal remains with artifact inventories at many of the sites represents an additional significant asset in any attempt to add cultural breadth to the potentially early dating results.

Settlement and Exploitative Patterns - Further evaluation of areal settlement and exploitative patterns requires intact deposits of artifacts and associated midden. Many of those sites listed above under "Chronology" have also apparently accumulated artifacts and food remains (midden) in conjunction with the datable charcoal and volcanic glass. The possibility clearly exists that at least some of these shelters may contain a temporal record of periodic abandonment and/or changes in use of these features over time. Such a circumstance would substantially enhance studies of regional adaptive strategies, particularly those designed to link changes in feature use over time with evolutionary trends in resource procurement and associated technology.

Site and Assemblage Variability, Material Culture and Technology, and Diet and Economy - While virtually all of the project area sites are relatively simple single- or dual-component sites, the fact that a significant percentage of these sites is represented by caves and overhangs ameliorates this potentially negative situation. Specifically, the co-occurrence at many of the sites of a relatively wide variety of data sets implies that it might be especially fruitful to further evaluate existing hypotheses which relate assemblage variability and material culture with changes in prehistoric diet and economy over long periods of time.

Socio-Religious Patterns - A number of questions should be addressed in relation to the numerous burials and burial remains documented at Punamano and the possible burial at Malaekahana's Site 4088. While there is no question that these features have been extensively looted, there is at least a remote possibility that additional burials remain undiscovered and intact among deep crevices at Punamano. Even the disturbed examples may contain information sufficient for evaluating whether they shared basically similar attributes in terms of offerings present, the position and treatment of the remains, and/or relative social status. Lastly, an effort should be made to account for the apparent differences in treatment between the individuals buried at Site 4082, on the one hand, and the possible burial at Malaekahana's Site 4088, on the other.

At this stage of analysis (inventory-level reconnaissance), archaeological sites with potentially high value as excellent examples of site types (Category B) (interpretive value), are identified by considering those attributes which, if occurring together at one site, would provide a representative example of particular kinds of behaviors, activities or conditions. In the present two project areas, only a single site possess attributes which render it worthy of consideration for possible preservation for interpretive development. The site is Malaekahana's Site 4089, a large limestone cave containing a substantial midden deposit, a high "majestic" primary chamber, and several internal features. The site has apparently not been subjected to significant lotting or other disturbance, and is unique in configuration among the inventory of sites recorded within both project areas. Preservation of the site "as is" would be an appropriate method for assuring that this unique feature with its accumulated cultural deposit is preserved for future researchers' use. In addition, some level of future "interpretive development" might also be appropriate, pending the results of further evaluation and data recovery.

Sites with cultural significance (Category C) (cultural value) would include those with traditional uses and those that have significant meaning in the context of a traditional way of life. The burial sites at Punamano's 4082, and the terrace site which may also contain at burial at Malaekahana's 4088, represent sites potentially possessing such value.

General significance assessments and the recommended general treatments are presented in Table 3.

RECOMMENDATIONS

Based on the findings of significance and potential significance and cultural value as outlined above, the following recommendations are offered (see also Table 3). Of the total 26 sites situated within the project area, 23 are assessed as significant solely for information content. For 13 of the 23 sites, no further work is recommended. For the remaining 10 of the 23 sites, further data collection is recommended. Of the remaining three of the total 26 sites, two are assessed as significant for information content and cultural value. For these two sites, further data collection is recommended. The remaining one site is assessed as significant for information content and as an excellent example of a site type. For this site, further data collection followed by preservation "as is" is recommended.

It should be noted that the above evaluations and recommendations are based on the findings of an inventory-level surface survey and limited subsurface testing. There is always the possibility, however remote, that potentially significant unidentified cultural remains might be encountered in the course of future development activities. In such a situation, archaeological consultation should be sought immediately.

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APPENDIX A:

PRELIMINARY HISTORICAL DOCUMENTARY RESEARCH PUNAMANO AND MALAEKAHANA GOLF COURSES LAND OF KAHUKU, ISLAND OF O'AHU

by Helen Wong Smith, B.A.

The following presents the findings of a preliminary historical literature search in connection with the five ahupua'a in which the project area is situated. The ahupua'a are Ulupehupehu, Punalau, Kahuku, Malaekahana, and Laie. There is some disagreement as to whether the South project area extends into Laie ahupua'a; however, according to the USGS map, it does, and for this reason a few references to Laie are included within this study. Preliminary historical documentary research on the lands of Opana, Kawela, Hanakaoe, Oio, Ulupehupehu, Punalau and Kahuku, Koolauloa, Island of Oahu was conducted by Carol L. Silva in 1984. Much of Silva's findings on the ahupua'a of Kahuku are presented in this report; in regard to Kahuku, the author has *merely* attempted to expand on Silva's work.

MYTHOLOGY

Kahuku is an ahupua'a rich with legends, ranging from legends of its one-time separation from the island of Oahu, to legends concerning its hala groves. The following legends are presented here in order to give an indication of how Kahuku was perceived by the ancient Hawaiians.

The natives of the windward side of Oahu, where Kahuku is located, relate a legend that tells of how Kahuku, the northeast point of Oahu, drifted in from the sea and was caught by the people of the Koolauloa district by its two loko (landlocked body of water), and was drawn in to shore and made fast. In evidence thereof, the hollow sound of a section of Kahuku as one rides over the ground is mentioned, and the coastal character of an alleged ancient shore now far inland is referred to as conclusive proof (Thrum 1902:178).

An important legend about Kahuku, similar to the one above, tells how its shore area to the middle of Waialee once formed a small island that floated separate from Oahu at the mercy of strong north to northeast winds. The island had been struck apart from Oahu by Lonokaeho, leaving an open gap at Kalaiokahipa Ridge, now located a mile inland, and leaving the Kahuku plain under water so that ocean waves lapped about Kalaiokahipa.

In reference to these legends concerning Kahuku as an island and Kahuku Plain as submerged, geologists verify that ancient coral reefs are found inland and that a white lime soil covers the flats near the sea (Wilcox 1975). In addition, while touring Oahu in 1928, Levi Chamberlain recorded this tale which gives us more insight into the nature of the land:

> The natives tell a marvellous story respecting the origin of this destrict [sic], which they say floated in from the sea, and attached itself to the ancient shore of the island, that there was a subterranean communication between the sea and the ancient shore, by which a shark used to pass, and make depredations up on land. The basis of the tract, which is from five to seven miles in length, and from one to two miles in breadth, appears to be of coral; and it was evidently redeemed from the sea, as a good deal of land, in many places along the shore around the whole circuit of the island, evidently has been (Chamberlain 1957:35-6).

McAllister (1933) tells another tale of the time when Kahuku was submerged:

> Kane and Kanaloa lived in the vicinity of the ridge (Kalaiokahipa ridge); but that was at the time when the Kahuku plain was still under water, and waves lapped about Kalaiokahipa. The brothers are said to have obtained fish by dipping into two holes on opposite sides of a large rock which now lies in the cane field (Sterling and Summers 1978).

There are many stories which explain the linking of Kahuku to Oahu. Here are two:

> Legend tells us that Kahuku was a floating island situated several miles out to sea. For a long time, the people of O'ahu had planned to make the island a part of their land, for they saw it come close to O'ahu's shores. The floating island of the Menehune did not have any fresh-water springs because there were no high mountains covered with verdure and trees to capture the rains. So, the Little Folk used to paddle their islet into the bays of O'ahu at night to haul water from the springs of the large island.
>
> One day, a resident of Kahuku suggested that all the people gather together to make strong hooks of whalebone and attach then to a stout rope made of sacred Olona fibres. This was done.
>
> The Menehune came to take water as usual, then the residents of O'ahu attached the large hooks to the floating isle while the Little Folk were off at the water-springs. When the water was loaded, the Menehune started to paddle off again, but they could not move their islet or free it from the ivory hooks and Olona ropes.
>
> Today, many people who travel Kahuku section on O'ahu and see the many islets seeming to float off shore, and hear the sea singing its songs, they say, 'Listen to the Menehune grumbling while they try to move their island that used to float!'

> The rumbling and grumbling is heard only at night, for that is the time for the Menehune to be working at Kahuku (Paki 1972:53).

Kamakau's version of the story gives a totally different perspective to the joining of the two land masses. According to him, it was Oahu that did the floating:

> According to traditions of some people, Oahu was said to have once been a floating land, he 'aina lewa o Oahu. The Kahuku side was a wide open gap (puka hamama) and this was called Ka puka o Kahipa a me Nawaiuolewa, "The opening of Kahipa and Nawaiuolewa." The piece of land that closed it up was called Kahuku, and the hooks that made fast the piece of land and joined it to the island were called Kilou and Polou (Kamakau 1974:38-9).

Kalaiokahipa Ridge, within the project area in the ahupua'a of Kahuku, is rich with its own legends. You will notice in the following legends concerning Kalaiokahipa that there is non-concurrence as to the gender of the characters in the legends. The following references concerning Kalaiokahipa Ridge are found in Sterling and Summers (1978):

> Nawai-o-lewa is on the northwest side of the rocky brow of Kalaeokihipa and now only one breast is left to move in the gusty winds of Kahuku-lewa. The other was broken off by that supernatural son of Ku and Hina...Between Kalaeokahipa and Nawaiuolewa, just above is a small round opening to a secret cave...The small secret cave belonged to Ka-alae-huapi (Red head mud hen) and others in the first Kahuku that was covered by a hala grove (J.K. Apuakehau, Kuokoa, June 29, 1922).

> The many caves in the porous formation were used as places of burial by the old Hawaiians. On the Waimea side is an overhanging ledge where formerly hung two stalactites from which water continually dripped. They very closely resembled the breasts of a woman, and this was said to be Nawaiolewa, a goddess of the region. Some years ago, a white man removed one of the stalactites, or breasts, according to the story, and the water immediately stopped dripping down from the other (McAllister 1933).

> It is here that the breasts of Lewa were set asway at the brow of the cliff Kahipa (J.A. Kahiona, Oahu Places, Kuakoa, Nov. 28, 1919).

> The Hole of Kahipa and Nawaiuolewa is pointed out today but the story is lost. Kanui, a woman 105 years old, told Mary Pukui that the two were brother and sister. In order to make it one, the two sat down and hooked their fingers together and drew the islands together. The hole marks the place where they sat (Kamakau Part II, Moolelo o Hawaii, Note 4, Chap 12; IN Sterling and Summers 1978).

> Kahipa, said to be the name of a mythological character, now applied to a place in Kahuku where the mountains present the form of two female breasts.
>
> | | |
> |---|---|
> | Kahipa, na waiu olewa | Kahipa with pendulous breasts |
> | Lele ana, ku ka mahiki akea | How they swing to and fro |

(Emerson, Unwritten Literature, p.205).

On Nov. 28, 1919, the newspaper Kuokoa published this item (concerning the hooks [loko]) by J.A. Kahiona:

> It was a land that moved to and fro and it was Maui who pinned it down again. Polou and Kalou are deep water holes...All of the islands know the tale that Kahuku was an unstable land (Sterling and Summers 1978).

These water holes are mentioned in the creation myth of the sacred princess, Laiekawai:

> Kahuku district, according to legend, was once a floating island blown about by the winds. As it banged against Oahu, it made noises which disturbed the old women guarding the Princess Laiekawai. The old women grappled the island with fishhooks and attached it securely to Oahu. Polou pool on the sea side of the Kahuku mill is one spot where the hook was fastened. The other end was fastened at Kukio pond, 300 feet inland at Kahuku Point (Boswell 1958:68).

It is through Kamakau and others that we learn of Kahuku's various underground structures and their connections:

> There is only one famous hiding cave, ana huna, on Oahu. It is Pokukaina. The opening on Kalaeoka'o'io that faces toward Ka'a'awa is believed to be in the pali of Kanehoalani, between Kualoa and Ka'a'awa, and the second opening is at the spring Ka'ahu'ula-punawai. This is a burial cave for chiefs, and much wealth was hidden away there with the chiefs of old. On the Kona side of the island the cave had three openings, one at Hailikulamanu--near the lower side of the cave of Koleana in Moanalua--another in Kalihi, and another in Pu'iwa. There was an opening at Waipahu, in Ewa, and another at Kahuku in Ko'olauloa. The mountain peak of Konahuanui was the highest point of the ridgepole of this burial cave "house," which sloped down toward Kahuku. Many stories tell of people going into it with kukui-nut torches in Kona and coming out at Kahuku. Within this cave are pools of water, streams, creeks, and decorations by the hand of man (hana kinohinoh'ia), and in some places there is level land (Kamakau 1974:38).
>
> Two stones known as Kahoa in the water about 250 ft. from the

beach just opposite from Kalaehila heiau, Kahuku Point. Many years ago a woman who lived on this beach was frequently seen to swim to these stones and disappear. At times she would be gone for as much as a week. Sometimes she was seen to put her clothes in a watertight calabash and swim away. When she returned she usually wore a kou lei. It was finally discovered that this was the entrance to another land, known as Ulukaa or Kahuna Moku (McAllister 1933).

Streams are said to connect Kahuku with Waipahu. In Olelo Noeau (1983), Pukui writes:

Pukana wai o Kahuku. The water outlet of Kahuku.

Refers to the outlet of an underground stream that once flowed from Kahuku to Waipahu, O'ahu (Pukui 1983:299)

T.G. Thrum, while touring the Kahuku area by train in the early 1900s, gives us the possible background to the proverb in Pukui.

A kapa-beating log of peculiar sound, unlike any other known on the island, which was placed in its waters at the close of a kapa-making season to keep it smooth and free from cracks that would impart an impression to the cloth in its manufacture, was missed, and believing it to have been stolen, search was made all through the Koolau, Waialua and other districts till at last it was found in use at Waipahu. Recognizing it by its resonant tone, it was claimed by the searching owner, and right thereto by those in possession was vigorously maintained. To test the truth of ownership as claimed, the Ewa people accompanied the claimant back to Kahuku to visit the scene and witness a test of the underground stream theory. A bundle of ti leaves were gathered, which was wrapped together and consigned to the waters of Punahoolapa (makai of the present project area). In the course of a few days they were lost to sight, whereupon the party set out for Ewa, and after careful watching, as predicted, the bundle of ti leaves came forth on the bosom of the waters of the Waipahu stream. The kapa log was thereupon recognized as the rightful property of the Kahuku claimant (Thrum 1911:130).

Although one thinks of sugar and pineapple when one thinks of Kahuku, this was not always so. Both legendary and early historic references cite the hala groves of Kahuku.

...he flew to Kahuku and adorned his neck with wreaths of the pandanus fruit and his head with the flowers of sugar cane." [This showed that he had come from Kahuku] (Thrum 1912:100).

This is the land of the hala tree..."I sent out word...among the people that there should be no one leaving here (Kahuku) for Waimea or Waialua who had not a wreath of hala-fruit..." (Cummins 1913:241-2).

> ...men from Kahuku were identified by leis of the orange hala fruit which they wore by order of their chief when they left their ahupua'a... (Wilcox 1975).

Halemano*, while attempting to win back the attention of his wife, composes a chant (Elbert 1965:280-281):

A kukui au a Kahewahewa
Ku au nana i laila,
Haloiloi kuu waimaka e uwe,
Nani na hala ka oiwi o Kahuku,
I ka lawe a ka makani he mikioi.

As I reported to Kahewahewa
I stood and gazed, then
Tears filled my eyes causing me to weep.
How beautiful are the hala, native trees of Kahuku,
As they are being fanned by the Mikoioi wind

Kahuku hala is also mentioned in Emerson (1915:97-98), who relates a story of Hiiaka's trek to Kauai to bring back Lohiau for her sister Pele. Hiiaka encounters two rude creatures who refuse the goddess the slightest acknowledgment. Their discourtesy causes Hiiaka to compose a chant using a word play on "hala" which according to Emerson may be translated to mean "a fault, a sin".

Komo i ka nahele ulu hinalo
Nahele hala o Po'o-kaha-lulu;
Oia nahele hala maki o Kahuku
Heaha la ho'ika hala
I kapu ai o ka leo, e?
I Hookuli ai oe i ka uwalo, e?
E uwalo aku ana au;
Maloko mai oe, e!

We enter the fragrant groves,
Hala groves whose heads make a calm
Wild growths by the sea of Kahuku,
But what, indeed, are your halas?

---

*Halemano was a mortal who is credited with the evolution of hula. Born in Waianae, Oahu, he becomes "faultless in beauty" (Beckwith 1970:524). He marries the beauty of Puna, Kamalalawalu, who is sought by the chiefs of Puna and Hilo. While seeking refuge at the court of Kukuipahu, ruling chief of Kohala, Kamalalawalu leaves Halemano several times for a new lover. His sister, the sorceress Laenihi, suggests that he win her back by learning the hula. It is during this wooing that the above chant is relayed. Kamalalawalu returns to him only to find that now he is weary of her love.

Shall their murmur forbid you speech?
Make you dumb to my salutation?
I make this kindly entreaty
To you who sit in the grove.

Punamano is the name of a spring and swamp (<u>makai</u> of the project area) (Pukui 1974). McAllister (1933) provides some information on this spring and swamp:

> Small water hole, called Punamano, pointed out by Kahione, Kaleo, and Luika Kaio in the flat limestone plain of Kahuku Point. It is about 15 ft. in diameter and brackish in taste. My informants told this story:
>
> One time when the people of Kahuku were fishing they caught a small shark. Putting him in a calabash of water they carried him to their houses near the beach. Here he was cared for and put in larger and larger calabashes as he grew bigger. Finally having outgrown even the largest calabash that could be found, it was decided to place him in one of the pools of brackish water which came to be known as Punamano. A man and woman living near the pool became guardians. They had lived in their grass huts with a breadfruit tree near the pool and taro and potato patches near the mountains for several years when the brother of the woman came to live with them. Sometime after, the man and his wife went to the mountains to gather taro and potatoes. The brother, who was staying at home, thought that he would like to have some food prepared when his sister and her husband returned. He climbed the breadfruit tree and gathered several, throwing the fruit into the water instead of on the ground, where it would have been bruised in the fall. After picking enough for a few days he descended the tree and gathered most of the fruit from the bank. Two had floated to the middle of the pond and he could not reach them. Now this man knew of the shark that lived in the water, but he had frequently bathed in the pool and no thought of fear crossed his mind as he swam to the breadfruit. He did not know, however, that his sister had warned the shark not to allow anyone to steal breadfruit when they were gone. When the sister and her husband returned they could not find the brother. Neither was the shark to be found, but they saw the breadfruit floating in the pool and a reddish color to the water. They guessed what had occurred. For nearly a mile they followed the bloody trail until they came to the spring known as Punahoolapa. Not only was the brother never seen, but the shark has never been seen to this day. A plantation pump now marks the site of the spring, near the sea side of the road.

Another version by S. Kaupuu, recounted in the newspaper, <u>Ka Hae Hawaii</u> in 1861, portrays the brother as a thief, taking the breadfruit for his own needs. At the site of his own home, about 10 fathoms away, the spring had newly appeared, also reddened with his blood.

Thrum (1911:128) also mentions Punamano:

> ...water-holes of the district with certain of them furnishing catches of fish, but only on the nights of Kane. One called Punamano is famed for a shark-man's exploits, and another as having underground stream Ku's rock spring, a lone rock out upon the plain, distant from hill connections, which gives forth its trickling stream of pure spring water.

J.A. Kahiona gives us a version of the same story, placing the focus of the tale at Punahoolapa. He also portrays the shark as a sinister being who can change form at will.

> Nanahu-ka-mano was a pool in which a shark lived and Puna-hoolapa was the pit where he watched for men to eat to fill his stomach. He asked, "Where are you going?" "To the beach for sea weeds, sand crabs, papi crabs and shell fish." "The shark has not yet had his breakfast." When these passed on, he questioned others and told them the same thing that the shark has not yet breakfasted. He, himself was the shark he was talking about that had not eaten breakfast. The mouth of the rascal was on his back, a little below..." (Kuokoa 1919) (eligible for NRHP)

Two other sites in Kahuku <u>ahupua'a</u>, Kukio Pond, a natural basin filled with brackish water located about 300 ft from the sea, and Kaauhelemoa Fishpond, once located on the Waimea side of Kahuku, are mentioned by McAllister (1933).

> The pond (Kukio) was formerly much larger and contained many kinds of fish. It is said to have been surrounded by a large Hawaiian settlement. Mrs. John Kaleo is probably the only survivor and her former friends and relatives have been buried in shallow graves in the sand between the pond and the sea.
>
> Old fishpond known by the name of its guardian (mo'o), Kaauhelemoa, who was half man and half chicken, a being of supernatural power who could change himself at will into a man or chicken. The pond is said to have been fed by a spring. The area has now been turned into cane.

Another site, Waiapuka, situated just outside the South project area, is mentioned by Beck (1970:526) in relation to Laie-i-ka-wai (Laie in the water), mentioned earlier in this study, and her twin sister. The twin sisters were born at Laie on Oahu of Kahauokapaka the father, chief of the northern lands of the island, and Malaekahana. Kahauokapaka had made it known that he should bear a son before a daughter. So when Malaekahana gave birth to the twin daughters, she gave them to close relatives who hid the babies. Laieikawai was given to Waka, who first hid her in a cavern in Laie. Waiapuka pool has a small crevice which is said to open into the cavern where Laieikawai was hidden. The pool was described by McAllister (1933:156-157) as being oval in shape and measuring 30 feet by 60 feet. On Jackson's 1884 map of Laie (IN Bath 1985), a small pond labeled "Laieikawai" is shown on the grassy plain.

A final legend for the Laie-Malaekahana area, which ties mythology with occurrences during the post-contact years, is found in Yent and Estioko-Griffin's report on Malaekahana (1980:12):

> Manuwahi, the keeper of the gods at Laie, lived in a house at Malaekahana with his son and grandson, all three men possessing supernatural powers (Rice 1923:113). At this time, Malaekahana was the only part of Oahu not conquered by Kamehameha I. Kamehameha I had sent his bodyguard Ka-hala-iu with his bravest soldiers to conquer Malaekahana but during the first attempt, Manuwahi had deceived them. On the second attempt, Manuwahi summoned the help of the akua from the North, South, East and West and killed all the soldiers except Ka-hala-iu. Manuwahi sent him back to Kamehameha I who in turn, sent Ka-hala-iu back with more soldiers. This third attempt was again unsuccessful and Malaekahan was never subdued by Kamehameha I. Manuwahi spared Ka-hala-iu's life and Ka-hala-iu decided to stay and help Manuwahi clear the land and plant 'awa.

EARLY HISTORICAL ACCOUNTS

Two of the earliest voyager descriptions of the northwestern part of Oahu mention expanses of cultivated fields and well-inhabited communities. Cook's officers, who assumed command of his ships after his death, provide the following impressions:

> SUNDAY 28th. ...Run round the Northern Extreme of the Isle which terminates in a low Point rather projecting; off it lay a ledge of rocks extending a full Mile into the Sea, many of them above the surface of the Water; the Country in this neighbourhood is exceedingly fine and fertile; here is a large Village, in the midst of it is run up a high Pyramid doubtlessly part of a Morai. I stood into a Bay just to the Westward of this point the Eastern Shore of which was far the most beautifull [sic] Country we have as yet seen among these Isles, here was a fine expanse of Low Land bounteously cloath'd with Verdure, on which were situate many large Villages and extensive plantations; at the Water side it terminated in a fine sloping, sandy Beach...(Clerk IN Beaglehole 1967:I:572).

> WOA'HOO We saw this Island the beginning of last year, but only just as a high lump, We this Time sailed along its NE & NW sides but say nothing of the Southern part. What we did see of this Island was by far the most beautiful country of any in the Groupe; particularly the Neck that Stretches to the Northward and its NW side. Nothing could exceed the verdure of the hills, nor the Variety which the face of the Country dispaly'd. It /s north-eastern/ parts were cliffy, & rugg'd to

> the Sea side, but the Valley look'd exceedingly pleasant, near the N point we were charmed with the narrow border full of Villages, & the Moderate hills that rose behind them...(King IN Beaglehole 1967:I:610).

In 1794, British captain, George Vancouver, says of Kahuku and the surrounding territory:

> Our examination confirmed the remark of Capt. King excepting that in point of cultivation or fertility, the country did not appear in so flourishing a state, nor to have been at that time, occasioned most probably by the constant hostilities that had existed since that period (Vancouver 1798(3):71).

Besides constant hostilities, a probable reason for a decline in the population of Kahuku and thus decline in cultivation was what one author has called the "devastating scourge of Western diseases" (Lind 1938:40). Venereal disease was introduced at the island of Niihau by the Cook expedition in January 1778 (Kuykendall 1938:14-15). Captain King, on Cook's third voyage, was shocked by its rapid spread in Hawaii between this first contact and the second contact later that same year (Beaglehole 1967:498). Depopulation was general by the time Vancouver returned to the islands in 1792, 1793, and 1794. Kahuku, being at the north point of the Oahu, may have been seriously affected by the disease. Between 1778 and 1823, when the first missionaries compiled estimates of the Hawaiian population, the population had declined from an estimated 300,000 persons to 134,925 (Schmitt 1968:10).

This population decline had severe repercussions. A missionary census (Schmitt 1973) shows a Laie population of 452 in 1831, out of a total Koolau population of 2,891. It is noted that a population loss of 210 for the entire district occurred between 1831 and 1835. In 1838, Hall makes the general statement in regard to Koolauloa: "Much taro land now lies waste, because the diminished population of the district does not require its cultivation" (McAllister 1933:153).

E.S. Craighill Handy (1940:156) notes that, although taro was cultivated at Kahuku, "sweet potato was the primary food in most of the districts of this section...". Handy (1972:287) mentions clusters of houses encircling the small bays along the windward coast at Laie, Kahana, Kaneohe, and Kailua. It is probable that Malaekahana conformed to this coastal pattern but with a smaller population than Laie (Yent and Estioko-Griffin 1980:16). Handy (1940:88) also mentions agriculture in lands <u>mauka</u> of the project site:

> Inland from Kahuku ranch house in Kaainapele Spring. Terrace symbols are shown south of the ranch house, but Judge Rathburn says that there flats were built by Chinese before 1890 for rice paddies. They were irrigated with artesian water, but the water turned brackish and the paddies were abandoned. They were never used for taro. The 1917 map show extensive terrace

> areas in the swampland seaward of Oahu Railway, stretching 1.5 miles south of Kukio Pond. These were originally terraces, were later planted to rice, and are now under sugar cane. According to John Kaleo, there is a small group of terraces up Kahuku Stream or Kaohiaae, its upland branch. Kaleo knew the names of 11 localities where terraces were formerly cultivated.

In Malaekahana ahupua'a, Handy states that there were terraces that were irrigated by Kaukanalaau Stream (1940:89).

In 1828, missionary Levi Chamberlain completed his second circuit of the island of Oahu, during which he had examined students and had generally evaluated the effectiveness of teachers and education upon the native populace. His remarks demonstrate that within Kahuku at that time there still existed a viable and fairly progressive community (Chamberlain 1957:35-6).

> Tuesday Feb. 5th. After breakfast I examined two schools, belonging to Laie & Malaekahana, and was pleased with the appearance of the scholars. At a quarter before 11 A.M. we set out for Kahuku, and after travelling about two hours over a level sandy country, arrived at the school house, where we found 83 scholars assembled, waiting to be examined...A good hog had been cooked for us & when the examination closed, dinner was waiting...my attendants made a heartly meal; and the remainder of the food was placed in the calabashes of our natives, and carried along to furnish food for us when we should be again in need.

LAND USE CHANGES

In 1848, the Mahele, in which Kamehameha III relinquished absolute ownership of all lands, drastically changed the land tenure system in Hawaii. Individuals were given a chance to register legal verifiable claims to their house and agricultural plots. The land that the king received as a result of the Mahele, after the division with the 245 konohiki (high-ranking chiefs) was concluded, was divided into two parts. One part was reserved for the kings and came to be called "Crown lands," while the other part was given over to the Hawaiian government and came to be called "Government lands" (Kuykendall 1938:288-289). As part of Crown Lands, the king (under the name of Victoria Kamamalu) retained the entire ahupua'a of Kahuku, excepting the rights of the native tenants. This amounted to 4,752 acres (Indices 1929:27-8).

The ahupua'a of Malaekahana was awarded to A. Keohokalole, the mother of King Kalakaua, Queen Liliuokalani, Miriam Likelike Cleghorn, and William Pitt Leleiohoku. The 3,280 acres that constituted Malaekahana were parceled out in the following manner during the Mahele (names are tenants who retained the right to cultivate the alii's land):

483-040489

LCA	Acreage	Awardee	Book	Page
8452	3280	Keohokalole	10	414
8355	.55	Kakau	4	680
8537	.38	Kahawaii	6	14
3870	.22	Puu	6	15
7727	.13	Paukoa	6	15

Three testimonies are given here to give an indication of the agricultural practices in Malaekahana:

> LCA 8537 AWARDEE Kahawaii (Deceased) - Kuhapa, sworn, says he knows the land claimed by Kahawaii in Malaekahana. Part of it is planted in wauke. This part is bounded on all sides by the Konohiki's lands. The house site of claimant is not enclosed. Claimant held land from his youth. He died last April (1840). His wife is his heir. Paakahi, sworn, says he knows of 3 kalo patches claimed by Kahawaii in Laie. The Konohiki took this land away because claimant did not got he poalima. The konohiki of Malaekahana consented to this claim.

> LCA 7727 AWARDEE Paukoa (Deceased) - Kuhapa, sworn,...in Malaekahana. Part of it has been given up to the Konohiki by claimant's widow. The portion retained by her is planted with wauke. It is bounded on the Hauula sideby Kahoowaha's land, Mauka by Kuhapa's land, Waialua side by Kananui''sland, makai by Nawai's land. Paukoa died in the present year.

> LCA 8355 AWARDEE Kakau - ...is not presently cultivated. Part of it was planted last year with bananas, wauke (about half an acre). Claimant occupied these lands since the time of Kamehameha I...

Ulupehupehu and Punalau, which the North project area barely overlaps, were considered part of the <u>ahupua'a</u> of Hanakaoe and were classified as Government lands during the Mahele (Indices 1929:41-43). A tally by Silva (1984) helps in assessing early land use in the following <u>ahupua'a</u>:

Ulupehupehu contained:

15+	kula plots and gardens planted with wauke, sweet potato, gourd, banana, sugar cane
7	koa canoe trees
2	cultivated upland plots planted with wauke, banana, orange trees
1	banana plantation
1	cluster of hala
1	houselot

Punalau contained:

10	taro patches
1	fish pond named Puekahi
10	kula plots and gardens planted w/sweet potato, banana, noni, ulu
4	cultivated upland plots
8	houselots
4	coconut trees
3	shore areas/fisheries
2	koa canoe trees

Kahuku contained

162	taro patches
39	kula plots & gardens planted w/awa, banana, wauke, gourd, sweet potato, sugar cane, noni, watermelon, pili grass
7	cluster of hala
6	salt lands
4	koa canoe trees
2	fishponds
10	houselots
1	sweet potato parch cultivated upon cliffs
1	watercourse bank
3	cultivated upland plots
1	brackish spring
1	wooded upland area of ulu, ohia, kukui, koa, ti,noni, etc...

Testimonies given for the above three ahupua'a can be found in Silva's report (1984:26-36). Bertell Davis (1981) notes that "...the only Land Commission Awards recorded in 1848 for this [general] region are located on the coastal plains (Indices 1929). With the exception of Crown Lands at Kawela and Kahuku, Government Lands at Hanakaoe...there are no Land Commission Awards in the uplands (Davis 1981:9).

The ahupua'a of Laie (6,194 acres) was awarded to King William C. Lunalilo. The Hawaiian historian John I'i (1959) recorded the succession of chiefly control in Laie after the battle of Nu'uanu in the last decade of the 1700s. Kamehameha I gave Laie ahupua'a to his half-brother Kalaimamahu. From Kalaimamahu, control passed to his daughter, Kekauluohi o Mano, and finally to his grandson, Lunalilo (Bath 1985:7). Laie ahupua'a too was subject to the rights of the tenants, and several kuleana were awarded to those who improved small areas for their own purposes. A look at the list of awards indicate that most of the claimants in Laie grew sweet potato and bananas and cultivated taro patches.

As a result of the Mahele, western entrepeneurs eventually acquired large tracts of Hawaiian lands; this later was to have a profound effect on the course of Hawaii's development (Walker 1986). R. Moffitt, an Irish cattleman, gained control of the konohiki land in Kahuku from the chief in 1846. (Nakamura [1981] dates Moffitt's purchases as late 1850s and early 1860s, which is probably more accurate.) His pastures extended along the shore for 12 miles and inland to the mountain range. His blooded herds and flocks ran over small homesteads scattered here and there through his land, stripping them of verdure. The Hawaiians asked in vain for protection of their (hala) trees and vegetable patches. They wrote to the missionary, Emerson, who urged them to build fences and appealed to authorities in their behalf asking that government pounds be set up to enforce newly established trespass laws. With the disappearance of their hala forests, the people also began to disappear. Once well populated, Kahuku became a lonely sheep and cattle ranch famous for its prize English breeds and its imported water fowl (Wilcox 1975).

In 1850-51, only three years after the Mahele, Englishman Charles Gordon Hopkins, agent for the rental and sale of the Crown lands (Korn 1958:208), purchased over 8,000 acres of Hawaiian lands, some from Moffitt and some in Malaekahana from A. Keohokalole, and founded Kahuku Ranch, a cattle and sheep ranch. In 1861, Laie was conveyed to Henry H. Howland. Other Englishmen who acquired large tracts of Kahuku lands at this time include R.C. Wyllie and H.A. Widemann. By 1873, Kahuku Ranch was owned solely by H.A. Widemann and included the ahupua'a of Kaunala, Pahipahialua, Opana 1 and 2, Kawela, Hanakaoe, Oio 1 and 2, Ulupehupehu, Punaluau, Kahuku, Malaekahana, Keana, and a part of Laie—a total of c. 15,000 ac. Previous archaeological surveys and Loebenstein's 1890 map of Kahuku Ranch indicate that scattered remains of the ranch have also been identified in the vicinity of Punahoolapa Marsh (Bath 1984:33,50; Davis 1986:7-8). In 1874, Kahuku Ranch, was renamed Kahuku and Malekahana Ranch, and was sold to Julius L. Richardson for $45,000 (Thayer 1934:138), and in 1876 Richardson sold the ranch for $63,000 to James Campbell (Wilcox 1975).

The following portion of a news article provides a brief overview of the particulars of Campbell's purchase:

> ...It includes 25,000 acres in fee simple, and large tracts of mountain land under long leases, with $34,000 worth of live stock, including 3,000 head of cattle, with the choice band of merino sheep and horses now on it. It is unquestionably the best stock ranch on these islands, and it has been brought to a high state of perfection under the management of the late proprietors, who divided the plain into ten or twelve large paddocks, walled with heavy stone walls. It stretches from Laie to Waimea, a distance of thirteen miles, and those who have ever visited it must have admired its lovely green pastures of manienie grass so fattening to stock. It is the intention to Mr. Campbell to increase his band of sheep to 30,000 of the choicest breed. The price paid is a handsome one, securing to its present proprietor the most desirable ranch on the Islands, and to Mr. Richardson a comfortable fortune, the result in part of his industry and good management, and in part of the Reciprocity Treaty, the first fruit from which he has been so fortunate as to reap... (Hawaiian Gazette 10/4/1876:3:2).

During the mid-19th century, the isolation of the Kahuku area from the city of Honolulu was being alleviated with the construction of roads. A description is provided by Kuykendall (1835:25):

> On Oahu, what came to be called the "round-the-island road"--ancestor of Kamehameha Highway--extended from Honolulu to Ewa, thence across the central plateau to Waialua; from that place it ran along the coast past Kahuku and Kualoa to Kaneohe, where it joined the road which came over the Nuuanu pali from Honolulu. In 1856, for the first time, a four-wheeled carriage drawn by a pair of horses was driven over the portion of this road between Honolulu and Kahuku. Three years later, a Captain Coffin is reported to have driven with a carriage and span of horses from Honolulu to Kahuku one day in ten hours and to have returned the following day in eight hours.

Campbell had a land colonization scheme to develop and acquired Ewa ranch lands. Meanwhile, Benjamin F. Dillingham spearheaded construction of a railway circling the island. Dillingham and Campbell found that they could best implement their goals by working together. Campbell leased his Kahuku lands to Dillingham for 50 years, the lease commencing Jan. 1, 1890 and concluding Dec. 31, 1939, at an annual rate of $50,000 (Kuykendall 1967:69). Dillingham sub-leased land and water rights to Castle (Liber 128:143), and Castle assigned the sublease to Kahuku Plantation Co., which was incorporated Jan. 30, 1890, to grow cane and produce sugar. Castle was the first president of the Kahuku Plantation Co. (Wilcox 1975).

At first, the plantation relied on pumped spring water, stream water, and rain to irrigate the sugarcane, but these sources were found to be insufficient. Thereafter, the company resorted to artesian wells, which came to be the main source of water (Kuykendall 1967:69).

For its first nine years Kahuku Plantation Co. relied on little coastal vessels which anchored offshore from Kahuku Landing to bring supplies and return raw sugar to Honolulu. Five miles of 36-inch gauge railway, some of it portable, had been laid in 1890 to haul the cane through the plantation fields to the Kahuku mill and thence to the landing. The plantation track extended south opposite Laie and the Mormon settlement, which sent its cane to be ground at Kahuku (Wilcox 1975).

The plantation's Manager's Report of Aug. 31, 1898 (in abbreviated form) is presented here:

> Planted last year...a total of 872 acres of cane--5200 tons of sugar could be expected. Besides these 5200 tons I expect 500 tons more of sugar from short ratoons, on 150 acres from the mauka portion of Malekahana, making crop total of 5700 tons; but then the 500 tons do not come in now, owing to change in rotation of crops caused by the flood, but will be made up in the two following crops as is shown hereafter. I had concluded to crop again, this year, the mauka portion of Malaekahana,

> about 150 acres, to come off next crop, together with field 4/10,by running this mauka portion of Malaekahana into short ratoons and after that raise it for long ratoons so as to bring this part of Malaekahana and field 4/10 into one cane field of about 500 acres. All to come of as long ratoons in 1900. Due to flood, prevented, and the mauka portion of Malaekahana a plant cane crop in 1900 and short ratoons in 1901. (Flood was March 27, Sunday) and for a while it looked as if there would be nothing left of the plantation but a few buildings...There was not a Government Road Bridge left in the district and our two Rail Road Bridges were carried away. Approximate Costs and Repairs of Damage done by Flood:
> Labor - $5,954.52; Railroad and Repair of Bridges: labor - $607.50, material - $392.61, manager - $1,000. Treasurer's Report: sold 4,140 tons at $71.24; Receipts $315,551.59; Expenses $311,370.86

In 1899, the Oahu Railway finally laid track to a terminal at Kahuku. It hauled sugar and the agricultural freight products back and forth across the windward part of Oahu. The Koolau Railway Co. laid tracks from Kahana to Kahuku and served as a common carrier until 1931. From then until the 1950s, its sole function was to carry cane from the northeastern field of the island (Hungerford 1963:77).

In 1900, Alexander & Baldwin, Ltd. (with Castle as its treasurer) became agent for Kahuku Plantation Co., which Castle still headed as president. In 1906, Castle sold his interest to A&B, which then became the largest stockholder, and Henry P. Baldwin, president of A&B, became president of Kahuku Plantation Co. (Wilcox 1975).

The Kahuku community flourished during its plantation day. The plantation's hospital was the only medical facility from Waialua to Kaneohe. The plantation pioneered concrete stoves for laborer's cottages and sanitation drains that were used as models for other plantations. The first plantation day nursery and high school were established by Kahuku Plantation Co. The town of Kahuku boasted the biggest baseball diamond and the first golf course. The company laboratories pioneered the carbonation of white raw sugar, using the native limestone around Kahuku for filter. The company devised the money-saving use of molasses as mill fuel. The company also discovered that night lighting of the fields prevented tasseling and increased sugar yield of cane (Wilcox 1975).

In 1916, the Kahuku Plantation Co. leased 171.5 acres of land to C. Okayama at a rate of ten dollars per acre, per year, for pineapple cultivation (Liber 443:364). Subsequently, the Oahu Railway & Land Co. leased land to several small individual pineapple growers; these growers, through signing "chattel mortgages," were obligated to sell their crops to Hawaiian Pineapple Co., Ltd; Libby, McNeill & Libby of Honolulu, Ltd; and California Packing Corporation. Eventually, large tracts of Kahuku land were leased to California Packing Corporation (later Del Monte Corp.); the Del Monte Corp in 1956 subleased nearly 200 acres in Kahuku to the United

States government, which wanted to use the land for a military training facility. In late 1956, Campbell Estate leased to the U.S. government over 3,000 acres of Kahuku land for military training activities which continue today. In the post-World War II period, sugar experienced fluctuations in value of sales (Schmitt 1977:165). The Kahuku Plantation Co. lasted for about 80 years, officially closing in 1971. A detailed history of the company can be found in the Honolulu Star Bulletin (October 19, 1935) (Nakamura 1981:11).

POST PLANTATION

What does one do with abandoned cane fields? An evaluation, "Kahuku Whole Plant Sugarcane Greenchop as a Ruminant Feedstuff," was conducted in 1973. The conclusion was that "although chopped sugarcane may have a slightly lower digestibility than pineapple greenchop, sugarcane contains considerably more dry matter on a fresh-chopped basis. Based on the results of this study, it can be concluded that chopped whole sugarcane plant from Kahuku is a fairly high quality fodder and should be at least equal to pineapple green chop on a fresh-chopped basis" (Olbrich, Koshi, and Wayman 1973).

Population densities in the Kahuku vicinity changed dramatically after the close of the plantation and is expected to continue changing. The Neighborhood Data Book filed these population trends during the 1970s:

> The population percentage increase between 1970-79 is more than double that for total Oahu for the same period. Predominately young; Filipino and Caucasian...Kamaainan in character...a majority of the residents have resided in Hawaii over 20 years...Over half of the households are below the Oahu median income and 3 out of 5 have incomes in the moderate-lower range. Housing units increased at a greater rate than Oahu's percentage housing units. Three-fourths of land is classified as agricultural and [is] predominately planned as agricultural and open space. Agricultural zoned lands are those with the capacity for intensive cultivation and a minimum lot size of one acre. It is regulated by the State Land Commission, but administered by the counties.

In 1975, the State of Hawaii began purchasing the <u>ma kai</u> acreage of Malaekahana from Campbell Estate for the development of Malaekahan a State Park. The areas that concern the project area are still used as ranch and pasture land. The South project area, which borders Malaekahana and Laie <u>ahupua'a</u>, contains small parcels that are leased to Cackle Fresh Egg Farms, Amorient Aquafarm Inc., and two businesses that run cattle on the lands.

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PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

Report 483-042789

RECEIVED
APR 28 1989
GROUP 70

April 27, 1989

Mr. Jeff Overton
Group 70
924 Bethel Street
Honolulu, Hawaii 96831

Subject: Addendum Report: Archaeological Inventory Survey
Additional Parcels Within Punamano Project Area
Punamano and Malaekahana Golf Courses
Lands of Ulupehepehu, Punalau, Kahuku, Malaekahana, and Laie
Koolauloa District, Island of Oahu

Dear Mr. Overton:

At the request of Mr. Ralph Portmore of Group 70, for their client, Asahi Jyuken Hawaii, Inc., Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the proposed Punamano and Malaekahana Golf Course project area (Jensen 1989). The project area consisted of c. 866 acres in the Koolauloa District, Island of Oahu. The survey field work was conducted December 19, 1988 through January 25, 1989. Field work involved a variable-coverage (partial to 100%), variable-intensity surface reconnaissance survey of the project area. The objectives of the survey were to (a) identify all sites and site complexes present within the project area, (b) evaluate the potential significance of all identified archaeological remains, (c) determine the possible impacts of the proposed golf course development upon the identified remains, and (d) define the general scope of any subsequent archaeological work that might be deemed necessary or appropriate.

A total of 26 archaeological sites containing 45 component features were identified within the 866-acre project area. Formal feature types present at the sites included caves, overhangs, walls, terraces and platforms, enclosures, isolated midden deposits, and historic components including WWII emplacements, historic dumps, roads, and agricultural ditches. Functional types present included habitation, burial, historic agriculture, and WWII activities.

Following completion of the survey and issuance of a final project report (Jensen 1989), various considerations led to the need to expand the area of potential environmental effect. Since the land located within the expansion areas had not been fully inventoried for cultural resources, the client, acting through Group 70, requested that PHRI undertake additional field work as appropriate.

The area of proposed expansion is located entirely within the Punamano Project Area and consists of two separate parcels designated A and B (Figure 1, attached). Parcel A consists of approximately 3.5 acres located within the east central portion of the original Punamano Project Area. Parcel B consists of a triangular parcel of approximately 17.8

305 Mohouli Street • Hilo, Hawaii 96720 • (808) 969-1763 or 966-8038

acres located in the inland portion of the original project area. Both land units involve archaeologically low sensitive zones within areas which have been subjected to intensive sugar cane cultivation.

Survey field work was conducted Wednesday, April 26, 1989, under the supervision of PHRI Senior Archaeologist Dr. Alan E. Haun, assisted by PHRI Field Archaeologist Jack Harris. Field work involved walking systematic transects, spaced 20-50.0 m apart, across both project areas until the entire areas had been inspected. Vegetation in the project areas included thickets of Christmas-berry (Schinus terebinthifolius L.) and koa-haole (Leucaena glauca L. [Benth]), but no visibility or other problems were encountered during field work, and all project objectives, as specified in the original project report, are considered to have been achieved.

In Parcel A, no evidence of prehistoric or early historic Hawaiian use or occupation was encountered. During the course of field work, it was determined that most of this parcel had already been examined in conjunction with the original survey field work. Parcel B also contained no evidence of prehistoric or early historic Hawaiian use or occupation. During the field work it was discovered that a portion of this parcel had been examined during the original survey field work. Evidence of contemporary agricultural use and activities was observed in the parcel, in the form of several raised, concrete-lined irrigation ditches, graded access roads, and contemporary trash.

Based on the negative field work results, no further work is recommended for Parcels A and B. It should be noted that this recommendation has been made on the basis of a 100% surface inventory survey of the parcels. There is always the possibility, however remote, that potentially significant unidentified subsurface cultural remains might be encountered in the course of future development activities. In such a situation, archaeological consultation should be sought immediately.

Sincerely yours,

Alan E. Haun, Ph.D.
Senior Archaeologist

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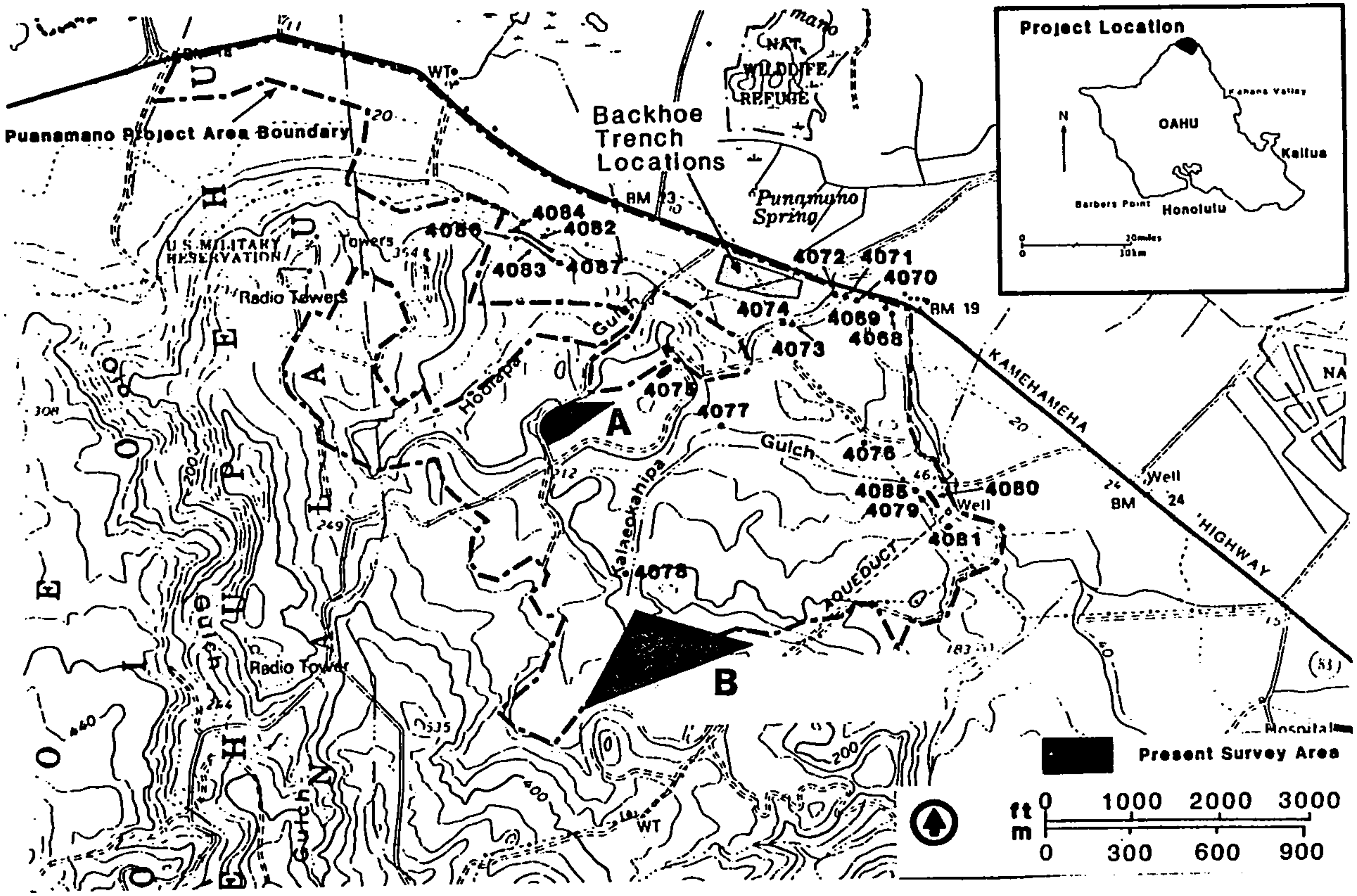

FIGURE 1. Project Area Location Map

APPENDIX O

COUNTRY COURSES AT KAHUKU

TRAFFIC IMPACT ASSESSMENT REPORT

FEBRUARY 1989

PACIFIC PLANNING & ENGINEERING, INC.

TRAFFIC IMPACT ASSESSMENT REPORT

for

COUNTRY COURSES AT KAHUKU

Kahuku, Hawaii

February 1989

Prepared by:

Pacific Planning & Engineering, Inc.
1144 Tenth Avenue, Suite 202
Honolulu, Hawaii 96816

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INTRODUCTION

Pacific Planning & Engineering, Inc. (PPE) was engaged to undertake a study to identify and assess future traffic impacts caused by the proposed Country Courses at Kahuku. This report presents the findings and recommendations of the traffic study.

This report contains descriptions of the proposed project, existing roadways, traffic conditions, methodology of study and an assessment of the traffic impacts resulting from the projected forecast.

This traffic study report identifies and evaluates the probable impact of the forecasted traffic generated by the proposed project's golf courses. The analysis primarily focuses on the traffic impact at intersections of Kamehameha Highway and the proposed golf course entry roads. The study describes the impacts during the afternoon peak hour when traffic from the proposed project is expected to have the most impact on the intersections with Kamehameha Highway.

Project Description

The Kuilima Resort Company, Inc. is proposing to develop four eighteen-hole golf courses in Kahuku, Oahu, Hawaii. Three of the courses will be located at the Punamano site which is approximately 1.5 miles west of Kahuku Village. One course will be located at the Malaekahana site, which is approximately 1.4 miles east of Kahuku Village. Figure 1 shows the locations of the proposed sites.

The Punamano site includes about 605 acres identified by Tax Map Key: 5–6–05:1,2,5,6 & 7 and 5-7-01:21. At this site each of the three golf courses will operate with its own clubhouse, including locker rooms, proshop, lounge/snack bar and administration offices. Each golf course will also have its own parking lot capable of accommodating 130 - 160 vehicles and its own maintenance facilities. Approximately 56 to 68 workers will be employed at each of the golf courses for a total of about 168 to 204 employees. There will be two driving ranges at this site. Figure 2 shows the Punamano Golf Course Layout Plan.

The Malaekahana Golf Course will be located on about 228 acres of land identified by Tax Map Key: 5-6-06:6 and 5-6-07:1. The clubhouse for this course is planned slightly larger than those at the Punamano site and will contain a restaurant and meeting rooms in addition. A driving range is also planned at this course. Malaekahana Golf Course plans to employ 63 to 82 workers. Approximately 160 - 200 parking stalls will be provided for the Malaekahana complex. Figure 3 shows the Malaekahana Golf Course layout plan.

The Courses at Kahuku is estimated to target the following user groups:

+ or - 50%	Kuilima Resort guests
+ or - 30%	Visitors at other hotels
+ or - 20%	Oahu residents

All four proposed golf courses will be daily-fee courses open to the public with no private membership. The completion of all four courses is estimated for 1997. Presently, there are no future plans for tennis courts, swimming pools, spas or other such facilities.

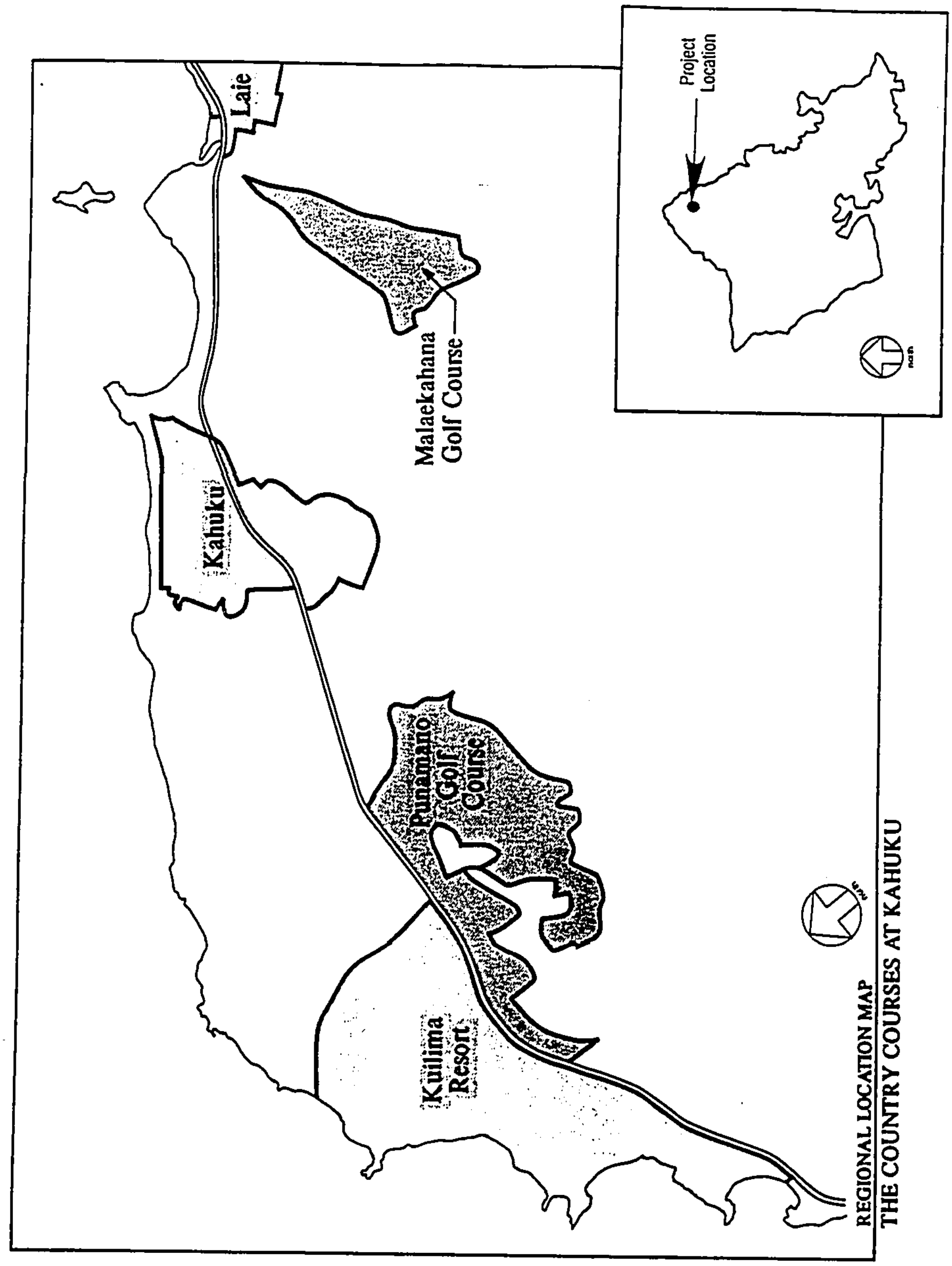


Figure 1. Project Location Map

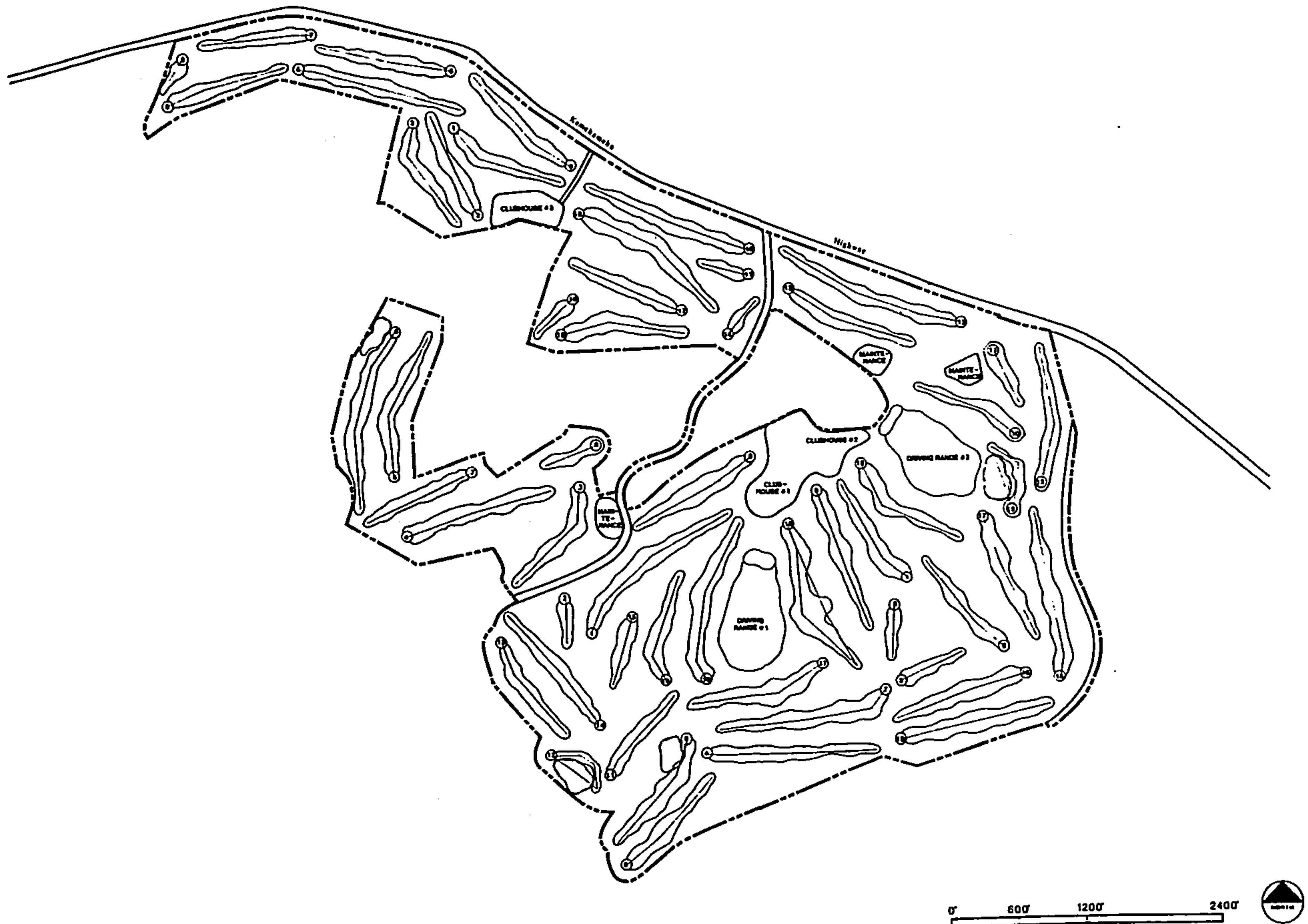
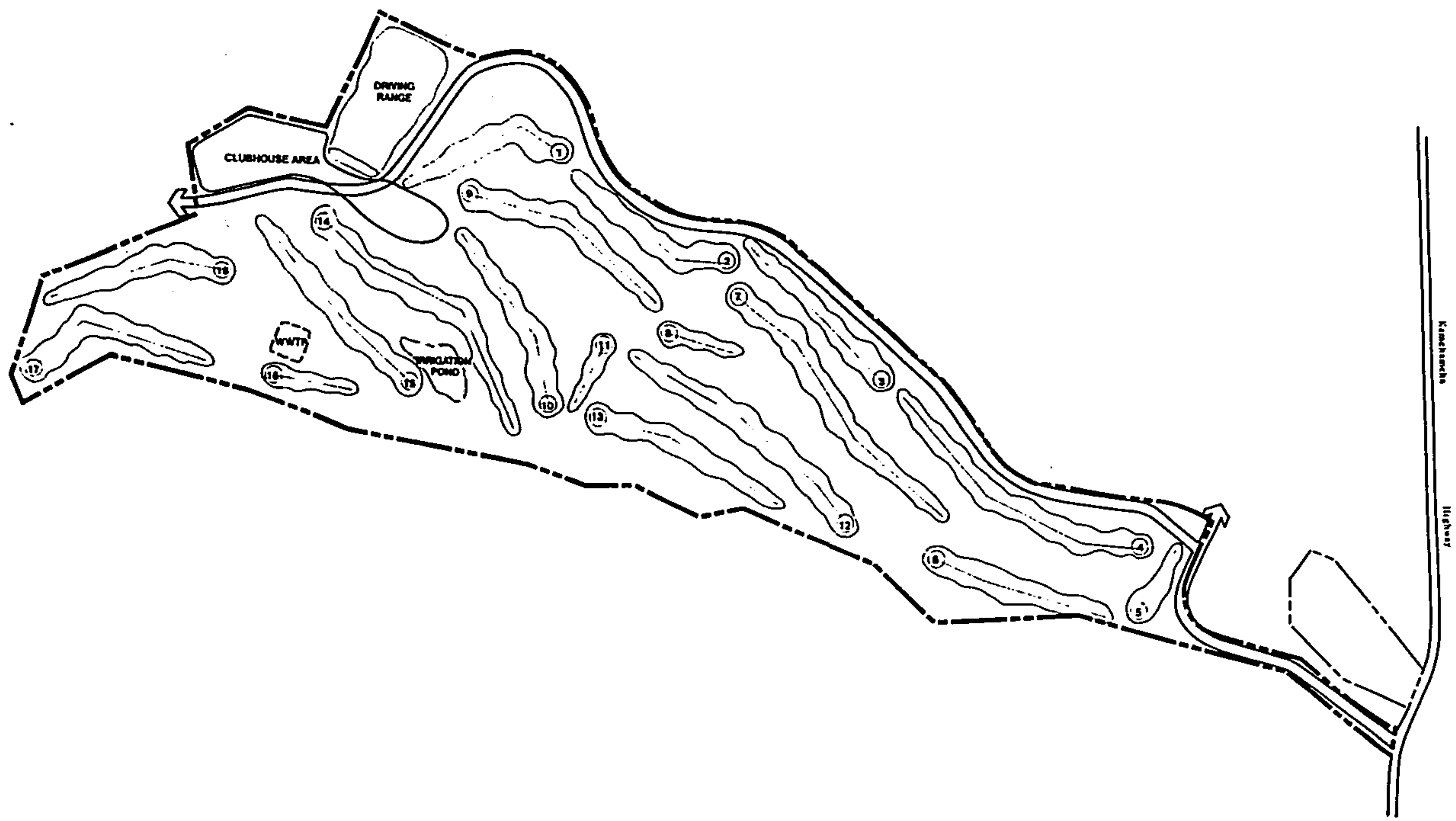


FIGURE 2

GOLF COURSE LAYOUT · PUNAMANO

THE COUNTRY COURSES AT KAHUKU



GOLF COURSE LAYOUT · MALAEKAHANA
THE COUNTRY COURSES AT KAHUKU
FIGURE 3

EXISTING CONDITIONS

Area Conditions

The Kuilima Resort, Kahuku Village and Laie Village are three significant nearby residential and commercial communities. The Kuilima development presently consists of a 400 unit hotel, an 18 hole golf course, tennis courts, small commercial shops, and about 400 residential condominium units. Kahuku and Laie Villages are primarily low density, rural communities with residential homes, small village commercial shopping center, churches, and schools.

The proposed Punamano site is located on marginal agricultural land previously used for sugar cane. Presently, this site is not utilized and is covered with natural vegetation. The site is surrounded by the U.S. Army Kahuku Training Area, active agriculture (banana, papaya farms and the State Agricultural Park) and the Kuilima Resort on the makai side of the highway. The Kahuku Aquaculture Farm is also makai of the highway, and east of Marconi Road.

At Malaekahana the proposed site is composed primarily of cattle and horse grazing land and unutilized land. Areas surrounding the site are primarily ranching and farming activities. Makai of the highway is Malaekahana State Park with picnic and camping facilities.

Roadway Conditions

Vehicular access to the proposed golf courses will be from Kamehameha Highway. At the Punamano Golf Courses, the west-most golf course will have a new driveway (referred to as Access Road A in this report) directly off of Kamehameha Highway, approximately one-half mile East of the existing Kuilima Resort main entrance. The other two courses at Punamano will be accessed from a roadway to the Kahuku Training Area used by the military (referred to as Military Road in this report). The Military Road is a narrow paved road that intersects Kamehameha Highway approximately 800 ft East of Marconi Road. Marconi Road will be used in the future expansion of Kuilima Resort. Presently, Marconi Road provides access to a few sport fishermen and beach goers and to the Aquaculture operations.

At the Malaekahana Golf course, access will be from an existing gravel road presently being used by a few local farmers and residences. The intersection with Kamehameha Highway is about three-fourths of a mile west of the Mormon Temple road.

Kamehameha Highway is a State-maintained highway with a 20-foot wide pavement and 6 foot to 10 foot grassed shoulders. It is the only major road serving the area. The posted speed of Kamehameha Highway is 45 miles per hour (mph) at Punamano and 35 mph at Malaekahana.

A recent Saturday traffic volume obtained from traffic count station 29 registered 1092 cars for two directions between the 2:00 to 3:00 pm peak hour on February 7, 1988.

Traffic Conditions

A review of State Department of Transportation (DOT) traffic count data for station C-29-B along Kamehameha Highway near the old Kualoa Sugar Mill indicated that the peak hour traffic generally occurs between 3:30 and 4:30 pm, on weekdays and between 2:00 and 3:00 pm on weekends. However, the heavier vehicular traffic are consistently found on the weekends. Table 1 shows a summary of the DOT 24-hour traffic count for the week of February 1 to 7, 1988.

Table 1. Seven Day 24-Hour Traffic Count
Kamehameha Highway DOT Station C-29-B

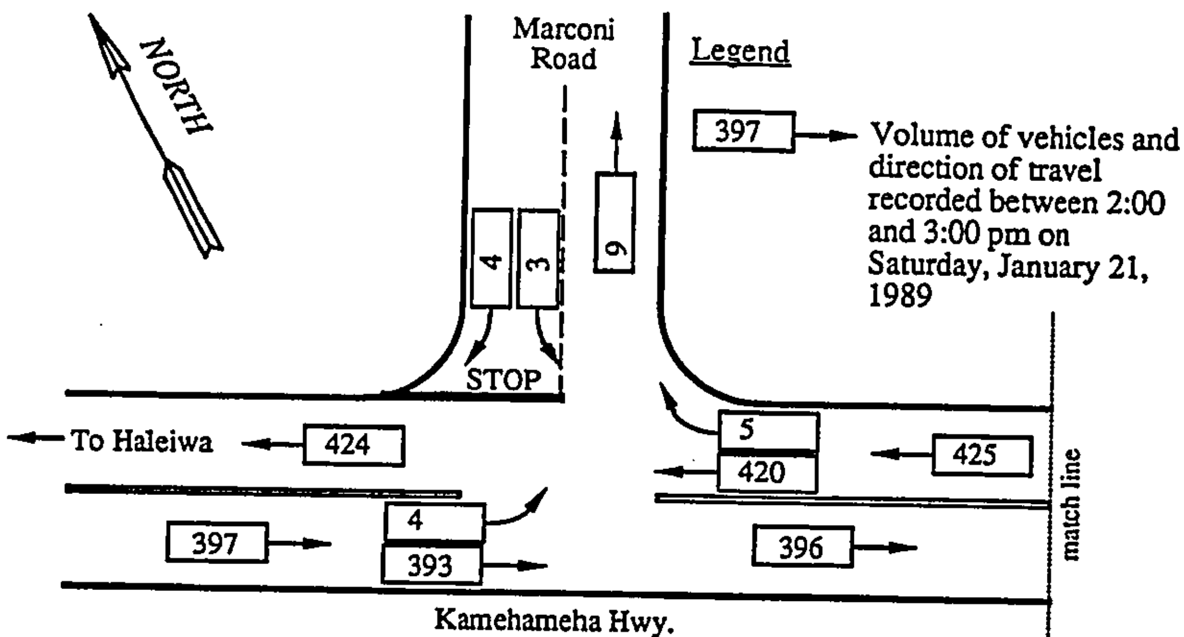
	24-Hour	Morning Peak Hour		Afternoon Peak Hour	
Date	Volume	Time (am)	Vol.	Time (pm)	Vol.
Sun, Feb 1	7864	11:00-12:00	649	12:00-1:00	767
Mon, Feb 2	9778	10:45-11:45	644	3:15-4:15	851
Tue, Feb 3	9379	11:00-12:00	622	3:45-4:45	792
Wed, Feb 4	9646	11:00-12:00	581	3:30-4:30	880
Thur, Feb 5	9696	10:00-11:00	570	3:30-4:30	799
Fri, Feb 6	10801	10:00-11:00	606	3:45-4:45	878
Sat, Feb 7	11828	10:30-11:30	789	2:00-3:00	1092

Appendix C contains the State DOT Highways Division 24-Hour continuous traffic count for the period February 6, 1988, 12:00 midnight to February 7, 1988, 12:00 midnight at Station C-29-B.

Additional turning movement counts were taken at the existing intersections of Kamehameha Highway and Marconi Road, the Military Road and residential/farming access road, on Saturday, January 21, 1989, between 2:00 and 3:00 pm. The present counts were used as baseline upon which future estimated traffic volumes were added. Figures 4 and 5 depict the present volumes and movements of traffic at the intersections at the Punamano and Malaekahana sites.

The recorded traffic counts data is shown in Appendix B. Manual counts were taken of passenger cars, trucks, buses, bicycles, motorcycles and pedestrians by turning movements and approaches. During the field counts, the weather was clear and the pavement was dry.

At Punamano, the traffic in both directions on Kamehameha Highway for the 2:00 to 3:00 pm period totaled about 820 vehicles. Approximately 48% headed in the Kahuku direction and 52% in the Haleiwa direction. Only a very small portion of the total traffic used Marconi or the Military Road as shown on the figure. At Malaekahana, during the same period, two-way traffic on Kamehameha was about 941 with 49% heading toward Kaneohe and 51% toward Haleiwa. Again, only a very small portion of the traffic used the access road.



1989 - PRESENT

PUNAMANO @ MARCONI ROAD

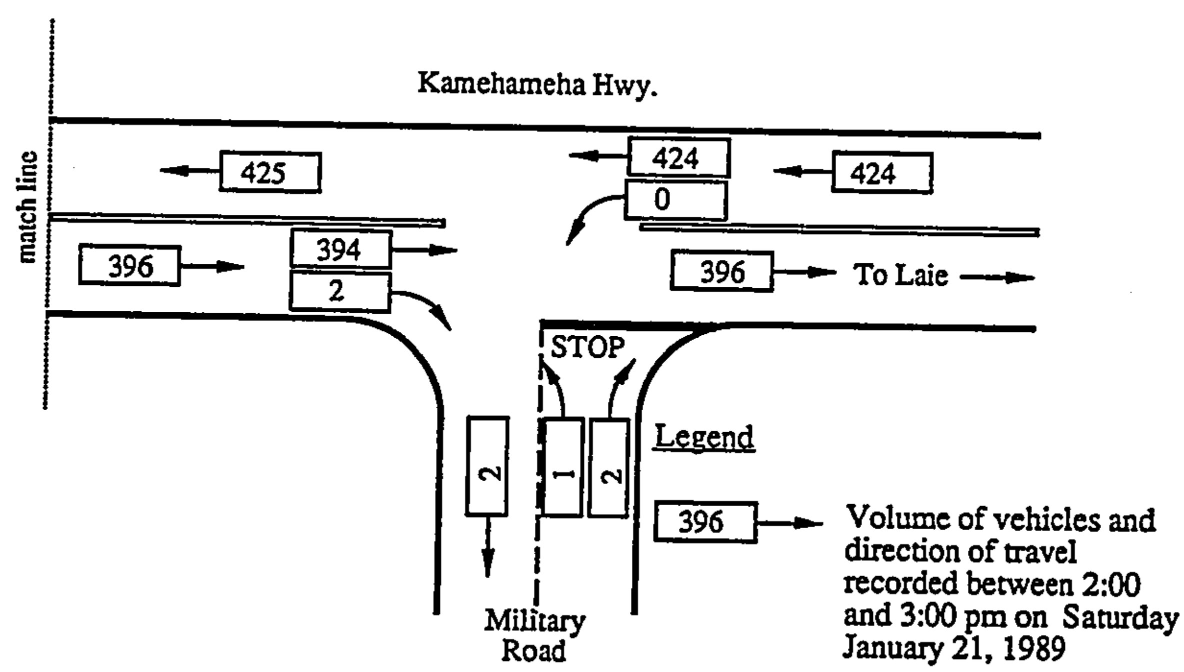


Figure 4. Afternoon Peak Hour Traffic
Kamehameha Highway & Marconi/Military Roads

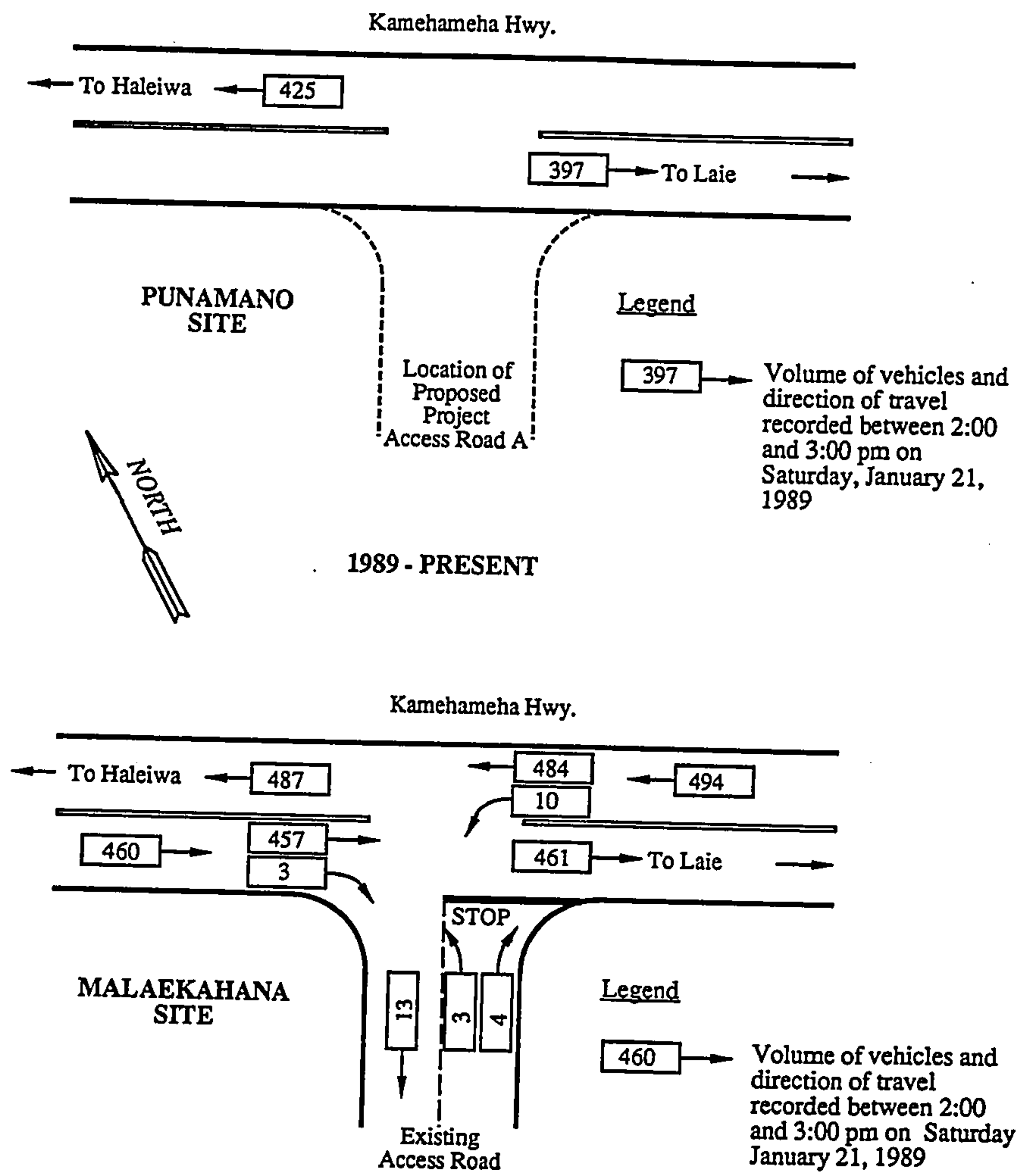


Figure 5. Afternoon Peak Hour Traffic
Kamehameha Highway & Access Road

TRAFFIC IMPACT ANALYSIS

Study Methodology

The focus of the study is to determine the impact of the project generated traffic at the intersections of Kamehameha Highway and the proposed entry roads at Punamano and Malaekahana, when the golf courses are completed and under operation in 1997.

Twenty-four hour traffic counts at the DOT traffic count Station C-29-B for the seven day period between February 1 to 7, 1988, and manual traffic counts taken by Pacific Planning & Engineering, Inc. at the intersections of Kamehameha Highway were used in the analyses.

Future traffic forecasts with and without the project were estimated for 1997. The Saturday afternoon peak hour was used as a basis for forecasting because it represents the worst case condition. As shown by the closest State DOT 24-hour continuous traffic counts station on Kamehameha Highway in Table 1, the heaviest traffic occurs on Saturday, between 2:00 and 3:00 pm.

The study intersections were analyzed for the conditions of the present case, 1997 *without* the project and 1997 *with* the project. The critical turning movements of each intersection were compared under the traffic conditions of the three cases. The resulting impacts are discussed and final recommendations are presented in the Conclusions and Recommendations Section of this report.

Future Ambient Traffic

Future ambient traffic along Kamehameha Highway was forecasted based on trend analysis, as shown on Figure 6. The analysis used twenty-four-hour traffic count data over the last nine years on Kamehameha Highway near the old Kualoa Sugar Mill (DOT traffic count station C-29-B). This count station was selected because it is the closest station (approximately 3 miles north of the project site) and the most representative of the traffic in the Kahuku area.

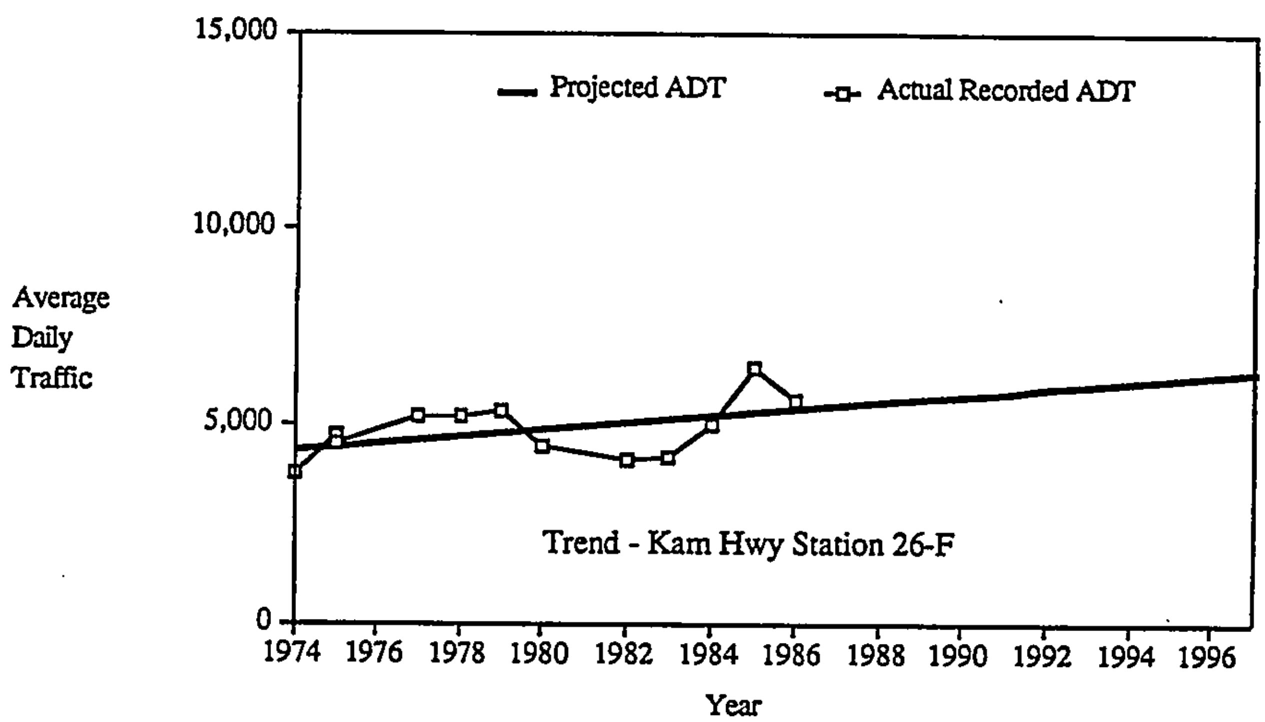


Figure 6. Recorded and Projected Traffic on Kamehameha Highway

The results of the trend analysis indicates a 2.5% annual growth in daily traffic on Kamehameha Highway. This only reflects the growth of traffic from developments outside of the immediate area of concern. The closeby effects of Kuilima Resort expansion was extrapolated from a traffic report completed in 1985 by Austin Tsutsumi & Associates, Inc titled, Traffic Impact Report For The Proposed Turtle Bay Resort. By the year 1997, the development at the Kuilima Resort will be close to the second phase of development mentioned in the report. This study uses the volumes and direction of traffic generated by the second phase of the Kuilima Resort Master Plan found in the ATA Traffic Impact Report.

Trip Generation, Distribution and Assignment

Data from previous traffic counts was used to estimate the traffic generated by the project. Traffic entering and exiting the Pearl Country Club in Honolulu was recorded on Sunday, February 14, 1988 between the hours of 2:00 and 3:00 pm. Thirty-seven vehicles were observed entering and 41 vehicles leaving the golf course during the hour.

When compared with the Pearl Country Club, the project's traffic per golf course, is expected to be less since it is not in urban Honolulu and much of the users (50%) is expected to be bussed from the Kuilima Resort Hotels. The larger Pearl counts are, nevertheless, used without adjustments, to account for unforeseen or unexpected factors of traffic.

The distribution and assignment of vehicles to and from the golf courses will be via Kamehameha Highway either in the direction of Haleiwa or Kaneohe. Based on the predicted target groups the following percentages of distribution and assignment of traffic are assumed:

	Directions To & From	
Target Group	**Haleiwa**	**Kaneohe**
Kuilima Guests (50%)	50%	0%
Visitors at Other Hotels (30%)	15%	15%
Oahu Residents (20%)	10%	10%

Traffic Impacts

Impacts on traffic resulting from the proposed Country Courses at Kahuku were measured by the change in Level-of-Service (LOS) at the study intersections for cases of present traffic, for the year 1997 without and for the year 1997 with the project. The established peak hour traffic period on Kamehameha Highway on Saturday, between 2:00 and 3:00 pm was used in all cases. The traffic counts recorded at the study intersections represents the *present* afternoon peak hour volumes of traffic which include ambient traffic, Kuilima Resort traffic and local traffic. The additional traffic volumes from ambient growth, Kuilima Resort expansion, and the proposed project were added to the present traffic counts to arrive at the 1997 forecast volumes. Tables 1 through 3 show the breakdown in traffic estimated for the various conditions at the three study intersections. Figures 7 through 10 are schematic drawings of the intersection showing the resulting turning movement volumes for the conditions *without* and *with* the proposed project.

TABLE 1 INTERSECTION TURNING MOVEMENTS PUNAMANO GC @ ACCESS A

	KAMEHAMEHA HIGHWAY				ACCESS A RD	
	Kahuku Bound		Haleiwa Bound		Makai Bound	
CONDITIONS	TH	RT	LT	TH	LT	RT
PRESENT	397			425		
PROJECT	78	28	9	86	31	10
KUILIMA*	121			132		
Ambt. Growth	79			85		
1997 W/O	597	0	0	642	0	0
1997 W/	675	28	9	728	31	10

*ATA's Turtle Bay Resort Traffic Impact Report, 1985

TABLE 2 INTERSECTION TURNING MOVEMENTS
MALAEKAHANA GC

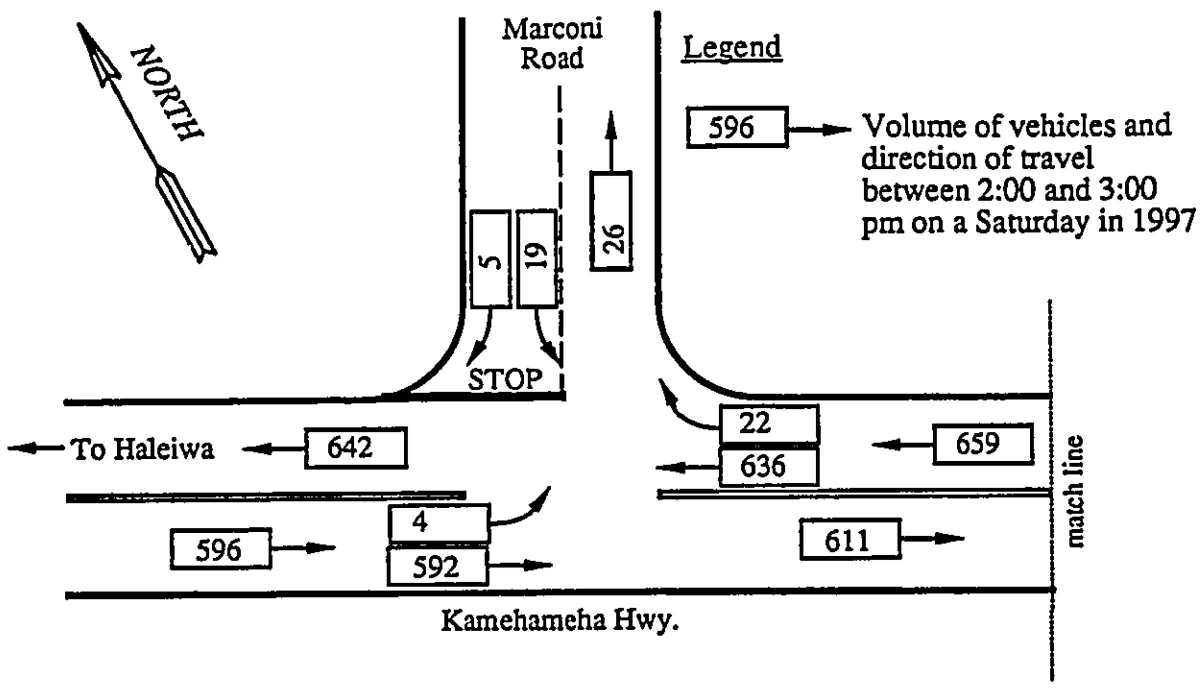
	KAMEHAMEHA HIGHWAY				ACCESS RD	
	Kaneohe Bound		Haleiwa Bound		Makai Bound	
CONDITIONS	TH	RT	LT	TH	LT	RT
PRESENT	457	3	10	484	3	4
PROJECT	31	28	9	28	31	10
KUILIMA*	136			148		
Ambient Grow	91			97		
1997 W/O	684	3	10	729	3	4
1997 W/	715	31	19	757	34	14

*ATA's Turtle Bay Resort Traffic Impact Report, 1985

TABLE 3 INTERSECTION TURNING MOVEMENTS
PUNAMANO GC @ MARCONI RD

	KAMEHAMEHA HIGHWAY						MILITARY ROAD			MARCONI ROAD		
	KAHUKU BOUND			HALEIWA BOUND			MAKAI BOUND			MAUKA BOUND		
CONDITIONS	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
PRESENT	4	391	2	0	420	5	1		2	3		4
PROJECT		38	50	19	40		55	6	21		6	
KUILIMA*	0	121			132	16				15		
Ambient Grow		78	0	0	84	1	0	0	0	1	0	1
1997 W/O	4	590	2	0	636	22	1	0	2	19	0	
1997 W/	4	628	52	19	676	22	57	6	23	19	6	

*ATA's Turtle Bay Resort Traffic Impact Report, 1985



1997 WITHOUT PROJECT

PUNAMANO @ MARCONI ROAD

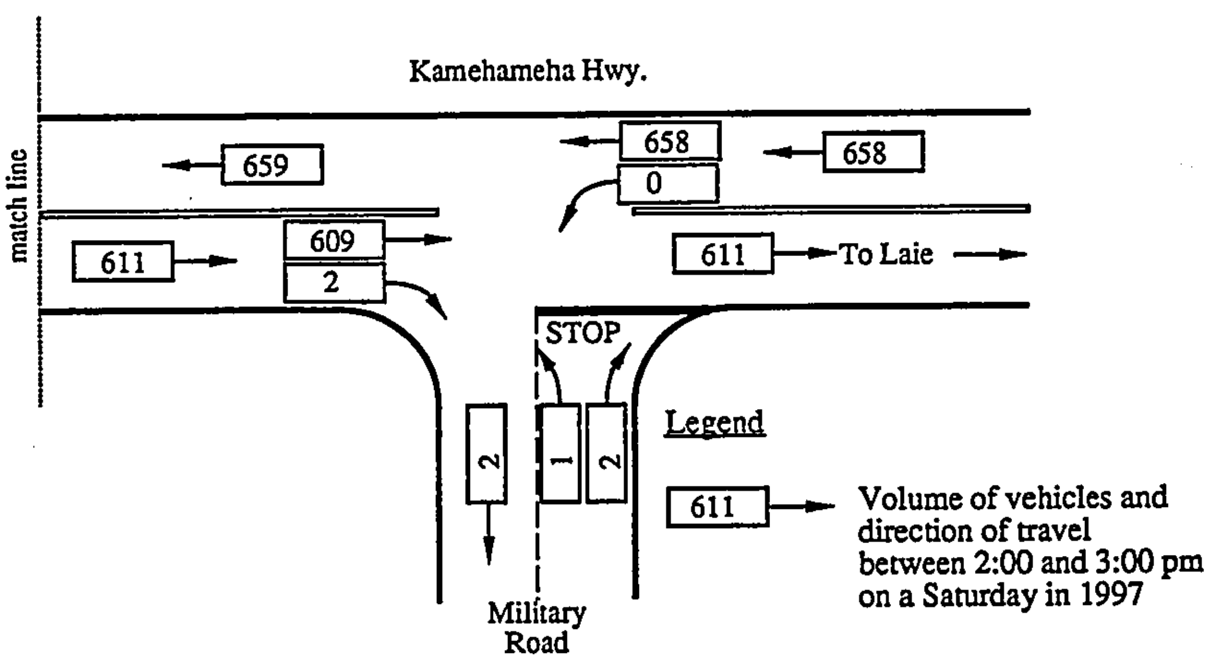


Figure 7. Forecasted Afternoon Peak Hour Traffic

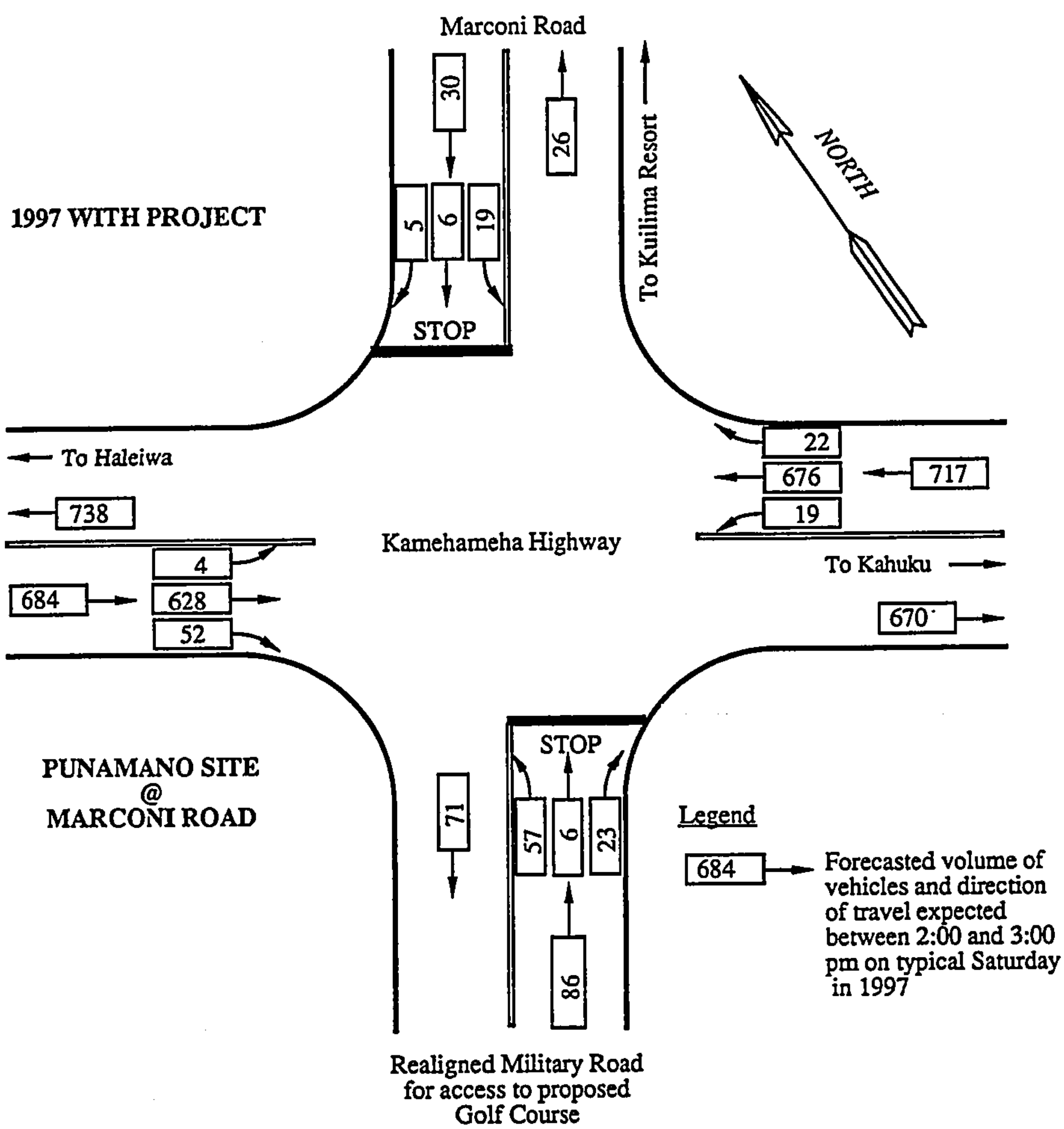


Figure 8. Forecasted Afternoon Peak Hour Traffic

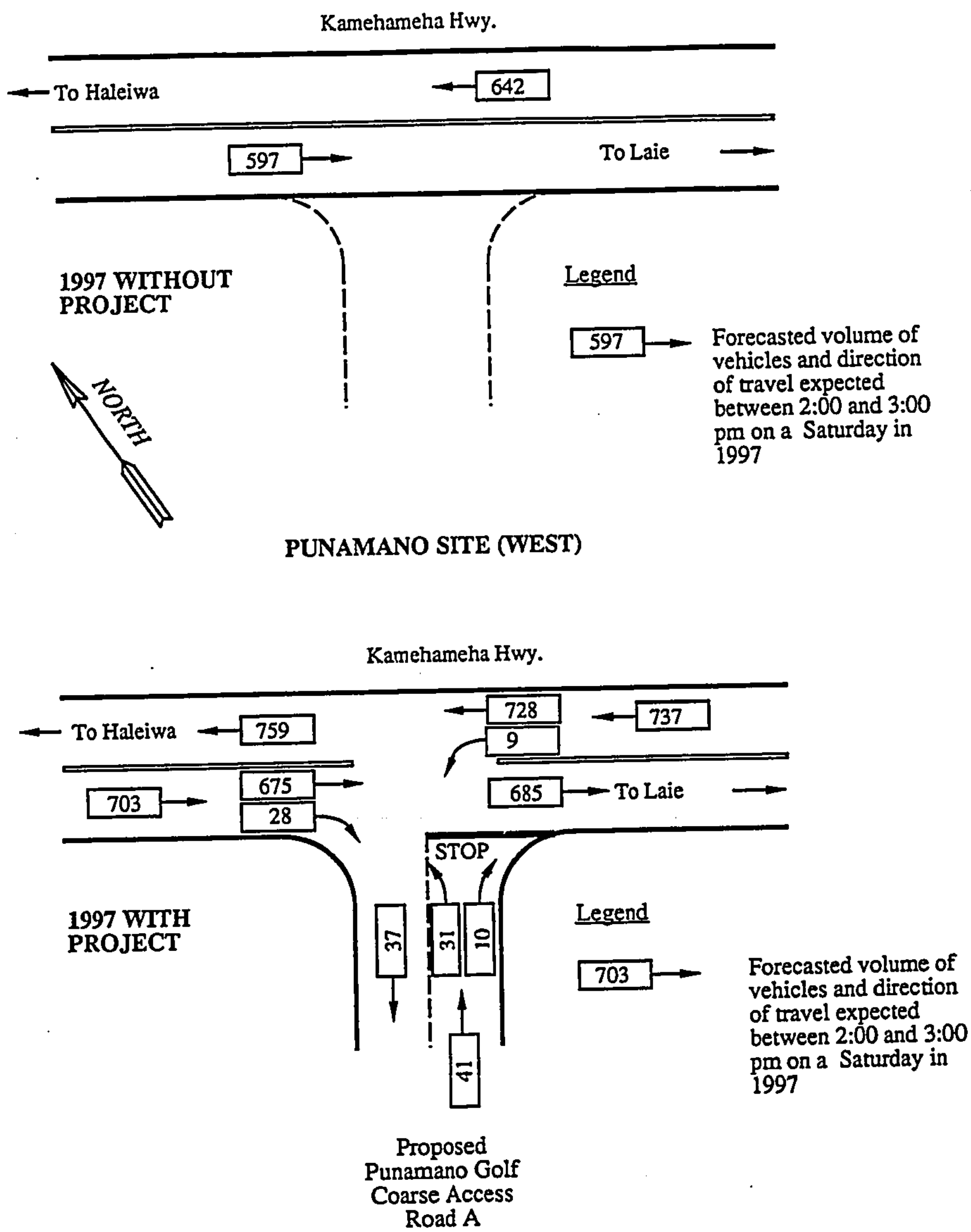
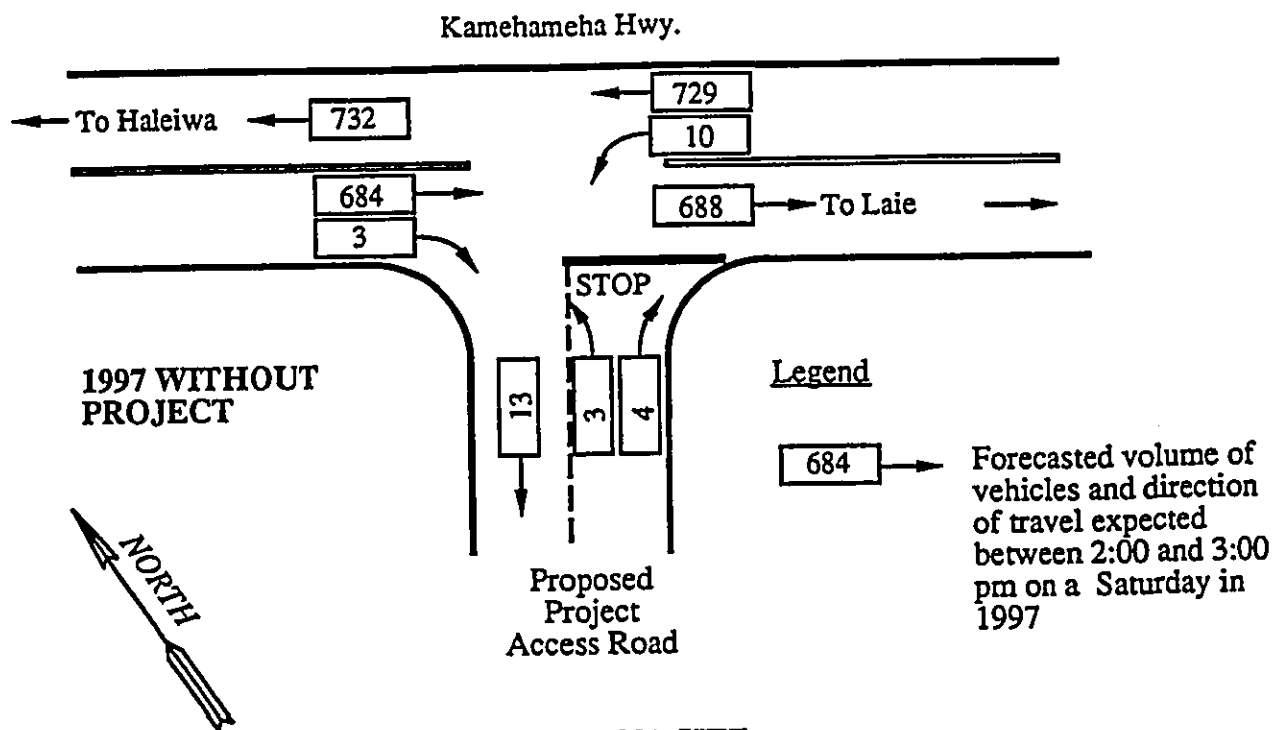


Figure 9. Forecasted Afternoon Peak Hour Traffic



MALAEKAHANA SITE

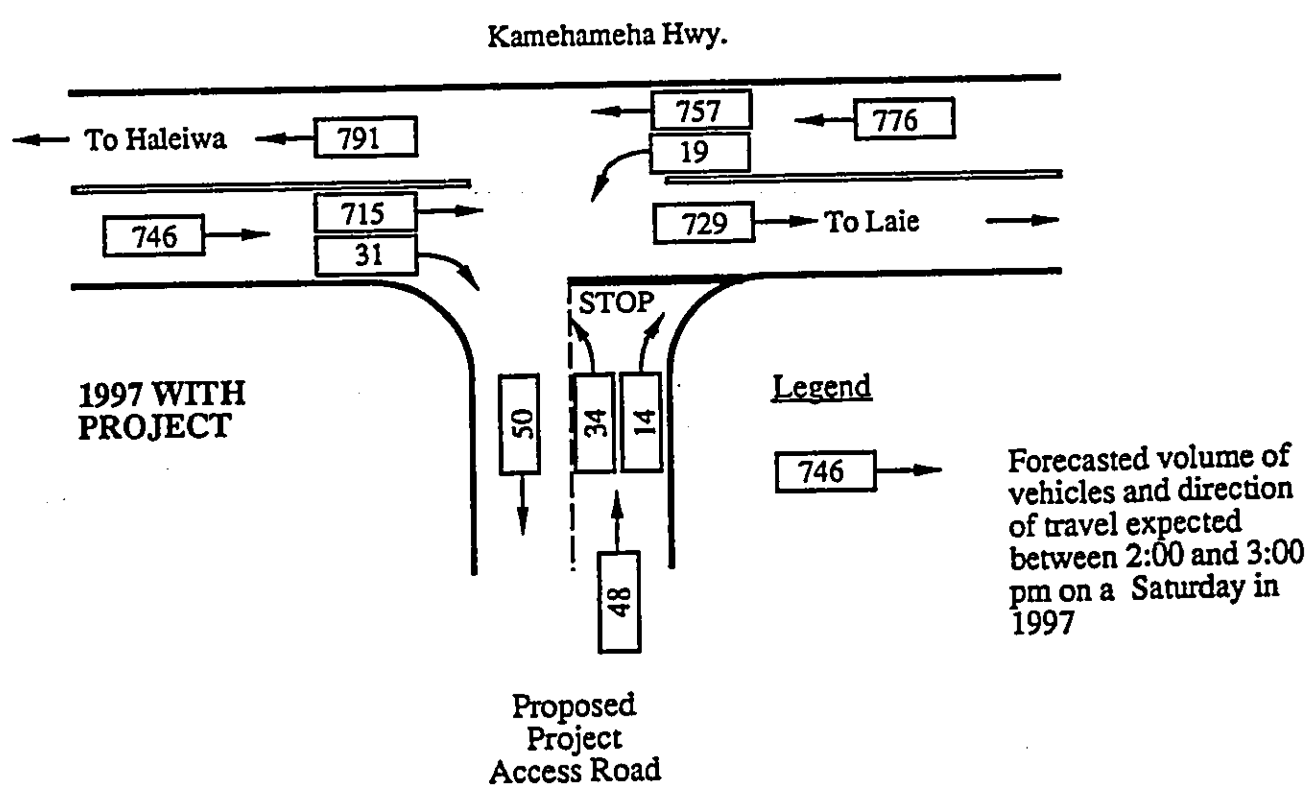


Figure 10. Forecasted Afternoon Peak Hour Traffic

Impacts from the proposed project were measured by the change in level-of-service (LOS) for specific turning movements in each case. The methodology for analyzing unsignalized intersections in the TRB Highway Capacity Manual, Special Report 209 (1986) was used.

The methodology yields LOS ranging from A to F (summarized in Appendix A) and should not be confused with the level of service for signalized intersections. The LOS for the traffic movements at an intersection is classified into six categories ranging from little or no delay (LOS A) to extreme delays (LOS F). Quantitative values of delay have not been associated with the levels of service. The results of the analysis are summarized on Tables 4, 5 and 6.

The analysis indicates that all but one or two movements will continue to have very good level-of-service at all of the intersections. Only the left turn movement and the through movement for the four-way intersection out of the minor access roads experiences difficulty as shown by the LOS E rating. Generally, the left turn movement from the minor access roads changes from LOS C at present to LOS D and LOS E for the cases without and with the project. The impact is caused by a combination of the increase in ambient traffic on Kamehameha Highway and the project generated traffic. The right turn movement out of the entry road will also suffer the same LOS E if the road is narrow and capable of accommodating only one turn lane. For the few vehicles that are expected to turn right at this time of day, however, the problem is not a serious one.

It should be emphasized here that the LOS E for the left turn out of the access road is for the worst one hour period on Kamehameha Highway, occurring on a Saturday between 2:00 and 3:00 pm. The delay, moreover, affects only the vehicles on the minor road and not the ones on the main highway.

TABLE 4
PUNAMANO SITE (WEST)
INTERSECTION OF KAMEHAMEHA & ACCESS ROAD

CONDITIONS	KAM HWY Haleiwa Bound LT	Access Rd Makai Bound LT	Access Rd Makai Bound RT
1989 - PRESENT	NA	NA	NA
1997 - W/O PROJ.	NA	NA	NA
1997 - W/ PROJ.	A	E	A

NA - Not Applicable

TABLE 5
MALAEKAHANA SITE
INTERSECTION OF KAMEHAMEHA & ACCESS ROAD

CONDITIONS	KAM HWY Haleiwa Bound LT	Access Rd Makai Bound LT	Access Rd Makai Bound RT
1989 - PRESENT	A	C	A
1997 - W/O PROJ.	A	D	A
1997 - W/ PROJ.	A	E	A

TABLE 6
PUNAMANO SITE
INTERSECTION OF KAMEHAMEHA & MILITARY/MARCONI ROAD

CONDITIONS	KAMEHAMEHA HIGHWAY Kahuku Bound LT	KAMEHAMEHA HIGHWAY Haleiwa Bound LT	Military Road Makai Bound LT	Military Road Makai Bound TH	Military Road Makai Bound RT	Marconi Road Mauka Bound LT	Marconi Road Mauka Bound TH	Marconi Road Mauka Bound RT
1989 - PRESENT								
@ Military Rd	NA	A	C	NA	A	NA	NA	NA
@ Marconi Rd	A	NA	NA	NA	NA	C	NA	A
1997 - W/O PROJ.								
@ Military Rd	NA	A	D	NA	A	NA	NA	NA
@ Marconi Rd	A	NA	NA	NA	NA	D	NA	A
1997 - W/ PROJ.	A	A	E	D	A	E	D	A

NA - Not Applicable

CONCLUSIONS AND RECOMMENDATIONS

The proposed Country Courses at Kahuku is not expected to have an adverse impact on traffic flow along Kamehameha Highway. All turning movements, except the left turn and through movements from the access roads onto the highway, are expected to operate at very good levels-of-services (LOS A). Under these conditions, no special improvements such as signalization or additional turn lanes are required for the intersections.

The poor level-of-service for the left turn movements, LOS E, and the through movements, LOS D, will primarily affect the patrons exiting the proposed facilities and not the traffic on Kamehameha Highway. Drivers attempting to enter or cross the highway at the peak hour period will experience long delays due to the large volume of traffic on Kamehameha Highway. This condition occurs during the one hour of peak traffic period on Kamehameha Highway and is expected to improve as the volume on the highway subsides. No special requirements are recommended for the exiting movements since the period for the LOS E and D is relatively short and involves only small volumes of vehicles.

As the ambient traffic on Kamehameha Highway increases and as the expansion of the Kuilima Resorts generate greater volumes of traffic, further studies should be conducted to reassess the changes in the traffic conditions.

APPENDIX A

Definition of Level-of-Service For

Unsignalized Intersections

APPENDIX A

DEFINITION OF LEVEL-OF-SERVICE

For unsignalized intersections, the traffic most impacted will be the minor or cross-street with the stop or yield control. The major roadway will have the right-of-way. The level-of-service is the amount of delay expected for the average vehicle desiring to cross or enter the major road. The following gives a general description of the measure.

The concept of levels of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

Level-of-Service definitions--In general, the various levels of service are defined as follows for uninterrupted flow facilities:

Level-of-service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

Level-of-service B is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

Level-of-service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

Level-of-service D represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

Level-of-service E represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuver. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

Level-of-service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go wave, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of the vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

APPENDIX B

MANUAL TRAFFIC COUNT DATA

PUNAMANO SITE (West Course)

TIME	KAMEHAMEHA HIGHWAY Kahuku Bound TH	RT	Haleiwa Bound LT	TH	ACCESS A RD Makai Bound LT	RT
1:45	103	NA	NA	105	NA	NA
2:00	91			120		
2:15	99			98		
2:30	101			99		
2:45	106			108		
Peak Hour	397			425		

MALAEKAHANA SITE

TIME	KAMEHAMEHA HIGHWAY Kaneohe Bound TH	RT	Haleiwa Bound LT	TH	ACCESS RD Makai Bound LT	RT
1:45	107	1	1	135	0	2
2:00	126	1	3	119	0	2
2:15	107	1	4	132	2	1
2:30	101	1	1	110	0	0
2:45	123	0	2	123	1	1
3:00	110	0	1	119	1	2
Peak Hour	457	3	10	484	3	4

PUNAMANO SITE (East Courses)

	KAMEHAMEHA HIGHWAY						MILITARY ROAD			MARCONI ROAD		
	KAHUKU BOUND			HALEIWA BOUND			MAKAI BOUND			MAUKA BOUND		
TIME	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
1:45	0	100	3	1	102	1	2		0	2		1
2:00	0	91	0	0	117	0	1		1	0		2
2:15	0	97	2	0	98	2	0		1	1		0
2:30	2	99	0	0	98	0	0		0	1		1
2:45	2	104	0	0	107	3	0		0	1		1
Peak Hour	4	391	2	0	420	5	1	0	2	3	0	4

APPENDIX C

State Department of Transportation

24-Hour Continuous Traffic Count

February 6, 1988

STATION NO.:000029 STATION DESCRIPTION: ,KAMEHAMEHA HWY, KUALOA OLD SUGAR MILL FAP 0083, MP 30.00, OAHU
POLLING DATE (07-FEB-88) POLLING TIME (00:05:00)
CHNA- TO CASTLE JUNCTION * CHNB- TO WEED JUNCTION

TIME-AM	CH-A	CH-B	TOTAL	TIME-AM	CH-A	CH-B	TOTAL	TIME-PM	CH-A	CH-B	TOTAL	TIME-PM	CH-A	CH-B	TOTAL
S 12:00-12:15	7	21	28	6:00- 6:15	34	15	49	12:00-12:15	95	144	239	6:00- 6:15	111	86	197
12:15-12:30	12	26	38	6:15- 6:30	45	29	74	12:15-12:30	80	142	222	6:15- 6:30	82	92	174
12:30-12:45	10	28	38	6:30- 6:45	39	27	66	12:30-12:45	106	156	262	6:30- 6:45	70	69	139
12:45- 1:00	7	19	26	6:45- 7:00	43	22	65	12:45- 1:00	96	152	248	6:45- 7:00	60	70	130
1:00- 1:15	9	15	24	7:00- 7:15	53	26	79	1:00- 1:15	75	145	220	7:00- 7:15	67	78	145
1:15- 1:30	11	11	22	7:15- 7:30	60	49	109	1:15- 1:30	93	154	247	7:15- 7:30	66	61	127
1:30- 1:45	6	15	21	7:30- 7:45	82	28	110	1:30- 1:45	109	125	234	7:30- 7:45	42	55	97
1:45- 2:00	3	6	9	7:45- 8:00	71	30	101	1:45- 2:00	82	138	220	7:45- 8:00	39	35	74
2:00- 2:15	4	13	17	8:00- 8:15	75	33	108	* 2:00- 2:15	114	196	310	8:00- 8:15	27	39	66
2:15- 2:30	4	13	17	8:15- 8:30	69	56	125	* 2:15- 2:30	127	132	259	8:15- 8:30	27	38	65
2:30- 2:45	2	11	13	8:30- 8:45	81	41	122	* 2:30- 2:45	114	127	241	8:30- 8:45	52	41	93
2:45- 3:00	3	7	10	8:45- 9:00	64	54	118	* 2:45- 3:00	116	166	282	8:45- 9:00	35	34	69
3:00- 3:15	3	4	7	9:00- 9:15	90	76	166	3:00- 3:15	106	113	219	9:00- 9:15	39	27	66
3:15- 3:30	4	6	10	9:15- 9:30	88	101	189	3:15- 3:30	115	118	233	9:15- 9:30	192	48	240
3:30- 3:45	2	12	14	9:30- 9:45	97	74	171	3:30- 3:45	127	132	259	9:30- 9:45	59	51	110
3:45- 4:00	7	10	17	9:45-10:00	76	80	156	3:45- 4:00	124	127	251	9:45-10:00	30	39	69
4:00- 4:15	7	7	14	10:00-10:15	101	68	169	4:00- 4:15	133	125	258	10:00-10:15	43	54	97
4:15- 4:30	5	7	12	10:15-10:30	85	98	183	4:15- 4:30	130	113	243	10:15-10:30	27	37	64
4:30- 4:45	9	4	13	*10:30-10:45	91	103	194	4:30- 4:45	129	94	223	10:30-10:45	32	30	62
4:45- 5:00	15	13	28	*10:45-11:00	92	116	208	4:45- 5:00	119	83	202	10:45-11:00	25	45	70
5:00- 5:15	25	3	28	*11:00-11:15	93	79	172	5:00- 5:15	97	93	190	11:00-11:15	25	32	57
5:15- 5:30	26	16	42	*11:15-11:30	83	132	215	5:15- 5:30	106	96	202	11:15-11:30	16	26	42
5:30- 5:45	37	19	56	11:30-11:45	75	98	173	5:30- 5:45	115	82	197	11:30-11:45	13	25	38
5:45- 6:00	27	22	49	11:45-12:00	77	131	208	5:45- 6:00	92	65	157	11:45-12:00	12	24	36

	CH-A	CH-B	TOTAL		CH-A	CH-B	TOTAL
AM-TOTAL	2009.	1074.	3083.	PM-TOTAL	3791.	4154.	7945.
6:00-12:00 TOT	1764.	1566.	3330.	12:00-6:00 TOT	2600.	3018.	5618.
AM-PEAK HR TIME	10:30-11:30			PM-PEAK HR TIME	2:00- 3:00		
*PEAK-HR TOTAL	359.	430.	789.	*PEAK-HR TOTAL	471.	621.	1092.
AM D-% (PEAK-HR)	45.5	54.5	100.0	PM D-% (PEAK-HR)	43.1	56.9	100.0
AM D-% (MN-12N)	51.7	48.3	100.0	PM D-% (12N-MN)	47.7	52.3	100.0
AM K FACTOR			6.7	PM K FACTOR			9.2

DIRECTIONAL TOTALS CHAN-A = 5800. CHAN-B = 6028. 24-HOUR TOTAL = 11828.
CH-A D% = 49.0 CH-B D% = 51.0

APPENDIX P

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#88-50
February 7, 1989

GROUP 70
924 Bethel Street
Honolulu, Hawaii 96813

Attention: Mr. Jeff Overton

Subject: Noise Impact Evaluation for the Proposed Kahuku Golf Courses (The Country Courses at Kahuku: Punamano, and Malaekahana), Oahu, Hawaii

Dear Mr. Overton:

A study has been performed to assess noise impact due to the proposed project. The following is provided as a result of this study:

1. **General Considerations** - The proposed golf course site shown in Figure 1 is situated away from noise sensitive locations except for two homes located at the makai side of Kamehameha Highway near the access road A. To the west of the westerly portion of Punamano golf courses, there are few agricultural structures which may be residential. Kuilima Resort is located further west of Punamano site with two story condominium buildings facing Kamehameha Highway with the nearest building located at about 300 to 500 feet from the highway. The town of Kahuku is located between the Punamano and Malaekahana golf courses. Noise sensitive locations within the town are homes, hospital, schools, churches and beach parks along Kamehameha Highway. The town of Laie is located east of the Malaekahana site with homes,

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KAILUA, HAWAII 96734 • (808) 254-3318 • FAX (808) 254-5295

school and churches as its noise sensitive areas.

Extensive noise measurements have been performed in the vicinity of the proposed project area to assess the acoustical environment. The measurement results indicate that the locations near Kamehameha Highway are dominated by traffic noise with an average A-weighted sound level of about 63 to 64 dB(A) at a distance of 65 feet. Refer to Appendix I for an explanation of A-weighted sound level. Ambient sound levels at residential locations away from the highway are dominated by neighborhood self-generated sounds, e.g. occasional local vehicle movements, lawn mowers, weed wackers, TV's, radios, and sounds from children and animals. Wind blowing in the foliage may often be the dominant sound along with occasional muffled noise events from traffic on Kamehameha Highway. Occasional military helicopters from Kahuku Training Center cause audible noise throughout the project area and may be the dominant noise source at times. The surf sound dominates the acoustical environment at locations near the coastline and during the hours when the traffic movement is minimal. A-weighted sound levels ranging from about 60 to 62 dB(A) generated by surf were measured at a distance of about 100 feet from the coastline during the night-time hours. Appendix II provides a complete listing of the measurement data including previous projects in the vicinity of the project site.

Primary concern regarding noise impact at the noise sensitive locations is the increase in noise levels due to additional traffic volume generated by the project. Also considered as potential source of impact are various activities associated with the golf courses such as clubhouse activity, maintenance, etc. Construction activity involved with the development of the project is also discussed as a potential source of impact.

2. **Traffic Noise** - Traffic noise level estimates have been made using the Federal Highway Administration (FHWA) Highway Traffic Noise Prediction Model (Reference 1). Noise measurements have been obtained at four locations along Kamehameha Highway. Traffic counts including the mix of vehicles were also made during the noise sample periods in order to validate the FHWA Traffic Noise Prediction Model. Table 1 summarizes the comparison of the measured short term Equivalent Noise Levels,(e.g. Leq [10 minutes] and Leq [20 minutes]) with predicted hourly noise levels (Leq [60 minutes]). The fact that the two values agree within one dB(A) for measurements is considered acceptable. Also presented in Table 1 are maximum A-weighted sound levels generated by the traffic and ambient levels recorded during the measurement period.

Traffic noise calculations were performed using the above calibrated traffic noise prediction model along with traffic data provided in Reference 2. The results of the calculations for existing, future (year 1997) with and without the project at various segments of Kamehameha Highway are summarized in Table 2. From Table 2 it can be seen that the increase in traffic noise level along Kamehameha Highway is less than one dB(A) and thus it is not considered a significant noise impact.

Table 1. Comparison of Measured and Predicted Leq; Measured Maximum Level(Lmax) and Ambient

Measurement Location	Meas. Leq	Predicted Leq(60 min)	Measured Lmax	Measured Ambient
Kamehameha Hwy. West of Punamano Site, mauka side, 350' from the highway	54.5 dB(A)	54.7 dB(A)	63.1 dB(A)	51.0 dB(A)
Kamehameha Hwy. West of Punamano Site, makai side, 500' from the highway	54.0	54.1	71.1	44.0
Kamehameha Hwy. Town of Kahuku 65' from the highway	63.9	63.4	85.3	52.6
Kamehameha Hwy. East of Malaekahana Site, 119' from the highway	61.3	62.0	75.3	43.4

According to the project description (Reference 3), three access roads to the golf courses are proposed: access road A, the access road at Marconi Road, and the access road to Malaekahana (refer to Figure 1.) Since there are no noise sensitive areas located at these access roads, construction, realignment and improvement of these access roads will not have any significant impact.

Table 2. Summary of traffic noise predictions for Year 1997

Location	Peak Hour Leq(60 min)		
	existing (1989)	future(1997) w/out project	future w/ project
Kamehameha Hwy. West of Punamano; West of Access Road A 350' from the highway	58.0 dB(A)	59.8 dB(A)	60.6 dB(A)
Kamehameha Hwy. b/ Access Road A and Marconi Road 350' from the highway	58.0	59.8	60.4
Kamehameha Hwy. b/ Marconi Road and the town of Kahuku 350' from the highway	58.0	59.8	60.4
Kamehameha Hwy. b/ the town of Kahuku and the access road to Malaekahana, 65' from the hwy.	65.1	66.8	67.1
Kamehameha Hwy. East of Malaekahana 119' from the highway	63.0	64.7	64.9

3. <u>Clubhouse Activities</u> - The project description provided in Reference 3 indicates that the clubhouses for Punamano courses will have minimal facilities and are rather small in size (about 12,000 to 14,000 sq. ft.) due to their

proximities to the main Kuilima Resort. The Malaekahana clubhouse is expected to be much larger (over 20,000 sq. ft.) than those at Punamano and would provide wider range of services.

There are two existing homes located at about 650 to 800 feet from a proposed clubhouse for one of the Punamano courses. Although the clubhouse is considered to be small, there is the possibility of equipment noise causing annoyance to the nearby residents. Included are kitchen equipment, refrigeration equipment, air conditioning equipment, fans, golf-cart chargers, pumps, and other stationary equipment. These equipment will not exceed the allowable noise levels in local noise regulations (References 4 and 5) at the property line of the project. Public address sound systems and entertainment sounds will not cause "unreasonable" or "excessive" noise as defined in Reference 4. The clubhouse should cease its operations by 7 p.m.

It is noted here that there are no known noise sensitive areas located near other clubhouses on the Punamano site and on the Malaekahana site.

4. <u>Ground Maintenance Noise</u> - Noise from equipment associated with ground maintenance activities, including lawn mowers and leaf blowers, could have an adverse impact on surrounding residential neighborhood particularly when the equipment is near the housing. However, noisy equipment is

also incompatible and disruptive with golf play. All equipment powered by internal combustion engines must have exhaust mufflers. Schedules will be developed so noisier maintenance operations do not occur near residences before 7 a.m. The noise from ground maintenance operations will not cause "unreasonable" or "excessive" noise as defined in Reference 4.

5. __Noise Impact from Construction__ - Development of the project site will involve grubbing, grading, and the construction of infrastructure and buildings. The various construction phases of a development project may generate significant amounts of noise; the actual amounts are dependent upon the methods employed during each stage of the process. Typical construction equipment noise ranges in dB(A) are shown on Figure 2. Earthmoving equipment such as bulldozers and diesel powered trucks will probably be the loudest equipment used during construction. Since it is anticipated that noise generated during construction will exceed allowable limits in Reference 4, a permit will be obtained from DOH. DOH may grant permits to operate vehicles, construction equipment, power tools, etc. which emit noise levels in excess of the allowable limits. Required permit conditions for construction activities are:

> "No permit shall allow construction activities creating excessive noise...before 7:00 a.m. and after 6:00 p.m. of the same day."

> "No permit shall allow construction activities which emit noise in excess of ninety-five db(A)...except between 9:00 a.m. and 5:30 p.m. of the same day."
>
> "No permit shall allow construction activities which exceed the allowable noise levels on Sundays and on... [certain] holidays. Activities exceeding ninety-five dB(A) shall [also] be prohibited on Saturdays."

In addition, construction equipment and on-site vehicles or devices requiring an exhaust of gas or air must be equipped with mufflers. Also, construction vehicles using trafficways will satisfy the noise level requirements defined in Reference 6.

6. __Noise Mitigation Measures__ - The design of the facilities will include noise mitigation measures in the planning of the location and orientation of the air conditioning equipment, exhaust fans, etc. such that local noise regulations (References 4 and 5) will be satisfied.

Sincerely,

Prepared by

Mike S. Lee
Senior Consultant

Approved by

Ronald A. Darby, P.E.
President

MSL;RAD:msl

REFERENCES

1. "FHWA Highway Traffic Noise Prediction Model", Federal Highway Administration, December 1978

2. "Traffic Impact Assessment Report for the Proposed Waikane Golf Course", Pacific Planning & Engineering, Inc., Jan. 1989

3. "Draft Project Description", provided by Group 70, Jan. 25, 1989

4. "Chapter 43 - Community Noise Control for Oahu", Department of Health, State of Hawaii, Administrative Rules, Title 11, 1981

5. "Section 3.100, Noise Regulations", Land Use Ordinance, City and County of Honolulu, October 22, 1986

6. "Chapter 42 - Vehicular Noise Control for Oahu", Department of Health, State of Hawaii, Administrative Rules, Title 11, 1981

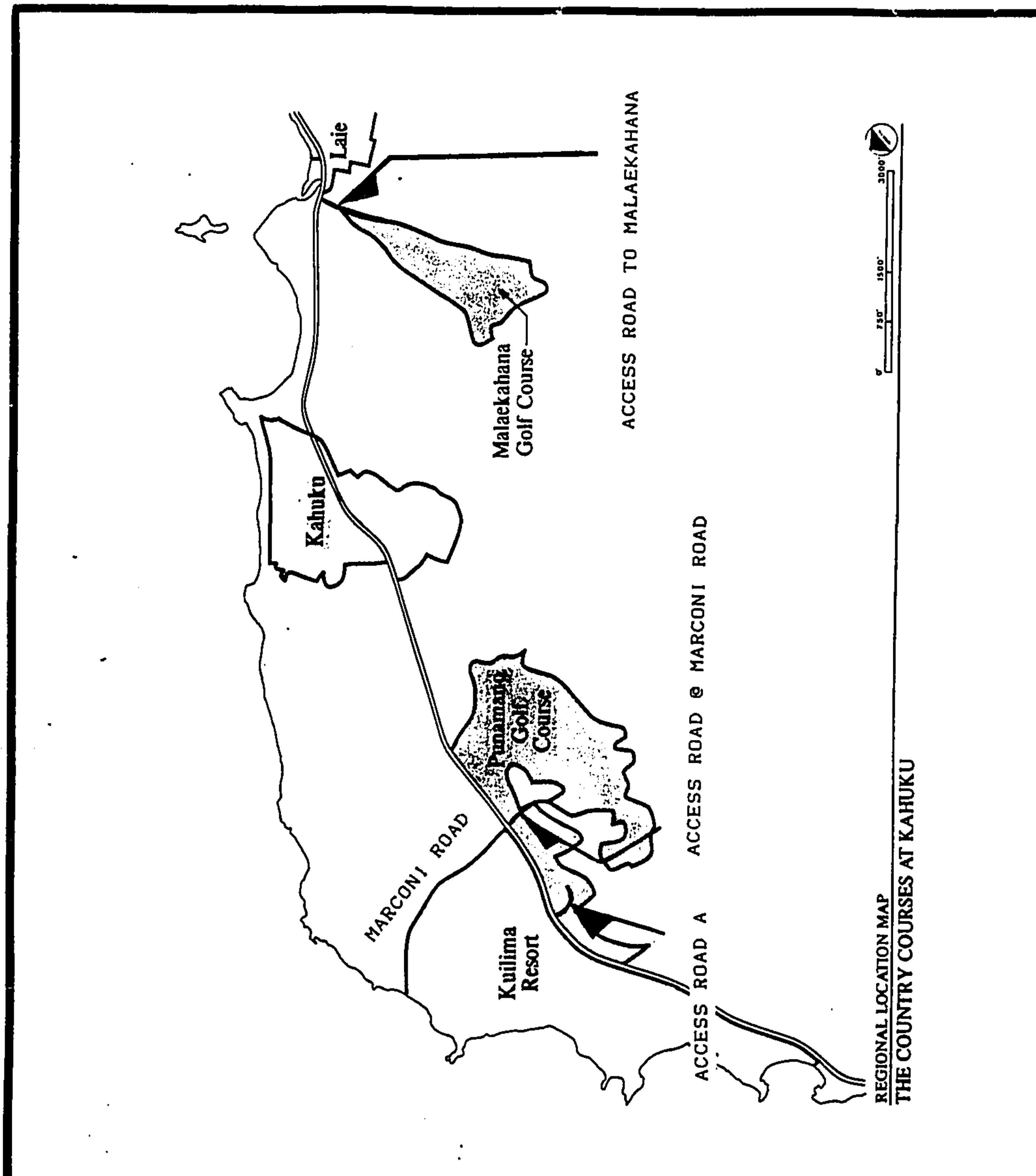

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FIGURE 1. VICINITY MAP

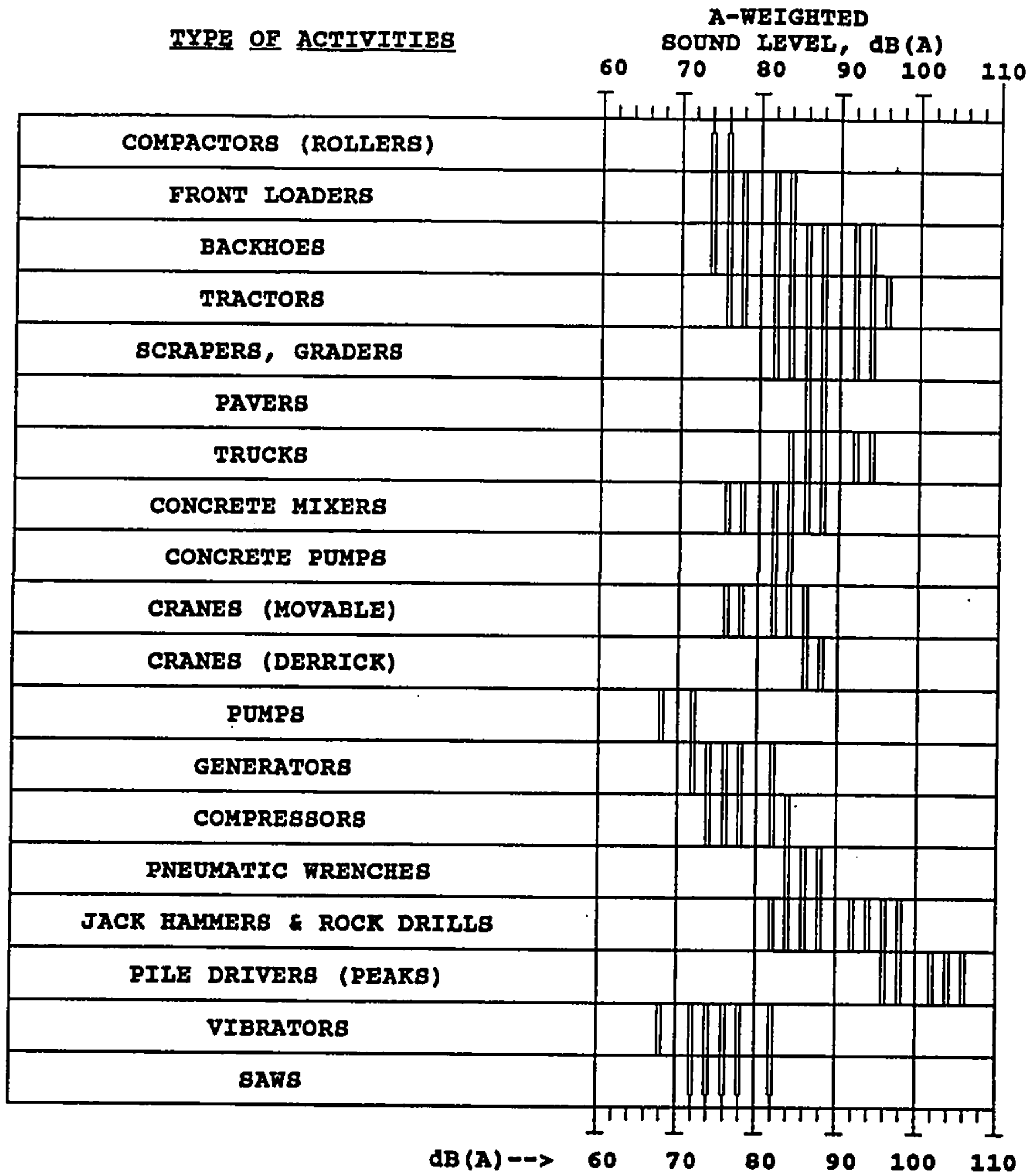

FIGURE 2. CONSTRUCTION EQUIPMENT NOISE RANGES

NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

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APPENDIX I

A-WEIGHTED SOUND LEVEL

The human ear is more sensitive to sound with frequencies above 1000 cycles per second, or Hertz (Hz), than with frequencies below 125 Hz. Due to this type of frequency response, a weighting system, namely a A-weighting , was developed to approximate the sound response of the human ear. A-weighted sound level is a single number rating of a sound signal which de-emphasizes the low frequency portion of the spectrum of a signal, and is denoted either dB(A) or dBA. The A-weighted sound pressure levels of a few typical sources are listed in Figure I-1.

The A-weighted sound levels of long term noise producing activities such as traffic movement, aircraft operations, etc. can vary considerably with time. In order to obtain a single number rating of such a signal, several special noise indices have been developed and instrumentation are available to measure them. The following are two of commonly used noise indices:

* **Leq** -- The Equivalent A-weighted sound level (the energy averaged level)
  A single number rating which represents the fluctuating sound signal measured over a given time period as a constant level with the same amount of the total acoustic energy during that period (refer to Figure I-2). In this report, Leq assume a measurement period of one hour. This number is widely used to assess community noise annoyance and hearing damage potential.

* **Ln** -- The A-weighted exceedence level
  A single number rating which represents a A-weighted sound level that is exceeded for n% of total samples taken. For example, an L10 of 60 dB(A) for a traffic noise measurement for 20 minutes would mean that 10 percent of all the noise signals measured during the 20 minute period exceeded 60 dB(A). Note that 'n' can take any values (usually integers) between 1 and 99, where L1 and L99 represent the near maximum and the near minimum sound levels, respectively. This number is primarily used to assess community noise annoyance.

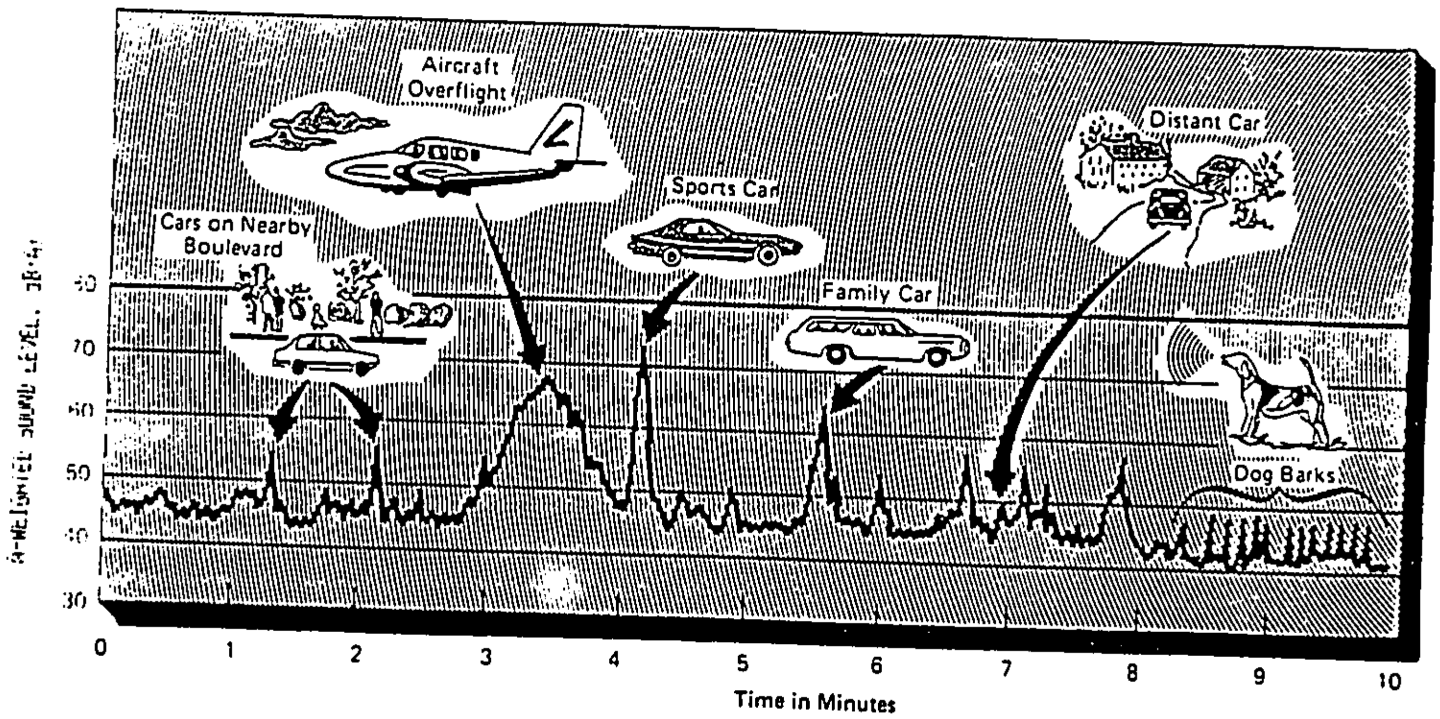

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FIGURE I-1. TYPICAL OUTDOOR A-WEIGHTED SOUND LEVELS MEASURED ON A QUIET SUBURBAN STREET

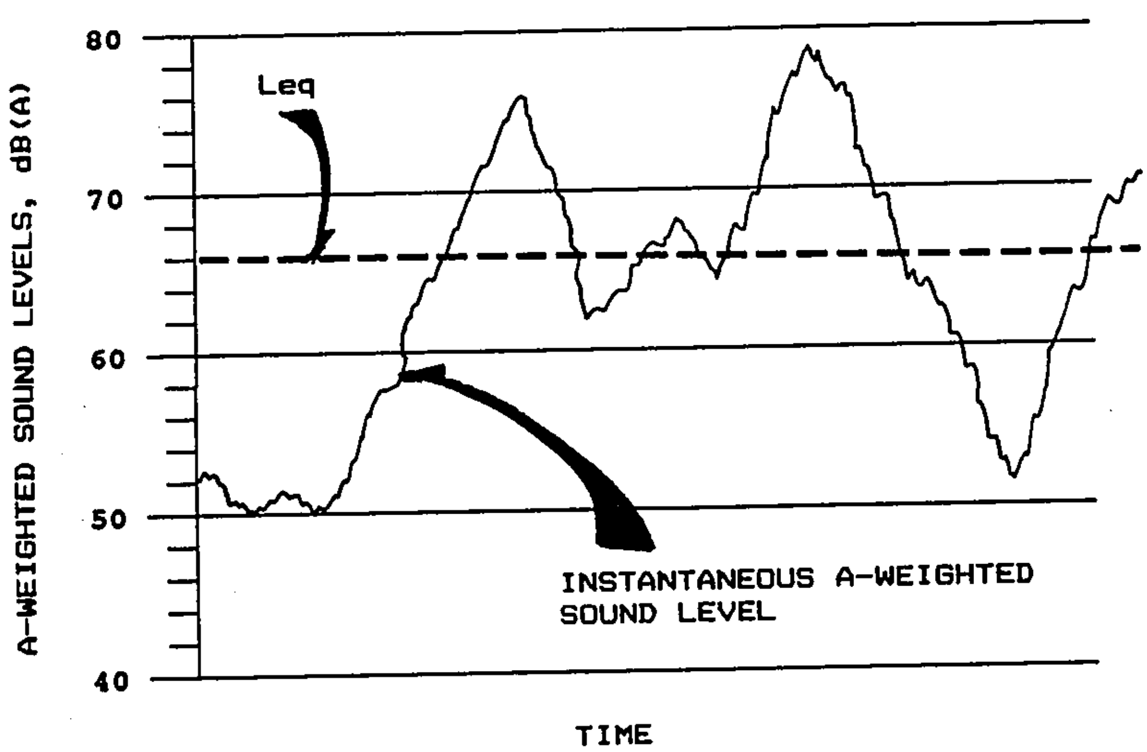

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FIGURE I-2. COMPARISON OF THE INSTANTANEOUS A-WEIGHTED SOUND LEVELS AND THE Leq

APPENDIX II

MEASUREMENT DATA LISTINGS

Table	Descriptions
1.	A-Weighted Ambient Noise Measurement Data, Position 1
2.	A-Weighted Ambient Noise Measurement Data, Position 2
3.	A-Weighted Ambient Noise Measurement Data, Position 3
4.	A-Weighted Ambient Noise Measurement Data, Position 3A
5.	A-Weighted Ambient Noise Measurement Data, Position 4
6.	A-Weighted Ambient Noise Measurement Data, Position 5
7.	A-Weighted Ambient Noise Measurement Data, Position 6
8.	A-Weighted Ambient Noise Measurement Data, Position 7
9.	A-Weighted Ambient Noise Measurement Data, Position 8
10.	A-Weighted Traffic Noise Measurement Data, Position 9
11.	A-Weighted Traffic Noise Measurement Data, Position 10

Sheet II-1 -- Notes and Legend for Tables 1 through 9

Figure II-1 -- Location of the Measurement Positions

TABLE 1 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 1, HOSPITAL

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA							Traffic**						Meteorological Data							Dominant Source+			NOTES
			L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Car	Pick up	Van	Trk	Cycle	Plane	Wind mph	Wind o	oF	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	1	2	3	
Thur "DAY"	11/12	1430	44	45	48	50	56	70	54.7	(4) 50	5	1	3	1	1	8	90	88	53	30.75		H	T	A	S	
Fri "DAY"	11/13	1500	42	44	47	49	54	63.1	51.1	(3) 58	(3) 10	(2) 5	3	1		6-8	90	82	62	30.57		H	T	S	P	
																						H				
Sat "DAY	11/14	1150	43	45	49	50	52	60.1	50.4	(1) 50	4	3				5-6	45	77	74	30.62		M	T	S	N	1
		2140	46	46	48	48	49	51.1	48.3	9	1					<5	45	70	75	30.58		M	T	S	N	
Sat "NIGHT"	11/14	2210	45	46	48	48	49	55.1	48.5	17		1				<5		70	75	30.58		M	S	T	P	2
																						M				
Sun "NIGHT"	11/15	2230	41	41	42	42	44	53.1	43.3	(1) 6	1					6-9	90	70	74	30.56	90	M	T	P	S	
		2240	40	41	41	42	45	56.1	44.2	(1) 5						6-9	90	70	74	30.56	90	M	T	P	S	
Mon "DAY"	11/16	1300	45	46	48	50	57	67.1	53.4	(7) 45	(1) 4	(1) 4	(1) 5		1	7	90	78	75	30.54	95	M	A	T	S	
		1310	44	46	48	49	54	66.1	51.9	(5) 60	(5) 13	3	(1) 4			7	90	78	75	30.54	95	M	T	S	P	
Mon "NIGHT"	11/16	1040	42	42	43	45	47	60.1	46.5	(2) 10						8	90	68	84	30.60		M	T	S	P	1
Wed "NIGHT"	11/18	2210	41	42	43	44	46	59.1	45.5	10			1	1		6-9	90	73	80	30.66	50	M	T	S	P	
	11/19	0300	40	41	41	41	42	49.1	42.0	1						6	90	73	84	30.62		M	S	T	P	

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TABLE 2 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 2, CONDO

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind °	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	1800	44	45	46	46	50	70.1	51.7	1																
Fri "DAY"	11/13	1100	45	46	49	50	53	67.1	51.9	1						6	90	74	62	30.72		H	T	S	P	
															1	8	90	80	64	30.62		H	T	N	P	
Sat "DAY	11/14	0800	41	43	46	48	52	71.1	52.3			(1)										H				
		0810	43	44	46	47	51	59.1	49.6							<5		68	76	30.60		M	P	T	S	
Sat "NIGHT"	11/15	0240	50	51	52	53	54	55.1	53.2							<5		68	76	30.60		M	P	T	S	
		0250	51	52	54	54	55	56.1	54.1							<5		66	78	30.62		M	S	P		2
Sun "NIGHT"	11/16	0220	41	42	43	44	44	54.1	44.0							<5		66	78	30.62		M	S	P		2
		0230	40	41	42	43	44	59.1	43.6							6-7	90	69	81	30.54	80	M	N	P	S	
Mon "DAY"	11/16	1640	45	46	48	49	51	63.1	49.5	(1)						6-7	90	69	81	30.54	80	M	P	N	S	
																8	90	73	80	30.54		M	T	S	N	
Mon "NIGHT"																						M				
Wed "NIGHT"	11/18	2250	45	46	47	48	49	52.1	48.1													M				
	11/19	0230	43	44	45	45	46	48.1	45.5							6	90	74	81	30.66	50	M	S	N		
																6-8	90	74	85	30.64		M	S	N		

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TABLE 3 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 3. CABANAS

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind o	^oF	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12																									
Fri "DAY"	11/13	1130	58	59	60	60	61	63.1	60.5													H				
																8	90	81	63	30.62		H	S			
Sat "DAY	11/14	0830	55	56	57	58	59	77.1	60.5													H				
																<5		70	78	30.60		M	S	P	N	
Sat "NIGHT"	11/15	2110	54	55	56	57	59	60.1	57.3													M				
																<5		66	78	30.60		M	S			
Sun "NIGHT"	11/16	0150	57	58	59	59	60	60.1	59.4													M				
																7-9	90	69	81	30.54		M	S			
		0200	57	57	58	59	59	61.1	59.0							7-9	90	69	81	30.54		M	S			
Mon "DAY"	11/16	1620	58	59	60	61	61	63.1	60.9	(1)						12	90	74	79	30.50	98	M	S	T		
Mon "NIGHT"																						M				
Wed "NIGHT"	11/18	2230	59	60	60	61	62	63.1	61.1													M				
																12	90	74	80	30.66		M	S			
	11/19	0220	59	60	61	61	62	64.1	61.6							10-14	90	74	85	30.65		M	S			

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TABLE 4 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 3A, HI-RISE

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up.	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind °	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	2150	60	61	62	63	63	65.1	63.0							8-10	90	74	64	30.62		H	S			
Fri "DAY"	11/13	0800	59	61	62	62	63	65.1	62.8							<5		80	64	30.62		H	S			
																						H				
Sat "DAY	11/14																					M				
																						M				
Sat "NIGHT"																						M				
																						M				
Sun "NIGHT"																						M				
																						M				
Mon "DAY"	11/16																					M				
																						M				
Mon "NIGHT"																						M				
Wed "NIGHT"																						M				
																						M				

TABLE 5 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 4, KAWELA BAY

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind o	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	1520	50	51	52	53	55	65.1	53.8						2	<5		85	55	30.72		H	S	A		
Fri "DAY"	11/13	1430	49	50	51	52	53	56.1	52.1							<5		80	64	30.56		H	S	P		
																						H				
Sat "DAY"	11/14	0910	49	50	52	53	55	63.1	53.6						(1)			73	78	30.62		M	S			
																						M				
Sat "NIGHT"	11/14	2240	49	50	51	51	52	53.1	51.5							<5		68	78	30.59		M	S			
		2250	49	50	51	51	52	54.1	51.3							<5		68	78	30.59		M	S			
Sun "NIGHT"	11/15	2310	47	48	49	49	50	58.1	49.8							<5		71	74	30.60		M	S			
		2320	47	48	49	49	50	52.1	49.6							<5		71	74	30.60		M	S			
Mon "DAY"	11/16	1540	49	50	51	52	54	59.1	52.3	(2)					1	<5		75	79	30.50		M	S	A		
																						M				
Mon "NIGHT"																						M				
Wed "NIGHT"	11/18	2310	48	49	50	51	52	55.1	51.3							<5		74	82	30.66		M	S			
	11/19	0200	48	49	51	51	52	55.1	51.5							<5		74	83	30.65		M	S			

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TABLE 6 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 5, BEACH PARK

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind °	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	1550	61	62	64	65	67	78.1	66.0	(9) 73	8	1	1	2	2	8	90	88	53	30.70		H	S	A	T	
Fri "DAY"	11/13	1323	59	60	62	63	66	73.1	64.3	(4) 56	4	7	4	4		8	90	83	56	30.61		H	S	T		
																						H				
Sat "DAY"	11/14	0950	61	62	63	65	69	84.1	68.6	51	5	1		3		5-7	90	74	75	30.64		H	S	T		
		1000	62	63	64	65	67	79.1	66.1	30	2	6	2	1		5-7	90	74	75	30.64		M	S	T		
Sat "NIGHT"	11/15	0050	59	59	60	61	62	70.1	61.5	5						<5		66	78	30.58		M	S			
																						M				
Sun "NIGHT"	11/16	0040	58	58	59	60	61	74.1	61.3	4						<5		70	78	30.55	90-100	M	S			
		0050	58	59	60	60	61	68.1	60.7	5						<5		70	78	30.55	90-100	M	S			
Mon "DAY"	11/16	1350	59	60	62	63	66	75.1	64.1	(9) 47	4	5	1			6	90	77	77	30.54	100	M	S	T		
Mon "NIGHT"																						M				
																						M				
Wed "NIGHT"	11/18	2320	58	59	60	61	63	72.1	62.0	12						<5		74	82	30.64		M	S	T		
	11/19	0050	58	59	60	60	61	67.1	60.7	1						<5		72	82	30.62	.	M	S			

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TABLE 7 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 6, WAIALEE, MAUKA

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA							Traffic**						Meteorological Data							Dominant Source+			NOTES
			L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Car	Pick up	Van	Trk	Cycle	Plane	Wind mph	Wind °	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	1	2	3	
Thur "DAY"	11/12	1620	51	51	53	54	56	63.1	54.5	(2) 43	(1) 11	2	3	1	1	6-9	45	82	53	30.64		H	T	A	S	
Fri "DAY"	11/13	1300	48	49	51	53	57	78.1	58.5	45	(2) 3	2	4	1	1	6-11	90	86	52	30.58		H	A	T	S	
																						H				
Sat "DAY"	11/14	1020	54	54	55	56	57	73.1	57.3	(2) 41	5	1	2			5-8	90	74	76	30.62		M	T	S	P	
		1030	54	54	55	55	57	71.1	56.8	(1) 39	3	2			1	5-8	90	74	76	30.62		M	T	S	P	
Sat "NIGHT"	11/14	2340	48	48	49	50	53	63.1	51.7	17	4					<5		78	70	30.58		M	S	T		2
		2350	47	48	49	50	52	63.1	51.3	13						<5		78	70	30.58		M	S	T		2
Sun "NIGHT"	11/15	2340	46	47	48	48	50	59.1	49.1	5						5-7	90	71	75	30.56	100	M	S	T		
		2350	47	48	49	50	53	60.1	51.0	6						5-7	90	71	75	30.56	100	M	S	T		
Mon "DAY"	11/16	1410	48	49	53	54	60	70.1	57.7	(3) 54	(1) 6	6	3		2	7-11	90	76	78	30.51		M	A	T	S	
		1420	49	50	53	55	59	70.1	56.6	(1) 60	(2) 7	2	4		2	7-11	90	76	78	30.51		M	A	T	S	
Mon "NIGHT"																						M				
Wed "NIGHT"	11/18	2340	46	47	48	49	52	64.1	50.6	(1) 15						5-8	90	74	82	30.66		M	T	S	N	
	11/19	0120	46	47	48	48	49	66.1	49.3	2						<5		72	84	30.61		M	S	T	N	

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TABLE 8 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 7, WAIALEE, MAKAI

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data: Wind mph	Wind °	°F	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	1650	47	48	50	51	55	70.1	55.1	(1) 48	9	2	1		3	6-9	45	78	57	30.65		H	A	T	S	
Fri "DAY"	11/13	1240	46	47	51	53	61	75.1	59.8	55	5	3	5	1	1	6-10	45	88	48	30.64	<10	H	A	T	S	
																						H				
Sat "DAY	11/14	1050	44	46	50	51	53	71.1	54	(1) 46	(1) 6	6	3			8	90	78	73	30.66		M	T	S		
																						M				
Sat "NIGHT"	11/15	0020	47	48	50	50	52	57.1	51.0	6	1					5		68	76	30.56		M	S	T		2
		0030	48	48	50	51	52	55.1	51.1	4	1					5		68	76	30.56		M	S	T		2
Sun "NIGHT"	11/16	0010	45	46	47	47	48	54.1	47.6	2						6	90	71	78	30.56	90	M	S			
		0020	46	46	47	48	48	56.1	48.0	2	1	1				6	90	71	78	30.56	90	M	S			
Mon "DAY"	11/16	1440	45	46	51	53	60	85.1	60.9	74	(1) 7	7	5		1	5		73	78	30.50	100	M	A	T	S	
		1450	46	47	51	53	57	74.1	56.8	45	(1) 9	1	7	1		5		73	78	30.50	100	M	T	S		
Mon "NIGHT"																						M				
Wed "NIGHT"	11/19	0000	42	43	44	45	48	56.1	46.5	7	1	1		1		7	90	74	84	30.62		M	T	S	N	
		0140	44	45	45	46	46	51.1	46.1							5-8	90	74	82	30.62		M	S			

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TABLE 9 - "A" WEIGHT AMBIENT NOISE LEVEL DATA - KAHUKU ENERGY PROJECT, LOCATION 8, CORNFIELD

Meas. Period	1981 Date	Start Time*	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{33}	L_{10}	L_{max}	L_{eq}	Traffic** Car	Pick up	Van	Trk	Cycle	Plane	Meteorological Data Wind mph	Wind o	oF	RH %	Pressure in.of HG	Cloud Cover %	*** Surf	Dominant Source+ 1	2	3	NOTES
Thur "DAY"	11/12	1730	54	54	55	55	55	56.1	55.5	50		2	4	2		7-8	90	78	58	30.67		H	S	N	T	
Fri "DAY"	11/13	1410	43	44	46	47	76	77.1	64.3	48	6	7	3	1	1	8-10	90	82	59	30.56		H	A	P	S	3
		1630	54	54	54	55	56	60.1	55.8	49	10	3	1		1	8	90	82	58	30.60		H	S	T	N	
Sat "DAY	11/14	0930	48	49	50	55	55	56.1	53.4	45	3	3	3			6-7	90	74	77	30.64		M	S	T	N	
																						M				
Sat "NIGHT"	11/15	0140	50	51	53	53	55	57.1	53.8	9						6-7	90	66	78	30.56		M	S			2
																						M				
Sun "NIGHT"	11/16	0120	40	41	42	42	43	48.1	42.7	6						7	90	70	82	30.54		M	S			
		0130	41	42	42	43	43	48.1	43.1	1						7	90	70	82	30.54		M	S			
Mon "DAY"	11/16	1510	46	47	48	49	50	57.1	49.3	52	8	2	6	1	1	9-10	90	75	80	30.50	100	M	S	T	A	
		1520	45	46	48	49	59	77.1	58.6	42	2	4			1	9-10	90	75	80	30.50	100	M	A	S	T	4
Mon "NIGHT"																						M				
Wed "NIGHT"	11/19	0020	41	43	46	46	46	48.1	46.1	3						7	90	74	82	30.64		M	N	S		
		0030	39	40	45	46	46	54.1	45.5	2						7	90	74	82	30.64		M	N	S		

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SHEET II-1

NOTES

* Start time for the 10-minute sample period.

** Traffic counts are on the highway. () is count of vehicles moving off the highway on side roads or parking lot. "Trucks" include buses. Planes are either 1 or 2 prop fixed wing aircraft or helicopters.

*** Surf heights are: H = 11' to 15', M = 6' to 10',

\+ Dominant Noise Sources:
S = Surf
T = Traffic
A = Aircraft
N = Natural Sources
P = Miscellaenous Sources

1. Highway pavement sufficiently wet to increase traffic noise.

2. Higher than normal surf noise levels believed due to sound refraction caused by thermal inversion.

3. Threshing machine in field.

4. Helicopter noise dominated sample.

TABLE 10

TRAFFIC NOISE MEASUREMENT DATA SHEET

PROJECT NO.: 88-50

MEASUREMENT DATE: December 21, 1988

MEASUREMENT PERIOD: 20 minutes

NOISE SOURCE: Traffic on Kamehameha Highway

REMARKS:______________________________

MEASUREMENT LOCATION: Position No. 9

MEASUREMENT RESULTS

Leq: 63.9 dB(A)	NO. OF PASSENGER AUTO COUNTED: 222 NO. OF PASSENGER AUTO / HOUR: 666
Lmax: 85.3	NO. OF MEDIUM TRUCKS COUNTED: 4 NO. OF MEDIUM TRUCKS / HOUR: 12
POSTED SPEED: 35 MPH	NO. OF HEAVY TRUCKS COUNTED: 4 NO. OF HEAVY TRUCKS / HOUR: 12
ESTIMATED AVERAGE SPEED: 35-40 MPH	TOTAL NO. OF VEHICLES COUNTED: 230 TOTAL NO. OF VEHICLES / HOUR: 690

MIC. DISTANCE TO THE SOURCE: 65 feet

MIC. HEIGHT RELATIVE TO THE SOURCE: 7 feet

TABLE 11

TRAFFIC NOISE MEASUREMENT DATA SHEET

PROJECT NO.: 87-41

MEASUREMENT DATE: February 18, 1988

MEASUREMENT PERIOD: 10 minutes

NOISE SOURCE: Traffic on Kamehameha Highway

REMARKS: ____________________

MEASUREMENT LOCATION: Position No. 10

MEASUREMENT RESULTS

Leq: 61.3 dB(A)	NO. OF PASSENGER AUTO COUNTED: 81 NO. OF PASSENGER AUTO / HOUR: 486
Lmax: 75.3	NO. OF MEDIUM TRUCKS COUNTED: 1 NO. OF MEDIUM TRUCKS / HOUR: 6
POSTED SPEED: 35 MPH	NO. OF HEAVY TRUCKS COUNTED: 1 NO. OF HEAVY TRUCKS / HOUR: 6
ESTIMATED AVERAGE SPEED: 35-40 MPH	TOTAL NO. OF VEHICLES COUNTED: 83 TOTAL NO. OF VEHICLES / HOUR: 498

MIC. DISTANCE TO THE SOURCE: 119 feet

MIC. HEIGHT RELATIVE TO THE SOURCE: not recorded

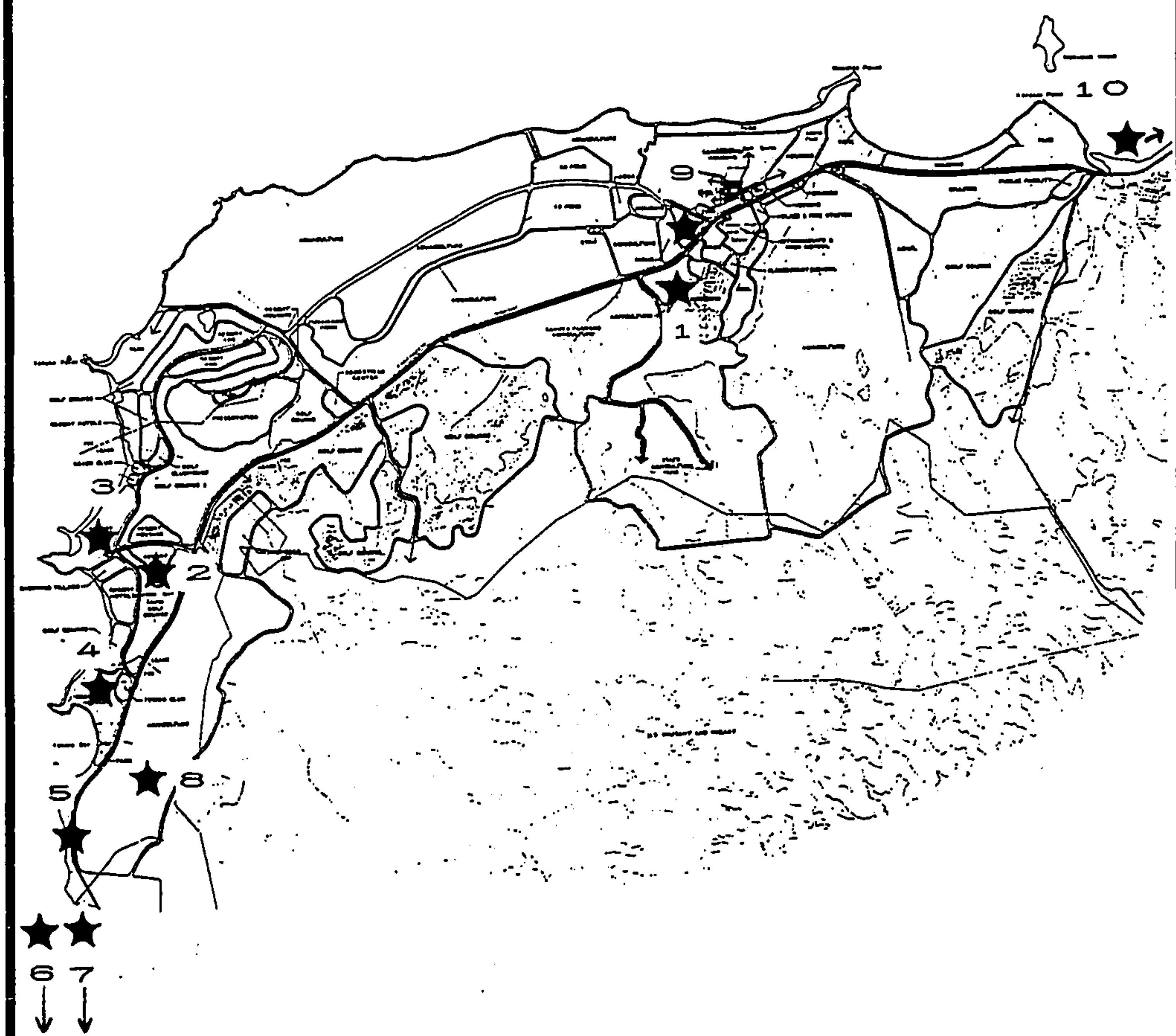

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FIGURE II-1. LOCATION OF MEASUREMENT POSITIONS

APPENDIX Q

AIR QUALITY STUDY

FOR THE PROPOSED

COUNTRY COURSES AT KAHUKU PROJECT

KAHUKU, OAHU, HAWAII

Prepared for:

Kuilima Resort Company

Prepared by:

Barry D. Root & Barry D. Neal

February 1989

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION AND PROJECT DESCRIPTION

The Kuilima Resort Company is proposing for development the Country Courses at Kahuku Project at two sites near Kahuku, Oahu, Hawaii. The first site, designated the Punamano site, is located mauka of Kamehameha Highway across from the Kuilima Resort on approximately 605 acres of land. Three 18-hole golf courses and associated golf facilities are planned for this site. The other site, referred to as the Malaekahana site, is also situated mauka of Kamehameha Highway directly across from Malaekahana State Park on approximately 228 acres of land. The Malaekahana site would contain one 18-hole golf course plus related facilities. Figure 1 shows the proposed project location map. Development is expected to be completed by 1997.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short-term and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Measures to mitigate these impacts are suggested where possible and appropriate.

2.0 AMBIENT AIR QUALITY STANDARDS (AAQS)

Federal Ambient Air Quality Standards (AAQS) are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are set in Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the Federal and the State AAQS that are specified in the cited documents. As indicated in the table, AAQS have been established for six pollutants. The pollutants for which AAQS have been developed include particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. Federal AAQS are stated in terms of primary and secondary standards. Federal primary standards are designed to protect the public health with an "adequate margin of safety". Federal secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the Federal AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from as little as one hour to as long as one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., one-to 24-hour) AAQS, both Federal and State standards allow one exceedance per year.

As can be seen from the table, State of Hawaii AAQS are in some cases considerably more stringent than comparable Federal AAQS. In particular, the State of Hawaii one-hour AAQS for carbon monoxide is four times more stringent than the comparable Federal limit.

Under the provisions of the Federal Clean Air Act [1], the U.S. Environmental Protection Agency (EPA) is required to periodically review and re-evaluate Federal AAQS in light of research findings more recent than those which were available at the time the standards were originally set. Occasionally new standards are created as well. Most recently the Federal standard for particulate matter has been revised to include specific limits for particulates 10 microns or less in diameter (PM-10) [2]. The State of Hawaii has not explicitly addressed the question of whether to set limits for this category of air pollutant, but Federal AAQS prevail where States have not set their own more stringent levels.

Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make them essentially the same as Federal limits. It has been proposed in various forums that the State also relax its carbon monoxide standards to the Federal levels, but at present there are no indications that such a change is being considered.

3.0 PRESENT AIR QUALITY

Present air quality in the Kahuku area could potentially be affected by air pollutants from four different types of sources: natural, industrial, agricultural and vehicular. Natural air pollutant producers which could affect the Kahuku area include the ocean (sea spray), plants (aero-allergens), dust (from the wind blowing over areas with no vegetative cover), or perhaps distant volcanic emissions from the Island of Hawaii.

Industrial and agricultural sources of air pollutants are located primarily on the leeward and central portions of Oahu. These sources are generally downwind from the project location. Upwind in the normal trade wind direction there are no industrial or agricultural air pollution sources for thousands of miles. The only long-term State of Hawaii monitoring station on the windward side of Oahu is located at Waimanalo. This monitoring site was selected by the State to measure background levels of particulate matter. None of the other regulated pollutants are measured. For the year 1987, the annual average total suspended particulate (TSP) concentration at Waimanalo was 27 micrograms per cubic meter; 24-hour values ranged from 13 to 45 micrograms per cubic meter. These values are well within the State AAQS for suspended particulate and are probably typical of most locations on the windward coast of Oahu.

Any air pollution currently affecting the project area is probably mainly from either natural or vehicular sources. Unfortunately, there are no nearby long-term measurements of vehicular-related pollutants (i.e., carbon monoxide, nitrogen oxides, ozone or lead) on the windward side of Oahu, so current levels of these pollutants are difficult to estimate very accurately. Some monitoring data for vehicular-related pollutants are available for the leeward side of Oahu, but these data are not representative of the project site. However, due to the low level of activity and development in the area and the persistent trade winds from the northeast, current air pollution levels are almost certainly low.

4.0 SHORT-TERM DIRECT AND INDIRECT IMPACTS OF PROJECT CONSTRUCTION

For a project of this nature, there are two potential sources of air pollution emissions which could directly result in short-term air quality impacts during project construction: (1) fugitive dust from vehicle movement and soil excavation and (2) exhaust emissions from on-site construction equipment. Indirectly, there could also be short-term impacts from slow-moving construction equipment traveling to and from the project site and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions may arise from grading and dirt-moving activities within the project site. The emission rate for fugitive dust is nearly impossible to estimate accurately because of its elusive nature and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of dirt-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [3] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and semiarid climate (precipitation/evaporation (P/E) index of 50). Uncontrolled fugitive dust emissions from project construction would probably be near or below the level suggested above. However, State of Hawaii Air Pollution Control Regulations [4] require that visible emissions of fugitive dust from construction activity must be controlled so as to be essentially nil.

Adequate fugitive dust control can usually be accomplished by establishment of a frequent watering program to keep bare-dirt surfaces in work areas from becoming significant dust generators. Control regulations also require that open-bodied trucks be covered at all times when in motion if they are transporting materials likely to give rise to airborne dust. Paving of parking areas and establishment of landscaping as early in the construction process as possible can also lower the potential for fugitive dust emissions.

On-site mobile and stationary construction equipment will emit some air pollutants in the form of engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are very low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Indirectly, slow-moving construction vehicles on roadways leading to and from the project site could obstruct the normal flow of traffic to such an extent that overall vehicular emissions are increased, but this impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity. Thus, most potential short-term air quality impacts from project construction can be mitigated.

5.0 LONG-TERM INDIRECT IMPACTS

5.1 Roadway Traffic

By serving as an attraction for increased motor vehicle traffic on nearby roadways, the proposed project must be considered to be a potential indirect air pollution source. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides, and those burning leaded gasoline contribute lead to the atmosphere. The use of leaded gasoline in new automobiles is now prohibited. As older vehicles continue to disappear from the numbers of those currently operating on the state's roadways, lead emissions are approaching zero. Nationally, so few vehicles now require leaded gasoline that the EPA is proposing a total ban on leaded gasoline. Even without such a ban, reported quarterly averages of lead in air samples collected in urban Honolulu have been near zero since early 1986. Thus, lead in the atmosphere is not considered to be a problem anywhere in the state.

Federal air pollution control regulations also call for increased efficiency in removing carbon monoxide and nitrogen oxides from vehicle exhausts. By the year 1995 carbon monoxide emissions are expected to be about one fourth less than the amounts now emitted. At present, however, no further reductions in vehicular emissions have been mandated and increases in traffic levels after 1995 will result in directly proportional increases in vehicle-related pollutant emissions.

To evaluate the potential long-term indirect air quality impact of increased roadway traffic associated with a project such as this, it is standard practice to utilize computerized atmospheric dispersion models to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the motor vehicle generated pollutants. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem, whereas nitrogen oxides air pollution most often is a regional issue. This is reflected in the fact the AAQS for carbon monoxide are specified on a short-term basis (1-hour and 8-hour averaging times) while the AAQS for nitrogen dioxide is set on an annual basis.

Three scenarios were selected for study: year 1989 with present conditions, year 1997 without the project and year 1997 with the project. To begin the carbon monoxide modeling study, critical receptor areas in the vicinity of the project were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic cycling: decelerating, stopping, queueing and accelerating.

The traffic impact assessment report for the project [5] describes the present and the expected future conditions and configurations of the roadway system in the vicinity of the project. Briefly, access to the Malaekahana Golf Course would be achieved by a two-lane road intersecting with Kamehameha Highway and running mauka into the site. Access to the Punamano Golf Courses would be made either by entering on a new two-lane access road that would intersect with Kamehameha Highway or by entering on the newly realigned military road which would become an extension of Marconi Road running mauka from Kamehameha Highway. Currently, Marconi Road and the nearby military road are offset about a half mile. More detailed descriptions of the roadways in the vicinity of the project are provided in the traffic study cited above.

The main objectives of the modeling study were to estimate both current and projected levels of maximum 1-hour average carbon monoxide concentrations in the project area which could be directly compared to the national and state AAQS. Three intersections were selected for analysis. These included the following: Kamehameha Highway/Malaekahana Access Road, Kamehameha Highway/Punamano Access Road, and Kamehameha Highway/Marconi Road.

The traffic impact assessment report indicates that the peak-hour traffic volume in the project vicinity occurs on Saturday afternoons. Worst-case meteorological dispersion conditions usually occur during the early morning hours, but traffic volumes associated with the proposed project would not be very large then. Thus, for this particular case, afternoon meteorological conditions are the ones most likely to be associated with the peak project traffic volumes that can be expected to result in worst-case carbon monoxide levels.

The EPA computer model MOBILE3 [6] was used to calculate vehicular carbon monoxide emission estimates for each of the years studied. Based on recent vehicle registration figures, the present and projected vehicle mix in the project area is estimated to be 91.9% light-duty gasoline-powered vehicles, 4.2% light-duty gasoline-powered trucks and vans, 0.5% heavy-duty gasoline-powered vehicles, 1% diesel-powered trucks and buses, and 1% motorcycles. It was assumed that about 21 percent of all vehicles would be operating in the cold-start mode and that about 27 percent would be operating in the hot-start mode. These are standard, default values that are used in calculating cold/hot start emissions. National averages for "mis-fueling" were assumed. An ambient temperature of 68 degrees F was used for morning peak-hour emission computations. This is a conservative assumption since ambient temperatures will generally be warmer than this, and emission estimates given by MOBILE3 are inversely proportional to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE3, these data were then input to the computer model CALINE4 [7]. CALINE4 was developed by the California Transportation Department and the EPA to simulate vehicular movement and atmospheric dispersion of vehicular emissions. It is designed to predict 1-hour average pollutant concentrations along roadways based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Input peak-hour traffic data were obtained from the traffic study cited previously. The traffic volumes given in the traffic study for the future scenarios include project traffic as well as traffic from other growth that is expected to occur in the area by the year 1997.

Model roadways were set up to reflect actual roadway geometry, physical dimensions and operating characteristics. Model receptor sites were located approximately 10 meters from the edge of the roadways near all roadway intersections at a height of 1.5 meters above grade to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 4 was assumed. This is the most conservative stability category that can be used for estimating afternoon pollutant dispersion in model calculations. A surface roughness length of 100 cm was assumed with a mixing height of 500 meters. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration.

Existing background concentrations of air pollution in the project vicinity are believed to be low. Hence, background contributions of carbon monoxide from distant sources not directly considered in the analysis were assumed to be close to zero. A small concentration of 0.1 ppm was added to all predicted concentrations for the 1989 scenario to make allowance for background. For the year 1997 scenarios, a background concentration of 0.5 ppm was assumed.

Table 2 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 1989 with existing traffic, year 1997 without project traffic, and year 1997 with project traffic. The locations of these estimated worst-case 1-hour concentrations all occurred at or near the indicated intersections.

Insofar as present conditions are concerned, the predicted worst-case 1-hour carbon monoxide concentrations in the project area were less than 1 mg/m^3. In 1997 without the proposed project, worst-case 1-hour concentrations were estimated to range from 1.0 to 1.4 mg/m^3. In the 1997 with project scenario, the worst-case 1-hour concentrations at the three locations studied ranged from 1.7 to 5.1 mg/m^3 with the highest value occurring at the Kamehameha Highway/Marconi Road intersection. All predicted worst-case 1-hour carbon monoxide concentrations were well within the state and national AAQS.

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a "meteorological persistence factor" of 0.6. This procedure is recommended in EPA guidelines [8] to account for two factors: (1) traffic volumes averaged over eight hours are lower than the peak 1-hour value, and (2) meteorological dispersion conditions are more variable (and hence more favorable) over an 8-hour period than they are for a single hour. The resulting estimated maximum 8-hour concentrations are indicated in Table 3. The estimated maximum 8-hour carbon monoxide concentration for 1989 was 0.5 mg/m^3 at the intersection of Kamehameha Highway and Malaekahana Access Road. The predicted maximum value for the year 1997 without project scenario was 0.8 mg/m^3 and would occur near the same location as the 1989 value. In the 1997 with project scenario, the highest estimated worst-case 8-hour concentration was 3.0 mg/m^3 and would occur near the Kamehameha Highway/Marconi Road intersection. All predicted 8-hour maximum carbon monoxide concentrations are within the state and the national AAQS.

The results of this study reflect several assumptions that must be made concerning traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is not very likely, and it may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above.

5.2 Electrical Generation

The annual electrical demand of the project when fully developed will be relatively minimal. Any air pollution emitted indirectly by electrical generating facilities providing this power will likely be negligible.

5.3 Solid Waste Disposal

Solid waste generated by the project when fully completed is expected to be minimal. Most if not all of this refuse would be hauled away from the project and either landfilled or burned at another location. Any indirect air pollution emissions are expected to be insignificant.

5.4 Golf Course Pesticide Usage

Once the project is completed and the golf courses are in use, it will be necessary to regularly apply various chemical fertilizers and pesticides to maintain grass quality. AAQS have not been established for any of the pesticides presently in use, although most of them carry warning or caution labels on their containers. The primary purpose of these labels is to provide occupational safety and health guidance regarding proper handling and application. The primary risk of using these chemicals is to the applicator rather than to individuals at possible receptor sites downwind, since these individuals should encounter airborne concentrations of these chemical substances only in greatly diluted form if at all. There are, however, certain precautions that must be followed by pesticide applicators in order to prevent significant downwind drift when spraying. Primary among these are the use of a coarse rather than a fine spray and application under low wind speed conditions when the wind direction will not contribute to drift towards the clubhouse area or to nearby residences. Provided that proper safety precautions are followed, the potential for serious air quality degradation from chemical spraying for golf course maintenance will likely be minimal.

6.0 SUMMARY OF IMPACTS AND MITIGATIVE CONSIDERATIONS

6.1 Impacts Summary

The major short-term air quality impact of the project will be project construction and the potential emission of significant quantities of fugitive dust. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month, but control measures will reduce this substantially. During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers traveling to and from the project.

All long-term air quality impacts associated with the proposed project are indirect. The primary long-term air pollution impact from the project will arise from the increased motor vehicle traffic associated with the project. Increased levels of carbon monoxide concentrations along roadways leading to and from the proposed development will be the main potential problem, especially near intersections. Based on mathematical modeling of the emissions and the movement of present vehicular traffic and combining this with atmospheric dispersion calculations, it is estimated that current carbon monoxide concentrations in the vicinity of the project are well within both state and national 1-

hour and 8-hour standards. Based on future traffic projections, concentrations in 1997 either with or without the project will be higher than present levels but should remain well within the standards.

Other indirect air quality impacts of the project from electrical power demand and from solid waste disposal are expected to be negligible.

Pesticides will be used on the project golf courses to maintain grass quality. If applied during low wind conditions using proper application techniques, contamination of nearby, downwind areas by airborne drift should not be a problem.

6.2 Mitigative Considerations

Strict compliance with State of Hawaii Air Pollution Control Regulations regarding establishment of a regular dust-watering program and covering of dirt-hauling trucks will be required to effectively mitigate fugitive dust emissions from construction activities. Twice daily watering is estimated to reduce dust emissions by up to 50 percent. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

The long-term projected impacts of carbon monoxide emissions from vehicular traffic associated with the completed development assume that all of the mitigative measures suggested in the traffic impact study will be employed to move traffic efficiently through the project area and adjacent locations. This includes a right turn lane for traffic entering Kamehameha Highway from the realigned military road.

Since indirect air quality impacts from project electrical demand and from solid waste disposal are expected to be minimal, no specific mitigative measures are suggested for these two issues. Compliance with existing safety guidelines for the spraying of chemicals for golf course maintenance should mitigate potential air quality impacts from this activity.

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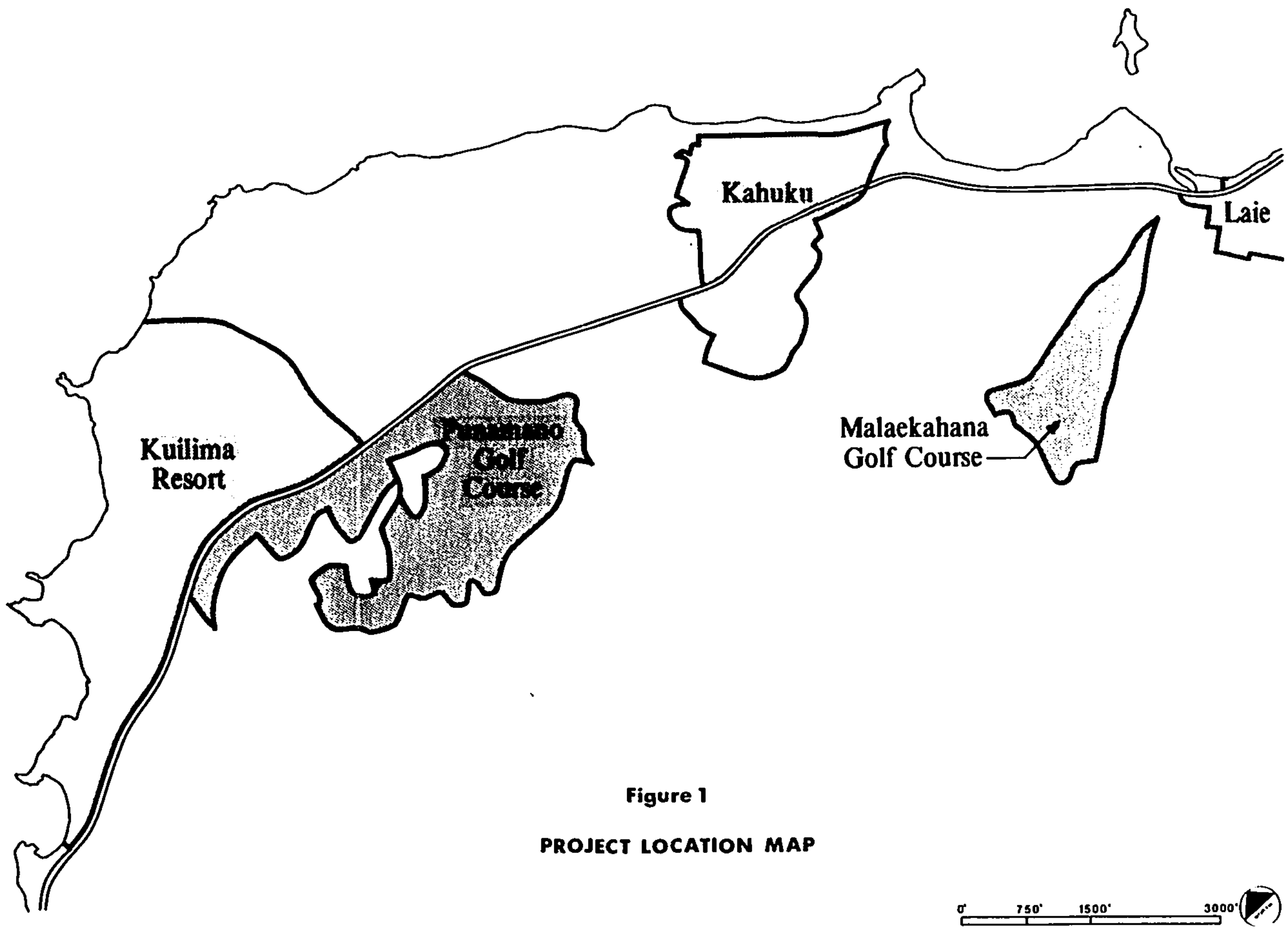

Figure 1

PROJECT LOCATION MAP

THE COUNTRY COURSES AT KAHUKU

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL
AMBIENT AIR QUALITY STANDARDS (AAQS)

Pollutant (units)	Averaging Time	Maximum Allowable Concentration		
		National Primary	National Secondary	State of Hawaii
Suspended Particulate Matter (ug/m^3)	Annual	-	-	60[a]
	24 Hours	-	-	150[b]
Particulate Matter[c] (ug/m^3)	Annual	50	50	-
	24 Hours	150[b]	150[b]	-
Sulfur Dioxide (ug/m^3)	Annual	80	-	80
	24 Hours	365[b]	-	365[b]
	3 Hours	-	1300[b]	1300[b]
Nitrogen Dioxide (ug/m^3)	Annual	100	100	70
Carbon Monoxide (mg/m^3)	8 Hours	10[b]	-	5[b]
	1 Hour	40[b]	-	10[b]
Ozone (ug/m^3)	1 Hour	235[b]	235[b]	100[b]
Lead (ug/m^3)	Calendar Quarter	1.5	1.5	1.5

[a]Geometric mean
[b]Not to be exceeded more than once per year
[c]Particles less than or equal to 10 microns aerodynamic diameter

Table 2

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR PROPOSED COUNTRY COURSES AT KAHUKU PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario 1989/ Present	1997/ Without Project	1997/ With Project
Kamehameha Highway and Malaekahana Access Road	0.8	1.3	2.3
Kamehameha Highway and Punamano Access Road A	0.6[a]	1.0[a]	1.7
Kamehameha Highway and Marconi Road	0.7	1.4	5.1

Hawaii State AAQS: 10
National AAQS: 40

[a]Assumes through traffic on Kamehameha Highway only. Access road built only in with project scenario.

Table 3

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR PROPOSED COUNTRY COURSES AT KAHUKU PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario		
	1989/ Present	1997/ Without Project	1997/ With Project
Kamehameha Highway and Malaekahana Access Road	0.5	0.8	1.4
Kamehameha Highway and Punamano Access Road A	0.4[a]	0.6[a]	1.0
Kamehameha Highway and Marconi Road	0.4	0.8	3.0

Hawaii State AAQS: 5
National AAQS: 10

[a]Assumes through traffic on Kamehameha Highway only. Access road built only in with project scenario.

APPENDIX R

SOCIO-ECONOMIC IMPACT ASSESSMENT

FOR

THE COUNTRY COURSES AT KAHUKU,

OAHU, HAWAII

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Prepared for:

Kuilima Resort Company

January 1989

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1.0 BACKGROUND

1.1 THE PROPOSED PROJECT

Kuilima Resort Company plans to develop approximately 833 acres of land mauka of Kamehameha Highway in the Koolauloa District of Oahu as "The Country Courses at Kahuku." The land is in two parcels, one at Punamano, between Kuilima and Kahuku, and the other at Malaekahana, between Kahuku and Laie (see Figure 1).

The company proposes to develop four golf courses -- three at Punamano and one at Malaekahana -- with clubhouses and driving ranges. The courses will be of different levels of difficulty, ranging from a relatively easy course to at least one tournament-level course. No residential development is proposed.

The golf facilities are intended primarily for use by visitors at the Kuilima Resort. Since the Resort offers varied dining and recreational facilities, most of the clubhouses and other facilities at the proposed golf courses will be modest.

Construction of the three courses at Punamano is expected to take at least 42 months. Clubhouses would be built within the period that course construction is under way. Construction of the course at Malaekahana is expected to take 18 to 24 months. The first course built could be completed in 1992. Plans call for all four courses to be built by 1997 at the latest.

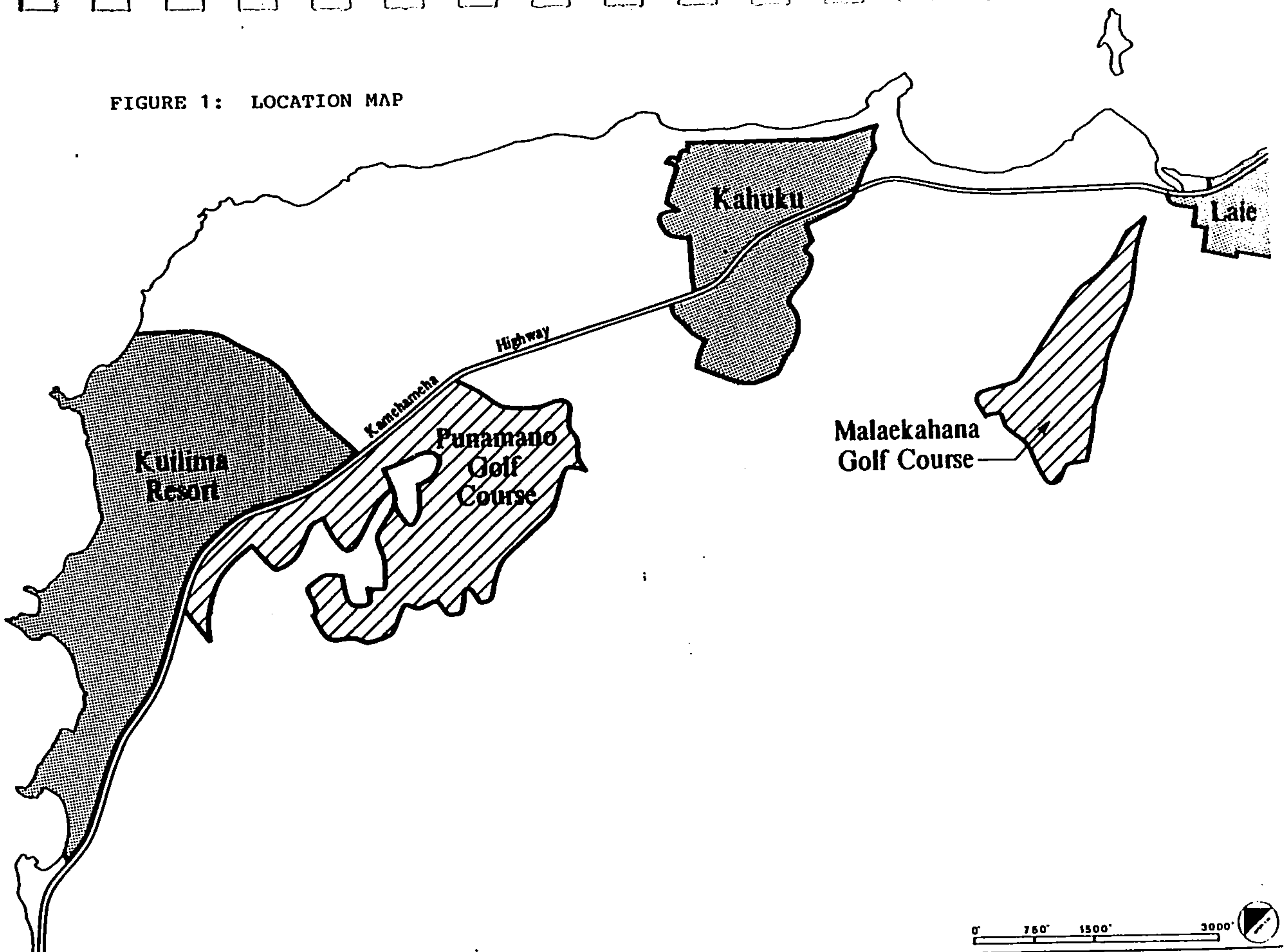
Kuilima Resort Company has made a commitment to keep all the proposed courses open to the public. No club memberships will be offered. It is expected that some tee times will be reserved at each club for Kuilima Resort guests, and some for Oahu residents.

1.2 SCOPE OF THIS REPORT

The following sections provide information concerning:

- Existing social and economic conditions in the region and the towns immediately surrounding the proposed project;
- Forces for change in the region apart from the project;
- Socio-economic impacts that may be expected to accompany the project; and
- Potential mitigations of such impacts.

FIGURE 1: LOCATION MAP



THE COUNTRY COURSES AT KAHUKU
LOCATION MAP

2.0 EXISTING SOCIO-ECONOMIC CONDITIONS

2.1 DEFINITION OF THE STUDY AREA

In this report, attention will be paid to a broad study area, the combined Koolauloa and North Shore regions (see Figures 2 and 3). Population centers near the proposed project -- Laie, Kahuku, and the Sunset Beach area -- will be discussed in some detail.

The properties lie within the Koolauloa District of Oahu, in the City and County of Honolulu's Koolauloa Development Plan Area, and in the Koolauloa Neighborhood Board (No. 28) Area. (The Koolauloa judicial district is somewhat larger than the Development Plan and Neighborhood Board areas of the same name, as shown in Figure 3. The combined areas -- the Koolauloa and North Shore Districts, or the Koolauloa and North Shore Development Plan areas -- are identical. Figure 3 shows that the difference between the two is that the Sunset Beach/Pupukea/Waimea area is included in the Koolauloa District, but is in the North Shore Neighborhood Board area.)

The Koolauloa region includes a series of small communities along Kamehameha Highway. The Highway is the major artery of both Koolauloa and the adjoining North Shore region. In the North Shore, the communities of Sunset Beach and Haleiwa are located on the highway.

(In official publications, the North Shore is often termed the "Waialua" area. This report follows informal practice, reserving that term for the town of Waialua, and using "North Shore" as the name of the judicial district and/or the Development Plan Area.)

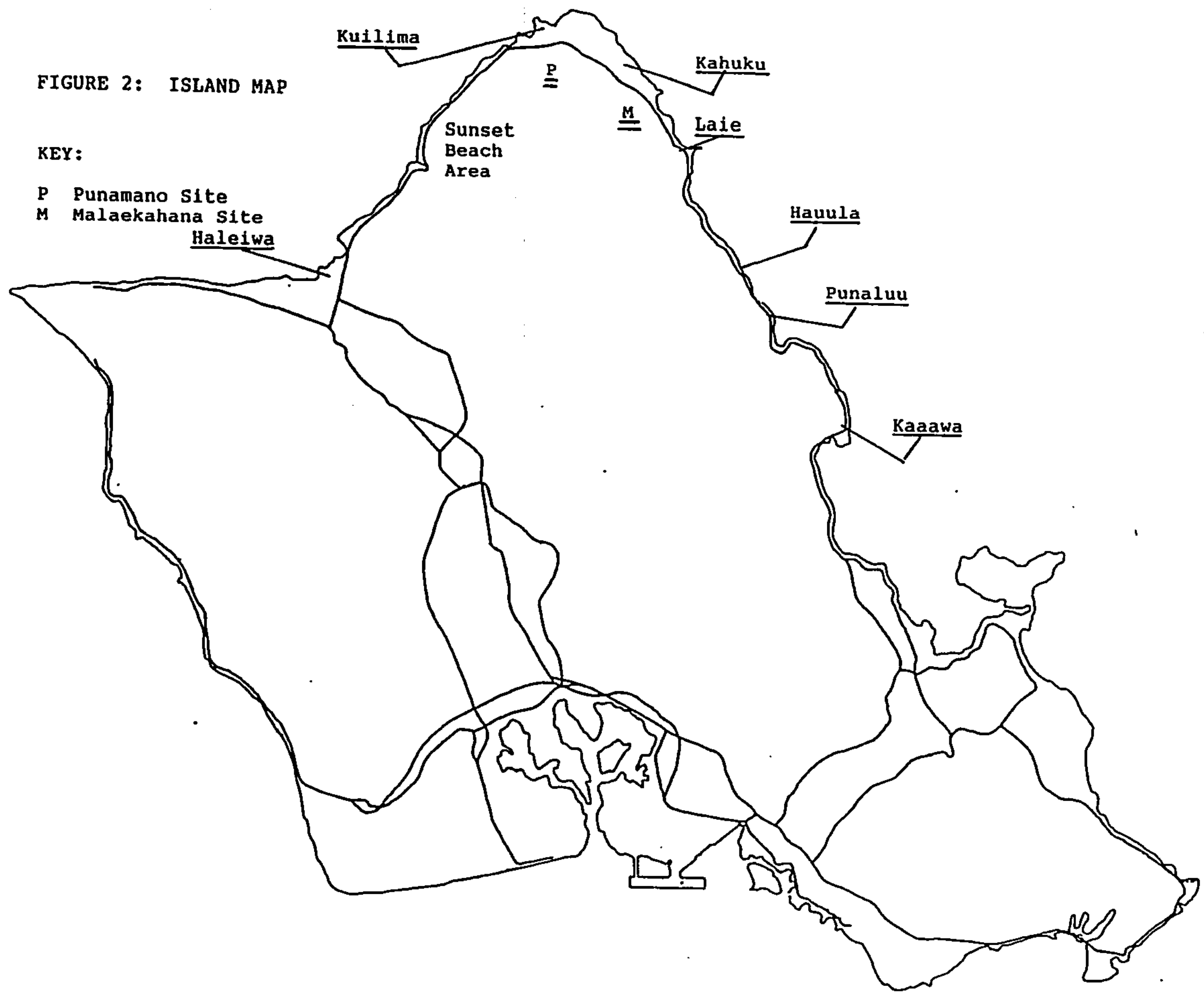
The major source of golfers for the proposed courses is expected to be the Kuilima Resort near Kahuku. Some golfers will come from other areas of the island, traveling along Kamehameha Highway. While this suggests that the project will have some effect on an islandwide scale, the impact on the region from Waialua to Kaaawa is likely to be much greater than on the rest of the island. Most employees are expected to live in the Koolauloa and North Shore areas.

Laie and Kahuku were treated as "Census Designated Places" by the U.S. Census, for which detailed reports were issued. Sunset Beach is not so easily isolated. A triangular area, including Sunset Beach, Pupukea and Waimea, is defined as Block Group 2 of Census Tract 101. Census data concerning that Block Group can be used to describe the Sunset Beach community.

FIGURE 2: ISLAND MAP

KEY:

P Punamano Site
M Malaekahana Site



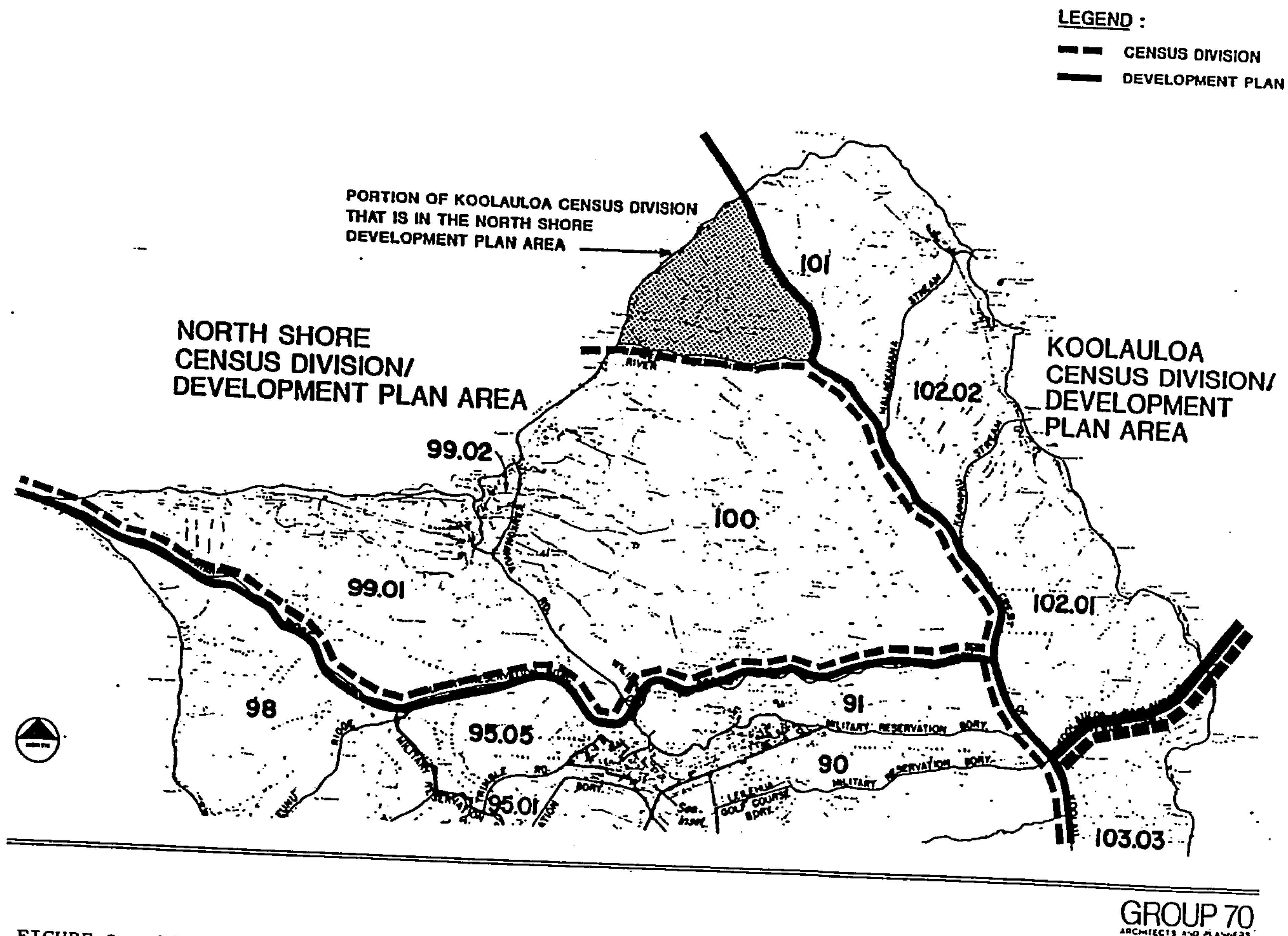


FIGURE 3: KOOLAULOA AND NORTH SHORE
CENSUS DIVISIONS vs. DEVELOPMENT PLAN AREAS

2.2 OVERVIEW OF THE STUDY AREA

The study area's population, estimated at 27,600 in 1987, has amounted to over three percent of the island total for decades (see Table 1). If the growth experienced in the area between 1980 and 1987 has continued, the January 1989 population would be 28,400.

In the following sections, existing conditions in the various parts of the study area are described. To make use of Census data, the discussion deals with Census Divisions or districts, rather than Development Plan areas.

2.2.1 Koolauloa

The Koolauloa region consists mainly of a strip of land bounded by mountains and the sea. A series of residential communities -- Kaaawa, Kahana, Punaluu, Hauula, Laie, and Kahuku --are spaced out along Kamehameha Highway, the region's single major roadway. Hauula, Laie, and Kahuku are the major population centers. Valleys are not densely populated. At the northern tip of Oahu, the coastal region becomes a broader plain, between Kuilima and Laie.

Earlier in this century, much land was planted in sugar. Sugar production in Koolauloa ended, however, in 1971. Major sources of employment and revenue now include tourism, aquaculture, and specialized agriculture. Major employers are the Kuilima Resort outside Kahuku and the Polynesian Cultural Center in Laie.

Koolauloa's population has increased over the past decades (see Table 1). The rate of increase has declined during the 1980's. Still, census data for 1970 and 1980 show that the Koolauloa population is relatively young, compared to the City and County as a whole (see Table 2).

The 1980 census indicated that the people of Koolauloa were fairly similar to the islandwide population with regard to their place of birth, residential mobility, and education. As for ethnicity, the district population includes substantial groups of Caucasians and Hawaiians. The proportion of families with dependent children was above the City and County average (shown in Table 3). Incomes were relatively low, but by 1980 had grown closer to the City and County average than in 1970.

Nearly two-thirds of the housing units in Koolauloa were occupied by renters in 1980 (see Table 4). This proportion was higher than that of any other Development Plan area (Honolulu Department of General Planning, 1988).

Housing conditions in Koolauloa improved between 1970 and 1980. The average household size remained high, however,

TABLE 1: POPULATION TRENDS, CITY AND COUNTY OF HONOLULU AND STUDY AREA

	April 1, 1950	April 1, 1960	April 1, 1970	April 1, 1980	July 1, 1987 (est.)
City and County of Honolulu	353,020	500,409	630,528	762,565	830,600
Koolauloa District	5,223	8,043	10,562	14,195	16,400
North Shore District	7,906	8,221	9,171	9,849	11,200
Total Study Area	13,129	16,264	19,733	24,044	27,600
Selected Census Defined Places:					
Kahuku	N/A	1,238	917	935	N/A
Laie	N/A	1,767	3,009	4,643	N/A

	Average Annual Rate of of Growth				
	1950-60	1960-70	1970-80	1980-87	1950-87
City and County of Honolulu	3.6%	2.3%	1.9%	1.2%	2.3%
Koolauloa District	4.4%	2.8%	3.0%	2.0%	3.1%
North Shore District	0.4%	1.1%	0.7%	1.8%	0.9%
Total Study Area	2.2%	2.0%	2.0%	1.9%	2.0%
Selected Census Defined Places:					
Kahuku	N/A	-3.0%	0.2%	N/A	N/A
Laie	N/A	5.5%	4.4%	N/A	N/A

NOTE: "N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1972 and 1981a, Hawaii State Department of Planning and Economic Development, 1973, and Hawaii State Department of Business and Economic Development, 1988.

TABLE 2: TOTAL POPULATION AND DEMOGRAPHIC BREAKDOWNS --- CITY AND COUNTY OF HONOLULU AND STUDY AREA, 1970 AND 1980

	CITY AND COUNTY OF HONOLULU 1970	CITY AND COUNTY OF HONOLULU 1980	KOOLAULOA DISTRICT 1970	KOOLAULOA DISTRICT 1980	NORTH SHORE DISTRICT 1970	NORTH SHORE DISTRICT 1980	STUDY AREA (Combined Districts) 1970	STUDY AREA (Combined Districts) 1980
TOTAL POPULATION	630,528	762,565	10,562	14,195	9,171	9,849	19,733	24,044
Ethnicity								
Caucasian	41.2%	33.1%	39.5%	38.2%	31.8%	31.2%	36.0%	35.3%
Japanese	26.8%	24.9%	8.7%	7.4%	24.1%	17.7%	15.9%	11.6%
Chinese	7.7%	6.9%	4.0%	3.2%	2.0%	1.0%	4.4%	2.3%
Filipino	10.4%	12.8%	10.7%	7.1%	32.0%	32.4%	20.6%	17.5%
Hawaiian	8.5%	10.5%	25.0%	22.9%	6.7%	11.6%	16.5%	18.3%
Other	5.5%	11.8%	12.1%	21.2%	3.4%	6.0%	8.1%	15.0%
Age								
Less than 5 yr.	9.3%	7.9%	11.5%	11.6%	10.5%	9.0%	11.0%	10.5%
5 to 17 yr.	26.2%	20.2%	28.0%	22.8%	28.1%	20.0%	28.0%	21.7%
18 to 64 yr.	59.5%	64.6%	55.7%	59.3%	54.7%	61.9%	55.2%	60.4%
65 or more yr.	5.0%	7.3%	4.8%	6.3%	6.7%	9.1%	5.7%	7.4%
Median age (yrs.)	24.6	28.1	21.4	23.8	24.3	26.3	22.85	25.05
Place of Birth*								
Hawaii	56.1%	55.1%	54.9%	50.9%	56.3%	55.2%	55.5%	52.7%
Other U.S.**	NC	30.1%	NC	31.4%	NC	27.0%	NC	29.6%
Foreign	NC	14.8%	NC	17.7%	NC	17.8%	NC	17.7%
Residence 5 Yrs. Before* (people aged 5 or more)								
Same house	42.5%	48.2%	41.0%	46.0%	47.3%	50.4%	43.9%	47.8%
Same county	23.9%	25.5%	NC	28.3%	NC	24.2%	NC	26.6%
Other county	1.2%	1.3%	NC	0.8%	NC	2.8%	NC	5.9%
Other state	20.9%	18.4%	NC	14.8%	NC	18.9%	NC	16.5%
Other country	11.5%	6.6%	NC	10.0%	NC	3.7%	NC	8.8%
Education* (people aged 25 or more)								
0-11 years completed	34.1%	24.4%	46.8%	24.7%	51.8%	37.4%	49.4%	30.2%
High School grad.	37.5%	35.5%	28.9%	31.9%	31.1%	32.0%	30.0%	31.9%
Some post H.S.	12.9%	18.3%	12.0%	23.3%	9.4%	15.6%	10.6%	20.0%
College, 4+ yr.	15.5%	21.7%	12.3%	20.1%	7.7%	15.0%	10.0%	17.9%

NOTES:
* Figures based on 15 percent sample; numbers hence represent estimates.
** Includes persons born in U.S. territories, or born abroad or at sea to U.S. parents.
"NC": 1970 categories not comparable to 1980 ones.
"N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1972, 1981a, 1981b; State Department of Planning and Economic Development, 1972.

TABLE 3: FAMILY CHARACTERISTICS AND INCOME LEVELS -- CITY AND COUNTY OF HONOLULU AND STUDY AREA, 1970 AND 1980

	CITY AND COUNTY OF HONOLULU		KOOLAULOA DISTRICT		NORTH SHORE DISTRICT		STUDY AREA (Combined Districts)	
	1970	1980	1970	1980	1970	1980	1970	1980
POPULATION IN FAMILIES	N/A	653,118	N/A	11,687	N/A	8,471	N/A	20,158
as percentage of total population	N/A	85.6%	N/A	82.3%	N/A	86.0%	N/A	83.8%
NUMBER OF FAMILIES	138,277	178,516	1,975	2,909	1,984	2,253	3,959	5,162
HEAD								
Husband/Wife	86.7%	82.8%	86.6%	83.7%	86.4%	82.8%	86.5%	83.3%
Male only	3.6%	4.5%	4.6%	5.7%	5.0%	4.6%	4.8%	5.2%
Female only	9.8%	12.7%	8.8%	10.6%	8.6%	12.6%	8.7%	11.5%
WITH OWN CHILDREN UNDER 18	63.4%	54.9%	63.6%	62.0%	60.8%	55.1%	62.2%	59.0%
Female head	6.2%	7.5%	6.0%	6.7%	5.4%	9.5%	5.6%	7.9%
BELOW POVERTY LEVEL	7.2%	7.5%	18.3%	13.5%	8.5%	9.0%	13.3%	11.5%
MEDIAN FAMILY INCOME	$12,035	$23,554	$8,000 to $8,999	$19,566	$9,000 to $9,999	$16,895	N/A	N/A
NON-FAMILY HOUSEHOLDS	N/A	53,298	N/A	943	N/A	639	N/A	1,582
percentage below poverty level	N/A	15.7%	N/A	25.3%	N/A	23.6	N/A	24.6%

NOTES: All figures (except "Population in Families" and "Non-Family Households") based on 15 percent sample; hence, numbers represent estimates.
"NC": 1970 categories not comparable to 1980 ones.
"N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1972, 1981a, 1981b; State Department of Planning and Economic Development, 1972.

TABLE 4: HOUSING STOCK AND CHARACTERISTICS -- CITY AND COUNTY OF HONOLULU AND STUDY AREA, 1970 AND 1980

	CITY AND COUNTY OF HONOLULU 1970	CITY AND COUNTY OF HONOLULU 1980	KOOLAULOA DISTRICT 1970	KOOLAULOA DISTRICT 1980	NORTH SHORE DISTRICT 1970	NORTH SHORE DISTRICT 1980	STUDY AREA (Combined Districts) 1970	STUDY AREA (Combined Districts) 1980
TOTAL YEAR-ROUND HOUSING UNITS	174,107	250,864	2,875	4,679	2,559	3,198	5,434	7,877
vacant (total)	5.4%	8.2%	17.8%	20.0%	8.7%	11.0%	13.5%	16.3%
vacant for sale	0.6%	0.5%	0.4%	0.8%	0.7%	2.9%	N/A	1.6%
vacant for rent	2.5%	3.6%	2.2%	9.3%	2.8%	1.9%	2.4%	6.3%
held for occas'l use	N/A	0.9%	N/A	5.8%	N/A	4.7%	N/A	5.3%
other	N/A	3.2%	N/A	4.1%	N/A	1.5%	N/A	3.0%
TOTAL YEAR-ROUND OCCUPIED UNITS	164,763	230,214	2,362	3,742	2,335	2,844	4,697	6,586
TENURE								
owner-occupied	45.0%	49.9%	37.2%	37.7%	40.2%	39.6%	38.7%	38.6%
renter-occupied	55.0%	50.1%	62.8%	62.3%	59.8%	60.4%	61.3%	61.4%
SELECTED CONDITIONS								
lacking some or all plumbing	3.5%	1.5%	8.5%	2.4%	8.3%	2.1%	8.4%	2.2%
1.5 or more persons/room	6.9%	7.4%	15.9%	16.0%	10.2%	7.2%	13.0%	12.1%
PERSONS PER HOUSEHOLD	3.60	3.15	4.10	3.55	3.87	3.35	3.90	3.45
MEDIAN CASH RENT (renter-occupied)	$130	$279	$80 to $99	$270	$80 to $99	$257	N/A	N/A
as % of median family income	12.9%	14.2%	N/A	19.2%	N/A	15.8%	N/A	N/A
MEDIAN VALUE* (owner-occupied)	$38,400	$130,400	$25,000 to $34,999	$96,500	$20,000 to $24,999	$79,400	N/A	N/A
MEDIAN MONTHLY MORTGAGE* (owner-occupied)**	N/A	$494	N/A	$482	N/A	$331	N/A	N/A
as % of median family income	N/A	25.2%	N/A	34.2%	N/A	20.3%	N/A	28.2%

NOTES:
* For 1980, median values are for non-condominium housing units.
** Figures based on 15% sample; hence, numbers represent estimates.
"N/A": Not Available.
"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, PHC(1)-88; 1980 Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

compared to the islandwide average, and relatively crowded houses were found in a much higher proportion than islandwide.

The Koolauloa labor force largely works within the region, unlike workers living in other rural areas of Oahu (Honolulu Department of General Planning, 1988, vol. I). (Employment is discussed further in Section 2.3.)

2.2.1.1 Laie

Laie is Koolauloa's largest community. Its 1980 population was 4,600. It is relatively self-sufficient, with a major visitor attraction and a college as local sources of employment and revenue.

The ahupuaa of Laie was purchased in 1865 by the Church of Jesus Christ of the Latter Day Saints to become a central settlement for members of the church in Hawaii and elsewhere in Polynesia. The Laie Temple was dedicated in 1919. Renovations of the Temple were recently completed.

Laie is not the gathering place for all of the Pacific area's Mormons that its leaders intended a century ago. However, it is a religious and educational center, with both the Temple and Brigham Young University - Hawaii. The Polynesian Cultural Center is closely related to the University, as it provides both jobs for students and income for the school.

Laie is still largely centered around the activities of the Mormon Church (or "Church of Jesus Christ of Latter-Day Saints") -- the Temple, Polynesian Cultural Center, and Brigham Young University - Hawaii campus. A survey sponsored by the land management arm of the church (Zions Securities Corp., 1981) found that nearly 70 percent of employed residents were working within Laie itself. Residents report a variety of socio-economic differences between the predominantly Mainland-originating college faculty and the largely Polynesian rank and file Laie working class.

The Mormon Church has historically encouraged community self-sufficiency, so that Laie residents in economic trouble tend to turn to family, neighbors, or the church rather than to public welfare agencies. People from neighboring communities interviewed for this report (Section 4.6) tended to view Laie as "self-contained" and having little contact with other towns.

However, Laie residents may be growing both more independent of the church on land/economic issues and also more involved with nearby communities. The Laie Community Association recently took the initiative in expressing its preferences to Zions Securities Corp. for future community development. And a lack of new housing in Laie itself is resulting in many Mormons taking homes in Kahuku and Hauula.

A recent survey for Zions Securities and the community association (Community Resources, Inc., 1987) found widespread reported crowding of existing Laie housing units. Majorities of Laie respondents said they care more about both new jobs and affordable housing than about keeping Laie "like it is now."

Laie has a large Polynesian community, with far higher concentrations of Samoans and Tongans than elsewhere on Oahu, as well as Hawaiians. (Hence the percentage of persons in Table 5 shown as of "Other" ethnicities is large.) Caucasians are also numerous in the community. The population was quite young in 1980 (shown in Table 5). Laie residents were also geographically mobile, with many coming from outside the United States or the mainland.

Many Laie families include dependent children (see Table 6) -- the percentage of families with dependent children in 1980 was above County and study area figures, and far above the Kahuku percentage. Also, nearly all families were headed by husbands and wives, not single parents, in 1980.

The average number of persons in Laie households -- 4.65 in 1980 -- is high (see Table 7). Over a third of Laie households had 1.51 or more persons per room in 1980 -- these were, in effect, fairly crowded. Plans for community development in Laie have been drafted, but little new housing has been actually built.

2.2.1.2 Malaekahana

Malaekahana consists of a string of vacation homes and cottages fringing Malaekahana Bay, below the site of the proposed golf course on the edge of Laie. Many of these homes were condemned by the State in the last 15 years in order to construct the Malaekahana Bay State Recreation Area.

According to one long-time Malaekahana homeowner (personal communication, Mr. Richard Kimball, January 11, 1989), there are about 40 remaining homes -- all or almost all of which are second homes for Honolulu residents. Few if any people live at Malaekahana on a full-time basis. Some of the homes are now owned on an investment basis by small groups of Honolulu professionals.

2.2.1.3 Kahuku

In Hawaiian tradition, the Kahuku area was associated with pandanus and sugar (Sterling and Summers, 1978, p. 149) -- agricultural products, but not the staples that supported large Hawaiian populations.

TABLE 5: POPULATION AND DEMOGRAPHIC CHARACTERISTICS -- SELECTED STUDY AREA SITES, 1980

	LAIE CDP	KAHUKU CDP	SUNSET BEACH/ PUPUKEA/WAIMEA AREA (Portion C.T. 101, Block Group 2) 1980
TOTAL POPULATION	4,643	935	3,212
Ethnicity			
Caucasian	30.0%	16.4%	60.6%
Japanese	4.1%	15.6%	7.3%
Chinese	6.3%	0.4%	1.6%
Filipino	1.6%	51.8%	13.0%
Hawaiian	11.5%	9.7%	11.6%
Other	46.5%	6.1%	5.9%
Age			
Less than 5 yr.	14.7%	6.7%	8.5%
5 to 17 yr.	22.6%	23.1%	16.5%
18 to 64 yr.	59.9%	46.5%	68.5%
65 or more yr.	2.8%	23.6%	6.5%
Median age (yrs.)	20.6	37.3	27.1
Place of Birth*			
Hawaii	35.1%	57.8%	43.5%
Other U.S.**	33.0%	13.3%	46.2%
Foreign	31.9%	28.9%	10.3%
Residence 5 Yrs. Before* (people aged 5 or more)			
Same house	32.7%	41.2%	40.9%
Same county	22.4%	44.2%	28.2%
Other county	0.6%	0.0%	1.9%
Other state	19.6%	2.4%	26.7%
Other country	24.7%	12.2%	2.3%
Education* (people aged 25 or more)			
0-11 years completed.	15.0%	61.6%	17.6%
High School grad.	26.2%	18.2%	31.5%
Some post H.S.	33.7%	11.7%	26.7%
College, 4+ yr.	25.1%	8.5%	24.2%

NOTES: * Figures based on 15 percent sample; hence, numbers represent estimates.
** Includes persons born in U.S. territories, or born abroad or at sea to U.S. parents.
"N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts, PHC(1)-99;
1980 Summary Tapes Files 1-A and 3-A;
State of Hawaii, 1973, Community Profiles for Hawaii.

TABLE 6: FAMILY CHARACTERISTICS AND INCOME LEVELS -- SELECTED STUDY AREA SITES, 1980

	LAIE CDP	KAHUKU CDP	SUNSET BEACH/ PUPUKEA/WAIMEA AREA (Portion C.T. 101, Block Group 2)
POPULATION IN FAMILIES	3,616	820	2,509
as percentage of total population	77.9%	87.7%	78.1%
NUMBER OF FAMILIES	734	222	732
HEAD			
Husband/Wife	96.3%	85.6%	78.7%
Male only	1.9%	4.1%	9.7%
Female only	1.8%	10.4%	11.6%
WITH OWN CHILDREN UNDER 18	74.1%	46.4%	60.1%
Female head	0.7%	5.4%	6.4%
BELOW POVERTY LEVEL	20.3%	9.9%	6.1%
MEDIAN FAMILY INCOME	$15,183	$13,611	$24,451
NON-FAMILY HOUSEHOLDS	89	80	632
percentage below poverty level	30.3%	18.8%	14.4%

NOTES: All figures (except "Population in Families" and "Non-Family Households") based on 15 percent sample; hence, numbers represent estimates.

"CDP": Census Designated Place.

"N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1981a, 1981b.

TABLE 7: HOUSING STOCK AND CHARACTERISTICS -- SELECTED STUDY AREA SITES, 1980

	LAIE CDP	KAHUKU CDP	SUNSET BEACH/ PUPUKEA/WAIMEA AREA (Portion C.T. 101, Block Group 2)
TOTAL YEAR-ROUND HOUSING UNITS	904	311	1,227
vacant (total)	9.0%	2.6%	14.0%
vacant for sale	1.1%	0.0%	0.7%
vacant for rent	4.2%	1.3%	3.9%
held for occas'l use	2.3%	0.6%	4.7%
other	1.3%	0.6%	4.7%
TOTAL YEAR-ROUND OCCUPIED UNITS	823	303	1,055
TENURE			
owner-occupied	33.3%	0.7%	43.1%
renter-occupied	66.7%	99.3%	56.9%
SELECTED CONDITIONS			
lacking some or all plumbing	2.4%	0.0%	2.8%
1.51 or more persons/room	36.5%	6.3%	5.7%
PERSONS PER HOUSEHOLD	4.65	3.04	2.97
MEDIAN CASH RENT (renter-occ'd)	$247	$50	$340
as % of median family income**	19.5%	4.4%	16.7%
MEDIAN VALUE* (owner-occ'd)	$83,800	N/A	$145,600
MEDIAN MONTHLY MORTGAGE* (owner-occ'd)**	$338	N/A	$515
as % of median family income	26.7%	N/A	25.3%

NOTES: * Median values are for non-condominium housing units.
** Figures based on 15 percent sample; hence, numbers represent estimates.
"CDP": Census Designated Place.
"N/A": Not Available.

SOURCES: U.S. Bureau of the Census, 1981a, 1981b.

Kahuku's history and social organization are particularly rooted in sugar. While the old Kahuku Sugar Plantation covered much of northern Koolauloa and employed residents of other towns, the mill and company headquarters were in Kahuku itself. Consequently, Kahuku is the site of many area services (e.g., police station, high school, hospital, etc.), despite a relatively small current population. Additionally, residents were accustomed to supporting decisions made first by the plantation management and, later, by union leaders.

When the plantation shut down in 1971, community leaders -- aided by the Campbell Estate and, initially, the ILWU -- fought to keep the community alive. They supported the new Kuilima hotel and a series of (not always successful) commercial ventures at the old mill, which area residents view as a prized symbol of the town's origin.

Perhaps most significantly, they formed a series of housing-related organizations to provide new and/or rehabilitated housing for original plantation camp residents. To a large extent, residents instrumental in forming and running these groups in the 1970's are still the community leaders in Kahuku today. This group has historically favored economic development in the area, so long as there are assurances that such development will actually benefit Kahuku residents.

However, Kahuku's tradition of community solidarity has recently begun to change. The City's 1982 housing project -- originally initiated by the Kahuku Housing Corp. -- turned out to provide homes for more newcomers than longtime residents, resulting in a substantial number of new residents who do not have any ties with "old" Kahuku. And there have been controversies in the past year over the need for longtime residents to move out of previous homes into new ones planned by the Kahuku Housing Corp. This has resulted in formation of a new community group which often challenges traditional Kahuku leaders.

According to the 1980 census, Filipinos formed the majority of the population in Kahuku. Caucasians and Japanese are also numerous in the population (see Table 5).

In 1980, nearly a quarter of the Kahuku population was over 65 years old. At that time, less than half the families in the town had dependent children and family incomes were well below both islandwide and district levels (see Table 6). (Newer residents include many younger adults.)

As a plantation town, Kahuku had almost no owner-occupied housing through 1980 (see Table 7). Rents were low, but the housing stock was old. The Kahuku Housing Corporation has developed plans and gained funding for new housing. Their project is proceeding, but has been involved in controversy.

By the end of 1988, infrastructure had been provided for the project's first three phases, where nine rehabilitated homes and 100 partially completed houses are located. In the project's next phase, homes on 170 to 190 lots are to be developed makai of Kamehameha Highway (personal communication, John Anderson, Project Director, Kahuku Housing Corporation, January 4, 1989).

Some Kahuku residents have expressed concern over the possibility that residents will be evicted from existing housing before their new homes are built, and over the general issue of local planning and control over the Housing Corporation's activities.

After the Kahuku Mill closed, a group of former sugar workers organized the Kahuku Farmers Association, a cooperative that has grown watermelons, papayas, corn and other produce.

Two other economic ventures in Kahuku involve developing technologies -- wind-generated electricity and aquaculture. Near the Punamano project site are several windmills, operated by Hawaiian Electric. On the makai side of Kamehameha Highway in the Kahuku Point area, shrimp are raised in ponds.

Kahuku Mill has become the site for a local shopping center. About 30,000 square feet of space has been developed and leased (Honolulu Advertiser, October 7, 1988, p. A-25).

2.2.1.4 The Kuilima Resort

The hotel at the Kuilima Resort opened in 1972. It was originally developed as a joint venture by Prudential Insurance and the Del E. Webb Corporation. Prudential bought out its partner in 1976, and found a professional hotel operator -- the Hyatt Corporation, and subsequently Hilton Hotels -- to run the hotel. Prudential's interest was acquired in 1988 by Asahi Jyuken, which continues to retain Hilton as operator of the hotel now known as the Turtle Bay Hilton. The Hilton currently offers 487 hotel and cabana units.

The facilities at Kuilima also include two low-rise condominium complexes, a golf course and clubhouse, a riding stable, and tennis courts.

Prudential developed plans for expansion in the late 1970's. The hotel's occupancy rates had been low at first, and it was thought that additional development was needed to make the area a viable resort destination.

The Kuilima Resort expansion plans call for an additional 3,500 visitor units (including both hotels and condominium units), a new golf course, a commercial area, beach parks and a wildlife preserve. Land use permits for the expansion have been acquired. The new owners of the Resort are implementing the plans. Work on the new infrastructure is to begin in 1989. The completion of the first additional hotel in the expanded resort is slated for 1991.

On the access road from the highway to the Turtle Bay Hilton are two low-rise condominium complexes -- the 200-unit "Kuilima Estates West" (completed in 1973) and the 168-unit "Kuilima Estates East" (completed in 1975), both of which consist of detached and townhouse-style wooden structures surrounded by the existing Turtle Bay golf course. Each has its own community association.

The mix of users and occupants in the condominiums varies over time. At present, property managers estimate that about 60 of the units are held by full-time owner-occupants, with the great majority being in the rental pool and/or held for part-time use by owners. Some rentals are to long-term residents -- primarily hotel mid-management personnel and professionals willing to commute to town. However, for full-time and many part-time occupants, golf represents a central aspect of shared lifestyle.

Bordering the Kuilima resort on the western side of Kawela Bay are approximately 26 units owned in fee simple (although many are now rented out).

2.2.1.5 Other Koolauloa Communities

Farther to the south in Koolauloa -- and not so proximate to the proposed new golf courses -- are Hauula, Punaluu, and Kaaawa.

Kaaawa, the most distant, was historically a Hawaiian agricultural area (Clark, 1977). Today, it contains few urban amenities or employment opportunities, and many residents commute to more urban Oahu areas. Beachfront homes in Kaaawa are generally larger and more elegant than homes across the highway.

Punaluu is another generally rural, lightly-populated area in which beachfront homes tend to be second residences for Honolulu people. However, some actual farming and aquaculture activities take place in the valley. There is one major oceanfront condominium complex, Pat's at Punaluu, and a few other scattered stores and restaurants.

Hauula is a Hawaiian Homesteads community with high poverty rates and reported shortages of affordable housing. With a 1980 population of 3,000 people, it is more of a village-style "community" than the more "country"-like Kaaawa and Punaluu areas. Hauula has a small shopping center and satellite City Hall. Its residents have historically been more interested in new employment opportunities.

2.2.2 The North Shore Region

The City and County's North Shore Development Plan area begins about two miles to the west of the Kuilima Resort area and extends southwest to Haleiwa/Waialua, where the coast runs due west to Kaena Point. Much of the area is a coastal strip. The plain becomes wider west of the Sunset Beach area, and extends inland near Haleiwa. Fields planted in sugar and, at higher elevations, pineapple extend on both sides of Kamehameha Highway as it rises towards Wahiawa.

The North Shore's population is more spread out than that of Koolauloa. Homes are found along the length of Kamehameha Highway, and, outside of Haleiwa/Waialua, retail centers consist of little more than a store or two. Haleiwa has become a center for surfers and visitors, and offers shopping for residents of the region as well as travellers. Waialua is the center of Waialua plantation, and is home to many of its employees. The plantation still operates, although its future is uncertain. Beyond Waialua is the beach area of Mokuleia, with scattered residences and second homes for Honolulu residents.

The Sunset Beach/Pupukea/Waimea area is considered part of the North Shore by the City and by many residents, but is counted in Koolauloa for census purposes. As a result, census data reported for the North Shore District cover the part of the region further from the proposed project. That data will be reviewed in Section 2.2.2.2.

The North Shore shares many characteristics of the Koolauloa lifestyle. However, its largest centralized communities (Haleiwa and Waialua) are about ten miles from the Kuilima Resort, and the North Shore areas nearest the Resort (Sunset Beach and environs) are more of a "country" character.

Additionally, the entire North Shore is heavily affected by an international surfing subculture (as well as other ocean sports such as windsurfing and diving). Each winter, hundreds and perhaps thousands of young people from around the nation and the world take temporary rentals in order to sample the North Shore's famed high surf. Consequently, there is a strong youth orientation -- and higher visibility of Mainlanders -- in this area than in much of Koolauloa.

2.2.2.1 Sunset Beach Area

The Sunset Beach residential area -- a strip of homes along and mostly below the Kamehameha Highway -- begins about a mile southeast of Kuilima Resort. It continues for approximately three miles. The southerly portion of this strip is also known as "Waimea," and the hills above Waimea contain the rural one-acre lots comprising the Pupukea Highlands.

Oceanfront homes in the Sunset/Waimea area are often large and comfortable, although few are true mansions or estates. Houses closer to the highway are more modest, generally set on 5,000-square-foot lots. Many become surfer rentals during the winter.

The area is heavily Caucasian and strongly ocean-oriented in lifestyle. Many community leaders are former young surfers (now somewhat older surfers) who chose to settle and work in the area. However, given the lack of nearby professional jobs, the more affluent are either retired or willing to commute long distances to Honolulu.

Thus, values and lifestyles in this semi-"country" area are often characterized by a self-sufficient, pioneer ethic. The Sunset Beach community has historically been reluctant to support new growth in the area.

Pupukea is a more "local" and truly rural community set in the hills, with a number of small nursery and truck farms. The adjacent Sunset Hills subdivision is more affluent, containing several large cliffside homes with spectacular ocean views. Both communities recently activated their own community associations; prior to this, residents were either uninvolved or participated in community events through the Sunset Beach Community Association.

The Sunset Beach/Pupukea/Waimea area population had a Caucasian majority in 1980 (see Table 5). Nearly half the residents were born in the U.S. outside Hawaii, and a quarter had lived in another state five years before the census was taken.

Family incomes were slightly higher than the islandwide average, and well above those reported in nearby communities (see Table 6). Although many housing units were rented, the proportion of owner-occupied units was higher than in Laie or Kahuku (as shown in Table 7). The median value of owner-occupied housing was higher than the City and County figure.

2.2.2.2 Other North Shore Communities

Farther from the proposed new golf courses are:

Kawailoa, is another beachfront and highway residential strip, located just south of Sunset/Waimea (but separated by Waimea Bay). It is similar in character, lifestyle, and values to the other surfing-oriented communities, although it has fewer large houses and a slightly more "local" population.

Haleiwa is the North Shore's commercial, retail, and arts/crafts center. The relatively small residential community, scattered in pockets in and around the town, is comprised of both established and transient residents. Residents are proud of the town's historic nature and lobbied for the Haleiwa Scenic District Design Ordinance to protect the area's character by requiring new buildings to match existing architectural design.

Waialua is Oahu's last functioning plantation town. The predominantly Filipino community thus leads a traditional Hawaii plantation lifestyle, in which the ILWU is a dominant political and social factor. Although the plantation's owners have said they will keep it operating for the near future, uncertainties about the future mark community attitudes.

Population growth in the North Shore District has been less rapid than in Koolauloa. The median age is slightly higher, according to 1980 census data, although both areas had younger populations in 1980 than the City and County as a whole (see Table 2).

The major ethnic groups in the North Shore District population in 1980 were Filipino and Caucasian. Persons of Japanese ancestry formed a sizeable group, but were a smaller part of the population than islandwide. The median family income in the district was below the islandwide and Koolauloa medians in 1980 (see Table 3).

2.3 LABOR FORCE AND EMPLOYMENT TRENDS

In 1980, the majority of the study area workforce was employed in service and white collar occupations (see Table 8). Agricultural workers and fishermen were somewhat more numerous than elsewhere on Oahu, but still formed only a small part of the labor force.

The 1980 census showed unemployment in both the Koolauloa and North Shore districts to be near the average of the City and County as a whole. As a result, current unemployment is estimated to be at about the same level as the island average -- near 3 percent. (Estimates of local unemployment are derived by the State Department of Labor and Industrial Relations from 1980 Census data and current statewide rates, on the assumption that the distribution of unemployment in different parts of the state has remained the same since 1980.)

A 1979 survey showed that 80 percent of employed Laie adult residents worked in the community (Robertson and Stanton, 1979). At that time, very few were employed by the Kuilima Resort. The Polynesian Cultural Center is the largest employer of Laie residents. (About half its employees, however, are Brigham Young University - Hawaii students.) Together, the University and the Polynesian Cultural Center provided jobs for about 70 percent of employed Laie residents in 1979.

TABLE 8: EMPLOYMENT CHARACTERISTICS -- CITY AND COUNTY OF HONOLULU AND STUDY AREA, 1970 AND 1980

	CITY AND COUNTY OF HONOLULU 1970	1980	KOOLAULOA DISTRICT 1970	1980	NORTH SHORE DISTRICT 1970	1980	STUDY AREA (Combined Districts) 1970	1980
POTENTIAL LABOR FORCE (AGED 25+)	427,601	574,903	6,797	9833	5,955	7,374	12,752	17,207
not in labor force	33.0%	30.8%	42.4%	36.4%	41.1%	36.2%	41.7%	36.3%
armed forces	11.5%	10.1%	2.9%	1.4%	8.3%	11.8%	5.4%	5.8%
civil. labor force	55.5%	59.1%	54.7%	62.2%	50.6%	52.0%	52.7%	57.8%
CIVILIAN LABOR FORCE	237,338	339,863	3,721	6,115	3,013	3,837	6,734	9,952
unemployed	3.0%	4.6%	2.8%	4.9%	6.7%	4.6%	4.5%	4.7%
TOTAL EMPLOYED CIVIL. LABOR FORCE	230,252	324,113	3,616	5,812	2,810	3,660	6,426	9,472
OCCUPATION								
service	15.0%	17.6%	17.1%	28.6%	14.3%	15.1%	15.8%	23.3%
manager,/profes.	N/C	24.7%	NC	22.2%	NC	18.1%	N/C	20.6%
technical, sales & adminis.	N/C	33.7%	NC	23.5%	NC	21.2%	N/C	22.6%
farm/fish/forest	N/C	1.8%	NC	5.8%	NC	10.4%	N/C	7.5%
precision, craft, repair	N/C	11.3%	NC	10.7%	NC	15.1%	N/C	12.4%
operators, fabricators, laborers	N/C	10.9%	NC	9.2%	NC	20.1%	N/C	13.4%
INDUSTRY (selected)								
agric., forest, fish, mining	2.1%	1.7%	N/A	5.1%	N/A	11.9%	N/A	7.7%
construction	9.5%	6.6%	13.1%	8.3%	8.0%	7.5%	10.8%	7.9%
manufacturing	10.3%	7.7%	9.0%	3.5%	19.3%	14.1%	13.5%	7.6%
retail trade	18.0%	20.5%	12.2%	11.9%	15.1%	17.1%	13.4%	13.9%
financial, insur., real estate	5.6%	8.1%	2.1%	4.9%	1.9%	3.8%	2.0%	4.4%
personal, entertain. & recreat. services	7.6%	8.1%	N/A	22.8%	N/A	5.7%	N/A	16.1%
health, educ., & professional	18.1%	18.5%	25.9%	25.4%	16.2%	15.0%	21.6%	21.3%
public adminis.	12.6%	10.9%	9.3%	8.7%	11.8%	11.9%	10.4%	10.0%
COMMUTE TO WORK								
45 minutes or more	N/A	11.9%	N/A	21.1%	N/A	27.2%	N/A	23.1%
mean travel (min.)	N/A	22.9	N/A	25.1	N/A	25.9	N/A	25.5

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: 1980 Summary Tapes Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

In Kahuku, nearly half the adult population was not in the labor force in 1980. Agricultural workers formed the largest single segment of the local labor force (see Table 9). Employment patterns of residents of Laie and the Sunset Beach area were closer to islandwide figures. Laie residents, however, tended to commute only short distances, while Sunset Beach area residents reported lengthy commutes to work.

2.4 LIFESTYLES AND VALUES

Lifestyles and values result in large part from an area's history, geography, economic base, and the ethnic heritage of its people.

The idea of "country" is one crucial concept for understanding lifestyles/values (and value conflicts) in Koolauloa and the North Shore. Equally important, however, is the concept of "community."

The combined study area is one of Oahu's two major regions (the other being Waianae) usually considered "country" by both the City and County and also by many residents. The region includes about 30 percent of Oahu's land area, but only about 3.3 percent of the estimated 1987 islandwide population.

However, of the area's combined 24,000 people in 1980, nearly two out of three lived in small towns with business or service centers and clearly demarcated neighborhoods -- i.e., Hauula, Laie, Kahuku, Haleiwa, and Waialua. By contrast to these "community" dwellers, only one-third lived in actual "country" settings or more strip-development neighborhoods such as Kaaawa, Punaluu, Sunset, Pupukea, Waimea, and Kawailoa.

As discussed below, the various communities differ from one another in many ways. However, "community" dwellers generally differ from the more rural "country" residents in that their homes are less isolated and there are more typical small-town pressures for cooperation and social cohesiveness. Additionally, many of the communities are or were once "company towns," resulting in some clear lines of social organization.

Ethnic factors also contribute to the country/community differences. According to the 1980 Census, the majority of Caucasians in the study area lived in "country" locales, while Filipinos tended to be concentrated in Kahuku and Waialua; people from South Pacific backgrounds in Laie; etc.

The country/community distinction is not absolute. Community residents value their country surroundings, and people living in the "country" areas report a sense of community, too.

TABLE 9: EMPLOYMENT CHARACTERISTICS -- SELECTED STUDY AREA SITES, 1980

	LAIE CDP	KAHUKU CDP	SUNSET BEACH/ PUPUKEA/WAIMEA AREA (Portion C.T. 101, Block Group 2)
POTENTIAL LABOR FORCE (Aged 16+)	2,512	659	2,484
not in labor force	18.8%	43.6%	30.7%
armed forces	0.8%	0.0%	3.0%
civil. labor force	80.4%	56.4%	66.3%
CIVILIAN LABOR FORCE	2,019	372	1,647
unemployed	3.7%	1.3%	8.4%
TOTAL EMPLOYED, CIVILIAN LABOR FORCE	1,945	367	1,509
OCCUPATION:			
service	32.5%	14.4%	32.2%
manage./profes.	24.9%	17.7%	21.5%
technical, sales & adminis.	27.0%	21.8%	19.9%
farm/fish/forest	2.2%	25.9%	5.8%
precision/craft/ repair	6.4%	2.7%	13.1%
operators/fabri- cators/laborers	6.9%	17.4%	7.4%
INDUSTRY (selected):			
agric., forest, fish, mining	1.4%	26.2%	5.7%
construction	1.4%	2.2%	12.8%
manufacturing	1.3%	5.2%	4.6%
retail trade	5.8%	6.5%	15.4%
financial, insur., real estate	2.0%	8.7%	8.2%
personal, entertain. & recreat. services	35.4%	18.3%	19.6%
health, educ., & professional	44.6%	11.2%	13.9%
public admin.	4.3%	15.0%	11.1%
COMMUTE TO WORK			
45 minutes or more	9.0%	6.0%	37.9%
mean travel (mins.)	12.6	15.0	34.0

NOTES: All figures based on 15 percent sample; hence, numbers represent estimates.
"N/A": Not Available.
"CDP": Census Designated Place.

SOURCES: U.S. Bureau of the Census, 1981a, 1981b.

However, the familiar phrase "Keep the Country Country!" may have somewhat different connotations to people in different areas. Communities in the study area were founded on various economic activities; there is a history of third- and fourth-generation families seeking preservation of their particular community as a home for the next generation. The more rural "country" areas, by contrast, have a higher proportion of first-generation residents attracted by recreational opportunities and/or the absence of nearby large-scale economic activity.

Thus, large-scale economic activity and centralized employment centers are (to a point) historically compatible with the lifestyles and values of "community" dwellers, but less so for the "country" residents of Koolauloa and the North Shore.

2.5 COMMUNITY ISSUES AND CONCERNS INDEPENDENT OF THE PROJECT

This section identifies major concerns voiced by members of the community. These issues and concerns form part of the social context of development, and hence may be relevant to the project. The focus is on general issues in this section -- the particular concerns and issues that are clearly linked with the project in the judgement of members of the community will be discussed in Section 4.6.

Sources for this section include interviews conducted by Community Resources, Inc. in early 1989, minutes of the Koolauloa and North Shore Neighborhood Boards, and minutes of community advisory groups for other developments -- the Kuilima Resort and the proposed Lihi-lani recreational community -- in the study area.

2.5.1 Issues Emerging from Community Interviews

As described in more detail in Section 4.6, some 60 prominent Koolauloa and North Shore community leaders, business people, and farmers were interviewed for this report. The principal focus was on issues and concerns related to the proposed golf course. However, many of them also volunteered insights into background (i.e., more general) community concerns.

The following rough prioritization reflects the comments of those interviewed (listed in Section 4.6), and may or may not be reflective of the general public in the area. It focuses on concerns of a regional nature rather than individual community issues.

Primary (Most Frequently Mentioned) Issues

(1) **Population/Economic Growth** is the general issue providing a framework for many other concerns. There is a general

desire to "Keep the Country Country" -- although, as discussed in Section 2.4, different groups interpret this in different ways (including acceptance of some types of growth which would preserve or benefit country "communities").

The overall growth issue will be more thoroughly discussed in Section 4.6, since it also provides a framework for assessing issues and concerns regarding the proposed Country Courses at Kuilima.

(2) **Need for Affordable Housing** was nominated by many (particularly in Koolauloa) as the "Number One Issue." There were frequent reports of crowding in existing homes as grown children unwillingly remained with parents, or as several young families shared units. Reportedly, there are also many illegal additions or partitions of existing homes.

The term "affordable housing" is coming to have new meaning in the area, as more people have at least temporarily given up the idea of being able to afford to buy. Now, according to community leaders, there is increasing demand for <u>rentals</u> affordable to people living in the area.

(3) **Groundwater Protection** is a major issue relating to two somewhat different underlying concerns. The first of these is a general environmental sensitivity (especially on the North Shore), related to fears of pollution and high awareness of periodic shortages of drinking water. The second has to do with widespread awareness of plans to pipe Windward water to support urban growth in Central Oahu and Ewa. There are fears that this will affect Koolauloa farmers and, indirectly, the rural character of the area.

(4) **Traffic Congestion** represented a near-universal complaint, but one for which few concrete corrective measures (other than the Haleiwa by-pass) were usually proposed. Rather, it was a reason to be apprehensive of future developments. Some North Shore residents said they preferred the current congestion to making Kamehameha Highway a four-lane road, since this might lead to further urbanization.

<u>Secondary Issues</u>

(5) **Lack of Nearby Jobs** continues to be a concern, particularly for lower-income people, despite the current labor shortage. Many people are commuting to Honolulu or other job centers, and they would prefer employment closer to home. (Others, of course, feel they have made a commitment to commuting as the necessary price to pay for "Keeping the Country Country.")

(6) **Improvements to the Educational System** are desired by many residents in both Koolauloa and the North Shore. The Sunset

Beach Elementary School lacks many permanent buildings and facilities. And there is concern that area high schools are not adequately preparing vocationally-oriented young people with adequate work habits and skills.

(7) **Need for More Youth-Oriented Recreation Activities** was a particularly prominent theme in Koolauloa, where there is a sense that teen-agers get into trouble because of a lack of places to go and things to do. And some North Shore parents also worry about lack of recreational attractions other than the beach parks, where there is dangerously high surf in the winter.

(8) **Foreign Investment and Land Values/Taxes:** The people interviewed generally felt there was a low-level but pervasive anxiety resulting from news media coverage of the islandwide issue. Few made any strong connection with the Japan-based new Kuilima owners. The greatest sensitivity to this issue seemed to be in the Sunset/Pupukea area.

<u>Occasionally Mentioned Other Issues</u>

(9) **Need for Community Amenities:** Particularly in Kahuku and Laie, some residents reported widespread for more retail/ commercial development (stores and restaurants), as well as light industrial service areas.

(10) **Beach Erosion:** While protection of the ocean is a critical North Shore concern (mentioned above in connection with water protection), Koolauloa residents are also becoming aware of the more specific issue of beach erosion, which is beginning to reach Kamehameha Highway itself in some places.

(11) **Child Care** is beginning to emerge as a concern, particularly among lower-income working families.

(12) **Sense of Alienation and Powerlessness** was a theme underlying many comments, although it was explicitly mentioned by a relatively few. It usually emerged in conjunction with growth/development issues. Ironically, the feeling that politicians and large landowners "don't listen to us" seemed equally strong among both pro- and anti-growth forces.

2.5.2 Issues Emerging from Minutes of Neighborhood Board Meetings

The minutes for 1987 and 1988 of the two Neighborhood Boards in the study area were analyzed to learn of major <u>topics</u> of concern and characteristic responses to them by the Boards and their members.

A total of thirteen persons served on the Koolauloa Board in 1987, and 11 in 1988. The North Shore Board had 18 members at one time or another in 1987, and 15 in 1988.

Topics of major concern to members of both Neighborhood Boards were:

(1) **Recreational Resources:** Both boards expressed interest in additional beach parks, and supported the development of camping areas. Beach access was of concern to both, but especially to the Koolauloa Board. The State's management plan for thrill craft raised questions for both boards as to whether restrictions on such craft would be enforced.

(2) **Development Proposals:** Both Boards reviewed carefully proposals for development of properties in their regions. The Boards largely sought to minimize population growth in their regions and to avoid changes in lifestyle. Members of the Koolauloa Neighborhood Board expressed concern that new developments:

- Provide economic opportunities for nearby communities and take into consideration the needs of nearby communities as plans are finalized;

- Do not have negative impacts on agriculture (e.g., lead to increases in agricultural rents); and

- Not add to traffic problems.

The North Shore Neighborhood Board devoted considerable attention to the implementation of the Haleiwa Historical, Cultural and Scenic Special Design District. Signs were discussed repeatedly. This concern is not just aesthetic -- the Board's members expressed support for the preservation of rural character in the town and elsewhere.

In response to presentations about proposed recreational developments, the Board expressed concern over public trail access, traffic, water and sewage problems, aesthetics and view planes, and possible noise impacts on neighboring areas.

(3) **Traffic:** Both Boards see traffic congestion as serious in the region. The Koolauloa Neighborhood Board supports road widening in Kaneohe, where commuter traffic backs up, but not along Kamehameha Highway further north. The North Shore Neighborhood Board supports highway widening and the Haleiwa Bypass, while it opposes a proposed road around Kaena Point.

Vehicles carrying tourists slow down traffic in both areas, according to Board members. Souvenir stands and the like were criticized as leading to congestion.

(4) **Housing:** This was of concern to the Koolauloa Board, especially in response to debates in Kahuku over the development of new housing by the Kahuku Housing Corporation. Board members expressed concern with inadequate utilities in other areas, which limit new construction. The possibility that government agencies might build despite limited utilities, when individuals cannot, was greeted with disapproval.

2.5.3 <u>Issues Discussed in Community Advisory Group Meetings</u>

2.5.3.1 The Kuilima North Shore Strategy & Planning Committee

The Kuilima North Shore Strategy & Planning Committee (K/NSSPC) since 1983 has served as an open forum for communication between the Kuilima Resort Co. and area residents. Monthly or bi-monthly meetings at the Turtle Bay Hilton have generally been attended by 50 to 100 business and community organization representatives. (In early 1989, the K/NSSPC formally voted in a Board of Directors to take official actions on behalf of the larger group. Prior to that time, all business was conducted by the unrestricted open forums and some ad hoc subcommittees.)

K/NSSPC minutes for calendar year 1988 were reviewed, and the following key issues identified:

(1) **Job Training for Area Residents** has been a major focus of the organization since its creation. Kuilima Resort has proposed the concept (formalized in City zoning conditions) of a nonprofit corporation to utilize training funds donated by the developer and any other sources. Much of the K/NSSPC's energies in the past year have gone to finalizing the proposed corporation and determining the community role in its operations.

(2) **Establishing Linkages with the New Owner:** Early 1988 meetings were marked by uncertainties over the identity and intentions of the new owner. New Asahi Jyuken personnel first met with the group in August 1988.

In September, the K/NSSPC and local Kuilima Resort Company representatives held a discussion of the new owners' role in Hawaii. Residents at the meeting accepted the Asahi Jyuken president's assurances of honorable intentions in Hawaii. Subsequent meetings focused on the new owners' proposed changes to the Kuilima master plan for development.

(3) **Other Issues** have included <u>community festivals</u> (the annual July 4 celebration sponsored by the group), Kuilima's <u>housing commitment</u> to build and sell 200 affordable homes in

the area, and golf fees at the existing Turtle Bay course. In December 1988, some original members of the Turtle Bay golf club, primarily part-time condominium residents, asked the K/NSSPC's support in regaining very low fees suspended by Asahi. The K/NSSPC declined, saying it wanted to work out uniform rates which would apply to all areas residents.

2.5.3.2 The Lihi-Lani Community Advisory Group

The developers and planners of the proposed Lihi-lani recreational community at Pupukea began holding informational meetings concerning the project early in 1988. They sought input from the community through informal gatherings throughout the study area and public meetings at Sunset Beach Elementary School. The planners have made presentations at regular meetings, and have sought input on questions of design, relations between the proposed development and its neighbors, and access to facilities at the project. A 25-page list of "Community Issues and Concerns" identifies questions raised by the community. Some of the major concerns implied by those questions were:

(1) **Minimizing Impacts on Neighbors:** Community members discussed water and sewage plans in terms of strong feelings that the area near Sunset Beach Elementary School and Sunset Beach's famed surfing areas be affected as little as possible. Minimal change in view planes was also wanted. A proposed helipad was deleted from the project in consideration of potential noise impacts.

(2) **Controlling Community Change:** Some residents have viewed the Lihi-lani development as causing increases in property values nearby, making the area less affordable to current residents and leading to a change in community character. Some concern was expressed that the project would be a Japanese enclave, as the property's owner is a Japanese corporation. A committee of residents is exploring ways the development can benefit the adjacent Sunset Beach Elementary School.

(3) **Recreational Resources:** Community members have joined in committees to explore ways to make the development's facilities available to the community. While many in the Sunset Beach area do not identify themselves as golfers, some participants in the meetings are golfers, while others have expressed interest in the hiking, riding, and tennis facilities proposed for Lihi-lani.

(4) **Traffic** is a strongly felt concern; residents voiced a need to minimize increases in traffic along Kamehameha Highway.

3.0 FORCES FOR CHANGE WITHOUT THE PROJECT

Specific project impacts are discussed in Section 4. This section provides information on relevant development proposals and government policies which could lead to important changes in the study area, independent of the proposed Country Courses at Kuilima.

The following forces for change are addressed:

- Recreational development in the study area;
- Economic change, including both already-approved Kuilima Resort expansion and potential changes elsewhere in Koolauloa and the North Shore;
- Population and housing growth; and
- Infrastructure changes.

Current government land use policies for the study area indicate relatively slow growth, except for the Kuilima expansion. There is some possibility of a worsening situation in regard to affordable housing, depending on whether existing residential-zoned "capacity" is actually economically feasible to develop.

3.1 RECREATION FACILITIES

3.1.1 Shoreline Recreation Facilities

The study area includes world-renowned sites for surfing along the North Shore. Surfing competitions and the surf industry have been growing in recent years. Surf meets generate an estimated 4.2 million dollars of income for the State (Miller, 1984; Mangiboyat, 1987).

Parks are found at beaches throughout the study area. Additionally, improvements in park facilities have recently been completed at Ehukai Beach Park. Land for Laie Point Park is being acquired (personal communication, Steve Salis, Advance Planning Branch Chief, Honolulu City Department of Parks and Recreation, January 18, 1989.)

Plans for the State's Malaekahana Beach Park call for further development, which is not yet funded (personal communication, Dan Quinn, Park Program Manager, Division of State Parks, Hawaii State Department of Land and Natural Resources, January 18, 1989.)

As part of the Kuilima expansion, two beach parks (and five other public access ways to the shore) are planned along the shoreline from Kawela Bay to Kahuku Point.

3.1.2 Inland Recreation Facilities

New inland recreation facilities in the study area are varied. They include areas for walking and more active sports.

The City has completed Phase I of the Kahuku Community Park, including playing fields and a comfort station. Expansion of the municipal golf course at Kahuku from 9 to 18 holes is being studied (personal communication, Steve Salis, January 18, 1989). The State plans to open a "living park" in Kahana valley eventually.

A proposed private development located in the Pupukea Highlands, Lihi-lani, would provide new golf, tennis, and riding facilities. A system of trails open to the public is also proposed.

Golf Courses. Substantial news media attention has recently been given the spurt of proposals for new golf courses. The impetus for these proposals is generally believed to include increasing demand from both residents and visitors -- but particularly Japanese visitors, who are accustomed to paying high fees. In part due to the favorable exchange rate, Hawaii greens fees may seem inexpensive to many Japanese visitors.

Newspaper accounts suggest that some 30 new golf courses are being proposed, including ten on the North Shore (Honolulu Advertiser, October 25, 1988, Merlet, 1988). Table 10 provides more information concerning existing and proposed golf courses.

Islandwide, there are 28 existing private, municipal, daily-fee, and military courses (Hawaii Department of Business and Economic Development, 1987). Another 10 are planned, with approvals in place. An additional 12 have active pending applications, for a total "planned or proposed" of 22. Three courses have been denied permits (and have not sought new permits with revised plans), and 5 are in the idea stage only, with no formal applications (personal communication, Calvin Ching, Chief of Zoning Branch, City and County of Honolulu Department of Land Utilization, January 9, 1989).

Study Area Golf Courses. In the Koolauloa/North Shore area, there are two existing courses; one planned with approvals; and six (including the four Country Courses at Kuilima) being actively proposed. Two others were recently denied (or had applications withdrawn), and one has yet to be formally submitted.

TABLE 10: EXISTING AND PROPOSED GOLF COURSES ON OAHU

	Number of Courses	Number of Holes	Comments
Koolauloa			
Existing:			
Kahuku	1	9	Municipal
Kuilima	1	18	Resort, daily fee
Proposed:			
Kuilima II	1	18	Approved, construction to begin 1989
Malaekahana	1	18	Proposed as part of project
Punamano	3	54	Proposed as part of project
Malaekahana	1	18	makai of project site; mentioned as possible by landowner representatives
North Shore			
Existing:	0	0	
Proposed:			
Lihi-lani	2	36	1 private, 1 daily fee (permit application withdrawn)
Waialua	1	18	permit denied
Mokuleia	1	18	permit denied
Rest of Oahu			
Existing:			
Municipal	3	54	
Daily Fee/ Resort	10	171	
Private	4	72	Not open to general public
Military	9	135	Not open to general public
Proposed:			
No further approvals needed	9	108	(2 courses not open to public)
Applications pending	6	108	(1 course not open to public)
Applications denied	1	18	
No applications made yet	4	81	
TOTAL -- ALL OAHU			
Existing	28	252	(13 courses not open to public)
Approved	10	126	(2 courses not open to public)
Applications pending	12	198	(2 courses not open to public)
Applications denied	3	54	
No applications made yet	5	99	

SOURCES: Hawaii Department of Business and Economic Development, 1987; personal communication, Calvin Ching, Chief of Zoning Branch, Honolulu City Department of Land Utilization, January 9, 1989.

Existing study area golf courses are limited to:

- o The 9-hole Kahuku Municipal Golf Course, located on Campbell Estate land leased to the City and County of Honolulu; and
- o The existing 18-hole Turtle Bay course at the Kuilima Resort, managed by Arnold Palmer.

The only planned and approved course is:

- o The second Arnold Palmer golf course at Kuilima, which will be of championship level.

In addition to the Country Courses, the only other currently proposed study area golf course project is:

- o Ohbayashi Hawaii's proposed two "Lihi-lani" courses at Pupukea. One of the proposed two courses would be fully public, while the other would eventually be part of a private club, with tee times available to the public on a limited basis. (Ohbayashi Hawaii has withdrawn its application for a Land Use Boundary Change, but is actively planning this potential development.)

The Campbell Estate -- original landowner for the property proposed to be developed as the four Country Courses -- has indicated interest in developing a fifth golf course. This would also be in the Malaekahana area, immediately below the course now being proposed for that area by Asahi Jyuken Hawaii (which is buying the land for the one course from Campbell). There have been conceptual discussions among representatives of Campbell Estate, the City, and nearby residents about Campbell's developing this second possible Malakahana course as an 18-hole municipal golf course, in exchange for the City's returning the Kahuku municipal course property to Campbell Estate. The proposed exchange has been controversial -- with both strong support and opposition among various area golfers -- and there is no formal application for the site as of this writing.

Additionally, courses have been proposed at Mokuleia and Waialua, at the far end of the North Shore area. Both have been denied permits, and have not as yet submitted revised applications.

Golf Courses and Agricultural Land. One concern expressed by citizens is that new golf courses may occupy much agricultural land and affect the viability of agriculture on Oahu (Yamaguchi, 1988; Merlet, 1988). Table 11 indicates the relationship between land designated as Agricultural in 1986 and existing and proposed

TABLE 11: EXISTING, APPROVED, AND PENDING GOLF COURSES BY DEVELOPMENT PLAN AREA

A. ALL COURSES (INCLUDING PRIVATE AND MILITARY)

D.P. Area	Existing Courses	Approved Courses	Pending Courses	TOTAL	Agri-cultural land (ac.)	Ratio of Ag. Land to Courses
Islandwide Total:	28	10	12	50	114,553	2,291
Primary Urban Center	10	0	0	10	636	64
Ewa	1	5	3	9	16,569	1,841
Central Oahu	4	1	1	6	23,277	3,880
E. Honolulu	3	0	0	3	113	38
Koolaupoko	6	3	1	10	8,098	810
Koolauloa	2	1	4	7	13,808	1,973
North Shore	0	0	2	2	42,393	21,197
Waianae	2	0	1	3	9,657	3,219
STUDY AREA (2 DP Areas)	2	1	6	9	56,201	6,245

B. COURSES OPEN TO THE PUBLIC (EXCLUDING PRIVATE AND MILITARY)

D.P. Area	Existing Courses	Approved Courses	Pending Courses	TOTAL	Agri-cultural land (ac.)	Ratio of Ag. Land to Courses
Islandwide Total:	15	8	10	33	114,553	3,471
Primary Urban Center	3	0	0	3	636	212
Ewa	0	5	3	8	16,569	2,071
Central Oahu	3	1	0	4	23,277	5,819
E. Honolulu	2	0	0	2	113	57
Koolaupoko	3	1	1	5	8,098	1,620
Koolauloa	2	1	4	7	13,808	1,973
North Shore	0	0	1	1	42,393	42,393
Waianae	2	0	1	3	9,657	3,219
STUDY AREA (2 DP Areas)	2	1	5	8	56,201	7,025

NOTES: Agricultural land based on 1986 designations.

SOURCES: Honolulu Department of General Planning (1988) and sources cited in Table 10.

golf courses on Oahu -- including courses neither on nor planned to go on agricultural land. Part A includes all courses; Part B excludes private and military courses, in order to focus on the impact of courses for public play.

Islandwide, over 2,000 acres of land are designated as Agricultural for every existing, approved, or actively proposed course, and nearly 3,500 acres exist per course open to the public (as shown in Table 11 A and B, respectively).

About half the island's agricultural land is in the study area, and the ratio of agricultural land per golf course in the study area is more than twice the islandwide figure. The amount of land actually or potentially used for golf courses is a smaller fraction of agricultural acreage in the study area than in the other Development Plan areas. The issue of agricultural viability is analyzed elsewhere (Decision Analysts Hawaii, Inc., 1989), while the impact of the proposed project on adjacent agricultural lands is examined in Section 4.4.

3.2 ECONOMIC CHANGE

3.2.1 Kuilima Resort Expansion

By far the greatest potential change agent for study area employment and business activity involves planned expansion of the Kuilima Resort. (Under consideration here are already approved new activities at Kuilima, rather than proposed new activities such as the Country Golf Courses.)

Kuilima has Development Plan and zoning approvals for:

- An eventual total of 4,000 "visitor units" (hotel and condominium units combined -- including the existing Turtle Bay hotel units but excluding the existing 368 condominium units);
- A second, championship-level 18-hole golf course below Kamehameha Highway, with a second clubhouse (as well as some realignment of the one existing golf course);
- An 8.5-acre shopping village complex;
- New tennis club, beach club, and equestrian facilities;
- Various recreational amenities for the general public, including conversion of Punahoolapa Marsh to a wildlife preserve with an overlooking park; two public beach parks; and a shoreline trail along the 100-foot setback.

The original project concept advanced by former owner Prudential Insurance would have divided the 4,000 visitor units into 2,000 hotel rooms and 2,000 condominium units. According to the EIS socio-economic projections for that project (Community Resources, Inc., and A. Lono Lyman, 1984), expansion under that scenario would have resulted in an eventual 2,700 new on-site jobs, plus 950 off-site positions elsewhere in the Koolauloa/ North Shore region, over a 20-year period.

The Kuilima Resort Company now plans a greater emphasis on hotel units -- 3,000 hotel rooms (including the 487-unit Turtle Bay Hilton) and 1,000 condominium units. In unpublished estimates given to the Kuilima/North Shore Strategy and Planning Committee in 1988, Community Resources, Inc., has projected that this will result in increased ultimate employment: about 3,375 full-time-equivalent on-site jobs, plus 1,075 jobs elsewhere in the region. (This total of 4,450 permanent jobs would also develop over several decades; in the meantime, construction could provide hundreds of short-term jobs.)

3.2.2 Changes in Agricultural Employment Patterns

Castle & Cooke's Waialua Sugar Company currently employs some 460 workers, including 65 salaried personnel. At one point, Castle & Cooke's new owners announced the plantation would be shut down, but then agreed to keep it operating at least for several years. Despite temporary lay-offs over the 1988 - 89 holiday period, the current manager foresees no immediate likelihood of a permanent shutdown (personal communication, George Fraser, January 16, 1989).

However, the survival of sugar throughout Hawaii has been in general doubt for some time, since it is dependent on Congressional renewal of price supports. If the Waialua plantation were to close, an unknown portion of the current workforce (along with some of the present acreage in sugar) might be shifted to pineapple cultivation.

In Koolauloa, there has been a slow and sometimes unsteady expansion of employment in truck farming and aquaculture. The State Agriculture Department is currently opening 24 new parcels in its agricultural park outside Kahuku, and a 1,000-acre aquaculture park has also been proposed for that area (Honolulu Department of General Planning, 1988, p. 113).

3.2.3 Other Potential Job-Generating Activities

The Campbell Estate is proposing a new 15-acre light industrial park for Kahuku. If approved -- and in conjunction with likely new housing development there (see following section) -- this would suggest that Kahuku will begin to move back toward its former position as an economic center for Koolauloa.

In Laie, Zions Securities Corporation's current Master Plan calls for future expansions of the Brigham Young University - Hawaii campus and the Polynesian Cultural Center, eventually creating up to 500 new jobs. However, City zoning and Development Plans would have to be amended to permit implementation of this Master Plan -- which, at any rate, is currently undergoing review and possible revision by both Zions and the Laie community.

On the North Shore, similar master plan revisions or development are under scrutiny for Waialua (by Castle & Cooke) and Haleiwa (by Bishop Estate). There have been no indications that these will lead to any major individual new job centers, although proposed commercial expansion in Haleiwa is likely (personal communication, Glenn Kimura, planner at Helber Hastert Kimura, January 16, 1989).

A proposed new major resort at Mokuleia was recently withdrawn "but may be proposed again in 1989" (Honolulu Department of General Planning, 1988, vol. I, p. 123). The proposal, which generated considerable community controversy, involved development of 3,300 visitor units and several golf courses on 1,000 acres of agricultural land. If approved, the project's economic impacts would rival those of Kuilima; however, the Mokuleia resort proposal is not currently active.

3.3 POPULATION AND HOUSING

3.3.1 Land Use Policy Implications

Current government figures and policies leave considerable uncertainty as to whether or not there will be much new residential development in the study area over the next 20 years.

Residential housing development and related population growth are controlled by zoning, which must conform to Oahu's General Plan and Development Plans for each of Oahu's eight Development Plan (DP) Areas. Koolauloa and the North Shore comprise two of these DP Areas.

The City and County's General Plan requires City planners to (1) adapt the State's official population forecast for a date approximately 20 years in the future; (2) allocate this future population among the DP Areas by percentage distributions, to be set forth in the General Plan itself; and (3) restrict Development Plan and zoning so that the estimated population capacity of zoned lands does not exceed the maximum allowable future population for each DP Area. (The percentage distributions are expressed in ranges of 95 - 105 percent of the target, so that the maximum allowable populations for the eight DP Areas would sum to 105 percent of estimated future Oahu population.)

On January 19, 1989, the Honolulu City Council amended the General Plan to:

- o Adapt the most recent State population forecast for Oahu (999,500 people in the year 2010);
- o Adjust the previous percentage distributions for the eight DP Areas. The maximum allowable North Shore percentage remained at 1.8 percent, while the maximum Koolauloa percentage was reduced from 1.5 to 1.4 percent.

Table 12 summarizes existing and allowable future population growth under the new General Plan figures. It indicates that Koolauloa contains vacant or under-utilized land already zoned for various types of residential uses which could accommodate another 2,300 people. This would slightly exceed the maximum allowable population target for the year 2010; therefore, <u>no additional Koolauloa rezonings will theoretically be granted by the City in the near future</u>.

In the North Shore DP Area, existing land use designations will accommodate an estimated additional 3,000 people, which is still 1,600 people below the year 2010 target figure. Thus, some additional residential rezoning might be granted on the North Shore.

According to the Honolulu Department of General Planning (1988), currently-zoned but vacant or under-utilized land would allow development of the following number of housing units in these locations:

<u>Area</u>	<u>Number of Housing Units</u>
TOTAL KOOLAULOA	983 (plus any residential condominiums from future Kuilima development)
Kahuku	255
Laie	156
Hauula	381
Punaluu	123
Kaaawa	61
Other	7

(Continued on page 41)

TABLE 12: NEW GENERAL PLAN POPULATION GUIDELINES FOR STUDY AREA AND OTHER PARTS OF OAHU

Projected Year 2010 Oahu Population: 999,500

Allocations by Development Plan Area (95% to 105% Range)

	PERCENTAGES (1)		POPULATION NUMBERS	
OAHU TOTAL	95.0%	105.0%	95.0%	105.0%
Primary Urban Center	45.1%	- 49.8%	450,775	- 497,751
Ewa	12.0%	- 13.3%	119,940	- 132,934
Central Oahu	14.9%	- 16.5%	148,926	- 164,918
East Honolulu	5.3%	- 5.8%	52,974	- 57,971
Koolaupoko	11.0%	- 12.2%	109,945	- 121,939
Waianae	3.8%	- 4.2%	37,981	- 41,979
KOOLAULOA	1.3%	- 1.4%	12,994	- 13,993
NORTH SHORE	1.6%	- 1.8%	15,992	- 17,991
STUDY AREA SUBTOTAL	2.9%	- 3.2%	28,986	- 31,984

Existing and Remaining Allowable Population in Koolauloa and North Shore

	Maximum Pop.	Existing Pop.(2)	Capacity of Zoned Lands(2)	Allowable Pop. from New Zoning
KOOLAULOA	14,000	12,000	2,300	0
NORTH SHORE	18,000	13,400	3,000	1,600

NOTES:

(1) Percentages are from Honolulu City Council Resolution 88-404, as amended by Council, and adopted on January 19, 1989.

(2) Source: Department of General Planning, City and County of Honolulu. Communication to Honolulu City Council covering "explanatory information on the General Plan amendment currently before the City Council." December 23, 1988. Table IV.

Area	Number of Housing Units
TOTAL NORTH SHORE	1,419
Waialua/Mokuleia	471
Haleiwa	161
Pupukea	408
Kawailoa	39
Helemano Military Area	340

However, there are several reasons to be uncertain whether or how rapidly the above potential new housing units (or the theoretical additional North Shore units which would absorb the allowable extra 1,600 people) will actually be built:

(1) As will be discussed at more length in Sections 2.5 and 4.6, there are indications of a considerable housing shortage and high demand in both Koolauloa and the North Shore today. Yet this has resulted in very little new housing development (at least with recorded building permits) in the past several years. The lack of recent housing development raises doubts as to the likelihood of much future housing construction on these lands.

Despite zoning availability, many of the undeveloped Koolauloa/North Shore residential lands apparently have limited potential for housing development. Reasons for this -- based on interviews with the Department of General Planning's area planner (personal communication, William Medeiros, January 17, 1989) and with representatives of large landowners in the area (Marvin Stone, Zions Securities Corp.; Wallace Miyahira, Oceanic Properties; Mark Hastert and Glenn Kimura of Helbert Hastert Kimura, week of January 10 - 16, 1989) -- may include:

- Many zoned lands are remnant pieces or too small to develop economically. There are few parcels much over ten acres, and several of these are being held for other uses -- e.g., a park in Laie.
- Low-lying lands vulnerable to flooding, marshlands, and areas with a high water table are difficult to develop. This is particularly true for Hauula.
- Some vacant lots interspersed with developed areas (e.g., in Pupukea or certain beachfront areas) may be held by absentee Mainland owners, who are likely to build retirement homes for themselves rather than for the local market (if they ever build at all).

- o The State Department of Health recently ruled that sewage must be treated before being deposited into cesspool. This regulation (to go into effect in 1990) could greatly increase housing development cost in rural areas.

(2) If preliminary 1990 Census figures indicate the study area population is greater than currently estimated by the City, theoretical availability of new zoning for an extra 1,600 people on the North Shore might be eliminated.

It may be noted that the Department of General Planning's estimated "Existing Population" (25,400 for the combined areas) in Table 12 is considerably lower than the State's estimate reported in Section 2.2 (27,600 for mid-1987, which suggests a possible January 1989 population of around 28,400). The reason for the difference is that State estimates are based on indicators such as telephone hook-ups and school enrollments, while the City's method relies on building permits for new units. Thus, if there are many illegal new units, or if there is increased crowding in existing units (as suggested by community interviews reported in Section 4.6), the City method may underestimate current population.

If, for example, the 1990 population in the North Shore DP Area turns out to be 15,000 -- and if the City still assumes that its already-zoned but vacant/under-utilized land could accommodate 3,000 people -- this would bring the North Shore's land to the 18,000 maximum population figure. That would suggest no further rezonings. (However, it should also be noted that many population-based City policies may have to be reworked after the 1990 Census.)

3.3.2 <u>Imminent New Residential Development</u>

Actual new development which is apparently imminent is limited to:

- o The Kahuku Housing Corporation's Phase IV (170 to 190 new units) to be built this year, after the 109 units in Phases I to III are completed; and
- o Construction by Kuilima Resort of 200 affordable units (as required by the City's zoning conditions), also probably located in Kahuku in the early 1990's. However, a number of specific details have yet to be worked out for this project.

At present, several large landowners in the study area are developing new (or reviewing old) master plans. Castle and Cooke has been continuously assessing lands in the Haleiwa area. Bishop Estate has been working with a community advisory group to develop a new master plan for lands in and around Haleiwa, although the thrust of discussions to date has focused more on commercial than on residential development. In Laie, Zions Securities Corp. is reviewing suggestions from the Laie Community Association.

However, none of these planning efforts appears to be on the verge of actual new residential development.

3.4 INFRASTRUCTURAL CHANGES

The largest proposed infrastructural change affecting the study area would be the Haleiwa Bypass Road. This will carry circle-island traffic around the more congested parts of Haleiwa. Funds have been budgeted for planning and engineering. Construction is to start in 1989. Completion is scheduled for late 1991 (personal communication, Herb Towill, Project Manager, Construction Contracts Administration Staff, Highway Design Division, State Department of Transportation, January 18, 1989).

The State Department of Transportation is also realigning Kamehameha Highway at Waimea Bay. (That site is closer to the project that the Haleiwa Bypass, but it still is about 5 miles from Kuilima.)

New wastewater treatment plants are scheduled to be built in the next few years at Haleiwa and Waialua (Honolulu Department of General Planning, 1988). Eventually, such plants are to be built for the Pupukea-Sunset Beach area, the Hauula-Punaluu area, and Kaaawa. A private wastewater plant is planned for the Kuilima Resort adjacent to the proposed Punamano golf courses.

The Board of Water Supply has filed Final Environmental Impact Statements for projects aimed at developing new sources of potable water in Windward Oahu. (VTN Pacific, 1988; Wilson Okamoto & Associates, 1988). Most of the proposed new wells are in Koolaupoko and the part of Koolauloa furthest from the proposed golf courses.

The Board of Water Supply lists wells at Malaekahana, and at Hanakaoe and Kawela, quite close to the Punamano site, as eventual proposed improvements. (The Estate of James Campbell and the Koolauloa Neighborhood Board have, however, argued against drilling the Hanakaoe well as possibly affecting farmers who use the site now (Ibid.).)

The planned improvements are intended to provide for anticipated islandwide demand, not local needs. Locally, current demand for water from the Kahuku wells is estimated as 30 percent of sustainable yield. Within Laie, Zions Securities is now building water system improvements, including a 16-inch transmission line and fire hydrants.

4.0 SOCIO-ECONOMIC IMPACTS

Development of the proposed project will have several impacts on the society and economy of the study area. Many of the anticipated impacts are positive. Others are more complex, and the anticipated impact of the project is closely linked to the effects attributable to other developments, notably the growth of the Kuilima Resort.

In this section, specific attention is given to:

- o Employment impacts;
- o Impacts of the project on the development of the Kuilima Resort;
- o Displacement of existing human activities on-site;
- o Impacts of golf course development on nearby property owners;
- o Community involvement in golf at the proposed project;
- o Other community concerns with regard to the project; and
- o Possible mitigations of anticipated impacts.

The project includes no housing, either for residents or for visitors, and hence no significant population impact is anticipated.

4.1 EMPLOYMENT IMPACTS

4.1.1 Construction and Preparation Phases

The construction of golf courses involves two distinct steps -- construction of the landforms and the preparation of greens, fairways, and other features.

The project plans call for the construction of four golf courses and up to four clubhouses. Details of clubhouse design are not yet final. Based on information provided by Asahi Jyuken Hawaii, Inc., discussions with construction managers, and plans for other golf facilities, on-site employment during the construction and preparation phases can be estimated as shown in Table 13. The courses may well be built one after another. They are to open over a period of three to six years.

TABLE 13: ON-SITE CONSTRUCTION PHASE EMPLOYMENT FOR THE COUNTRY COURSES AT KAHUKU

Component	No. Employees	Timeframe	Full-Time Equivalent Person-Years
Golf Course construction			
per course:	18 - 24	12 - 16 mo.	
all courses:		48 - 54 mo.	88 - 99
(average)	22		(94)
Golf Course preparation			
per course:	20 - 22	6 - 8 mo.	
all courses:		24 - 28 mo.	42 - 49
(average)	21		(46)
Clubhouses and other structures			
all bldgs.	18 - 28	40 - 42 mo.	60 - 98
(average)	23		(79)
TOTAL			190 - 246
Average Total			218

NOTES:

The number of employees and timeframe shown <u>per course</u> indicates the range in employment from simpler to more complex construction jobs. The timeframe shown for <u>all courses</u> takes into account the fact that work on some courses will take longer than on others. The calculation of person-years provides an abstract count of employment -- the number of on-site construction employees in any one year will be far less than the number of person-years shown for a project which will take three to six years to complete.

Construction of one golf course will probably begin soon after construction work -- as distinct from preparation -- on another ends. It is, then, likely that a single crew could build the four courses. With this schedule, only one grounds crew at a time will be involved in preparation work -- however, since a grounds crew will be needed for each course when it is completed, it is possible that most of the grounds employees for each course will begin work during the preparation phase and continue as operational employees.

Any construction project involves both on-site and off-site employment. (Off-site jobs include support personnel and administration, and are estimated as numbering 25 percent of on-site construction jobs.) Construction further supports secondary employment generated by the purchase of materials from other businesses and the expenditure of workers' wages. Secondary employment can be estimated at 80 percent of the total on- and off-site construction jobs, based on the State of Hawaii's construction model.

The golf course preparation jobs listed above are included in the count of on-site jobs. These are excluded from further calculations of off-site construction jobs and jobs generated by construction spending since they are normal golf course maintenance jobs that come on-line before other operations of the golf courses.

The total employment impact of the construction phase of the project is estimated as 435 person-years, as shown in Table 14.

4.1.2 Operational Phase

The operational phase begins when the golf courses and clubhouses are open and operating. Operational jobs are permanent jobs. It is likely that the four courses will open one after the other, so the number of operational jobs will increase over an initial period, to stabilize in a few years.

On-Site Employment: Based on interviews by Community Resources, Inc. with golf course and country club managers in Hawaii and California, it is estimated that the four golf courses in the project would, when all are operating, provide from 231 to 286 full-time equivalent on-site jobs. (Some of these may be broken into part-time jobs.)

The above estimate is derived from estimates of employment in the various aspects of golf course and clubhouse operations for the two sites:

TABLE 14: TOTAL ON-SITE AND OFF-SITE CONSTRUCTION PHASE EMPLOYMENT FOR THE COUNTRY COURSES AT KAHUKU

<u>On-Site and Off-Site Employment</u>:	
Preparation work	46
Construction work	173
Direct off-site workers: 173 x .25 =	<u>43</u>
Total Direct Employment	262 person-years
<u>Direct and Indirect Employment</u>:	
Preparation work	46
Direct construction work: 173 + 43 =	216
Indirect construction work: 216 x .8 =	<u>173</u>
Total Direct and Indirect Employment	435 person-years

NOTES:
Numbers included here are taken from Table 13 and multipliers described in the text.

Malaekahana (separate operation, clubhouse)

Grounds and maintenance:	20 - 22 jobs
Golf and pro shops:	15 jobs
Administration and support (locker room, etc.):	10 - 15 jobs
Food and beverage:	18 - 30 jobs
MALAEKAHANA TOTAL:	63 - 82 jobs

Punamano (up to three operators; three clubhouses)

Grounds and maintenance:	60 - 66 jobs
Golf and pro shops:	45 jobs
Administration and support (locker room, etc.):	27 - 33 jobs
Food and beverage:	36 - 60 jobs
PUNAMANO TOTAL:	168 - 204 jobs
PROJECT TOTAL:	231 - 286 jobs

A preliminary list of the operational jobs available at the Country Courses at Kahuku is in Table 15.

Jobs at the project will offer both indoor and outdoor work, as well as jobs suitable for full-time breadwinners, part-time workers supplementing family incomes, and young people just starting out.

The great majority of anticipated jobs require little technical training or experience. They accordingly offer the characteristic advantages and disadvantages of service jobs -- relatively few high-paying skilled jobs, but easy entry for younger and/or less educated workers.

Labor Supply Availability: According to estimates by the Hawaii State Department of Labor, about 275 adults in the study area labor force were unemployed in June 1988, and the study area unemployment rate was 2.7 percent (personal communication, Manuel Fragante, Research Statistician, Research and Statistics Office, Hawaii State Department of Labor, January 19, 1989).

The Kuilima Resort Expansion is expected eventually to generate about 4,500 new jobs in the study area, mostly on-site at the Resort. (Its impact will not reach that level until well after the year 2000.) The cumulative employment impact of the expansion plus the Country Courses should be over 4,700 jobs in the study area.

Clearly, new jobs will outpace unemployment. There are indications, however, that new jobs are wanted (a) in preference

TABLE 15: OPERATIONAL JOB CATEGORIES FOR THE COUNTRY COURSES AT KAHUKU

Job Title	No. of Jobs Available*	Starting Pay Range*	Required Qualifications
A. GROUNDS			
Superintendent	4	$2,000-3,000/month	5 years or more horticulture experience. Expertise in growing and maintaining grass. Personnel management skills also required. No college degree necessary.
Assistant Superintendent	2 - 3	$1,500-2,000/month	Some prior horticulture experience needed. No college degree necessary.
Maintenance Superintendent	4	$1,300/month	Mechanical, carpentry and air conditioning repair skills. Heavy work involved.
Mechanic	8 - 9	$1,600/month	Knowledge of general heavy machinery, both diesel and gas operated. Heavy work involved.
Equipment Operator	20 - 22	$1,300-1,400/month	No experience necessary. Must learn to operate heavy and light equipment such as gangmowers and greenmowers. Heavy work involved.
Groundskeeper	22 - 24	$1,300-1,400/month	No experience necessary. Must learn to use grounds equipment. Heavy work involved.
Laborer	20 - 22	$1,300-1,400/month	No experience necessary. Heavy work involved.
SUBTOTAL	80 - 88		
B. GOLF			
Directing Golf Professional	4	$2,000-3,000/month	Managerial skills, knowledge of golf course operations.
Teaching Golf Professional	8	$1,500-2,000/month	Experienced golfer with teaching skills.
Attendant**	24	$1,000/month	No experience necessary. Heavy work involved.
Golf Pro Shop Sales Assistants**	24	$1,000/month	No experience necessary.
SUBTOTAL	60		

NOTES:
Salary figures are in 1988 dollars.
* All figures about "No. of Jobs Available" and "Pay Range" are APPROXIMATE and PRELIMINARY.

** Some of these jobs may be part-time.

TABLE 15 (CONTINUED)

Job Title	No. of Jobs Available*	Pay Range*	Qualifications
C. ADMINISTRATION AND SUPPORT			
Clubhouse Manager	4	$2,000-3,000/month	Managerial skills, knowledge of golf course operations. College degree required.
Assistant Manager	0 - 1	$1,500-2,000/month	Some prior managerial experience needed.
Accountant	2 - 4	$2,000-2,500/month	Certified Public Accountant.
Secretary	4	$1,000-2,000/month	Executive secretary skills. Prior experience not necessary.
Receptionist**	4	$5.00/hour	No experience necessary.
Janitor	8 - 10	$5.00/hour	No experience necessary.
Locker Attendant**	9 - 12	$5.00/hour	No experience necessary.
Valet Parking Attendant**	2 - 5	$4.00/hour	Driver's license and clean driving record. No experience necessary.
Security**	4	$8.50/hour	No experience necessary.
SUBTOTAL	37 - 48		
D. CLUBHOUSE: FOOD AND BEVERAGE			
Specialist/Supervisory Cook	1 - 4	$8.00-10.00/hour	Experienced cook.
General Cook	9 - 12	$5.00/hour	General cooking experience.
Cashier**	6 - 9	$8.00/hour	Prior experience necessary.
Waithelp**	22 - 40	$6.80/hour plus tips	No experience necessary.
Bushelp**	10 - 16	$5.00/hour	No experience necessary.
Bartender**	6 - 9	$5.00/hour plus tips	Prior experience necessary.
SUBTOTAL	54 - 90		
TOTAL	231 - 286		

NOTES:
Salary figures are in 1988 dollars.
* All figures about "No. of Jobs Available" and "Pay Range" are APPROXIMATE and PRELIMINARY.

** Some of these jobs may be part-time.

over jobs at a considerable distance from homes in the study area, and (b) for young people entering the job market. Residents of the area have repeatedly expressed support for job creation (see Section 2.5).

The 1980 Census indicated that over 2,300 workers in the study area commuted over 45 minutes regularly (see Table 8). The number of long-distance commuters has probably grown since 1980, due to population increase. (The study area's population has grown by about 4,000 persons since 1980, as noted in Section 2.2.) Few or no jobs have been created since 1980 in Koolauloa. On the North Shore, the number of agricultural jobs has been declining, while the future of Waialua Sugar and its workforce remains uncertain over the long term. The exact size of the currently employed study area workforce ready and willing to apply for jobs at the Resort and the project cannot be calculated. It is clear, however, that a sizeable pool exists of workers interested in work near home.

In order for the new study area jobs to be absorbed largely by existing residents, programs will be needed to help job applicants qualify for the available jobs and to mesh the needs of employers and residents. The Kuilima Resort has already devoted attention to job training efforts, to be discussed further below, in Section 4.7.1.

Off-Site and Total Employment: Off-site jobs are created when the operators of a project purchase services and supplies from other businesses, providing jobs there ("indirect employment"), and when employees of a project spend their wages, creating employment in local enterprises ("induced employment").

Indirect and induced employment are a function of the circulation of money, goods and services in the economy. These constitute an identifiable impact only when they are added to the economy -- when they result from new inputs to the economy, not just a reshuffling of existing capital. To estimate that impact, indirect and induced employment attributable to visitor spending -- to money brought in to Hawaii from outside -- are treated as the off-site employment created by the project.

Using estimates by Peat Marwick Main & Co. of the eventual breakdown of users of the golf courses when the Kuilima Expansion and the project are completed, over three-quarters of the cash spent at the project would come from visitors to Hawaii. As Table 16 shows, this percentage can be used in conjunction with the State's Input-Output model to generate an estimate of off-site and total employment generated by the project.

The Punamano and Malaekahana golf courses would generate some 301 to 372 indirect and induced jobs in Hawaii, for a total employment impact of 532 to 658 jobs. Taking the midpoint of that range as an average, the employment impact would amount to about 595 jobs statewide.

TABLE 16: DIRECT, INDIRECT AND INDUCED EMPLOYMENT ATTRIBUTABLE TO FULL-SCALE OPERATIONS AT THE COUNTRY COURSES AT KAHUKU

Industry (1)	On-Site Jobs (2)	Visitor Share (3)	Industry Multiplier	Indirect and Induced Jobs	TOTAL
Amusement Services	158 to 172	.765	1.6947	205 to 223	363 to 395
Eating and Drinking	73 to 114	.765	1.7139	96 to 149	169 to 263
TOTALS:	231 to 286			301 to 372	532 to 658
AVERAGE (from mid-points):	259			337	595

NOTES:

(1) Industry definitions and multipliers from Hawaii State Input-Output Matrix (Hawaii State Department of Planning and Economic Development, 1977).

(2) On-site jobs: from estimates in text. Administration and support jobs allocated equally to the two industries (Amusement and Eating and Drinking) shown above.

(3) Derived from estimates of the "Projected Golf Market Mix" at Kuilima and the Country Courses developed by Peat Marwick Main & Co. (1989). Estimates for 2005 were used as representative of activities at the project when all courses are built and the Kuilima Expansion is complete.

In 2005, the following market mix is projected: Kuilima hotel resort guests -- 43% of golf rounds at the all six Kuilima courses (including the project); Kuilima condominium occupants -- 16%; other Oahu visitors -- 19%; other Oahu residents -- 17%; and complimentary rounds -- 4%. (These figures total 99 percent because of rounding.) To calculate visitor share, complimentary rounds are excluded and full-time condominium residents -- about a third of the condominium occupants -- are treated as residents.

4.1.3 De Facto On-Site Population

The project will have no residential population, since no housing is proposed for the Punamano and Malaekahana sites. De facto population on-site can be estimated.

A maximum de facto population can be calculated as follows:

Golfers on the Country Courses -- 1 foursome per hole, 72 holes:	288
Golfers waiting to play -- 3 foursomes per course:	48
Golfers at the clubhouses after play -- 4 to 12 foursomes:	16 - 48
Employees on-site (at any given time) -- 75 percent of all operational staff	173 - 215
Total maximum de facto population:	525 - 599

Maximal population levels will not be reached until the demand for the Country Courses is well established. When the project is completed in 1997, a demand for 710 rounds of golf per day -- 85 percent of capacity -- at the Country Courses and the two Kuilima Resort courses has been projected (Peat Marwick Main & Co., 1989). At that time, it is likely that clubhouse employment at the project will be well below maximal levels. The number of golfers on-site should be about 85 percent of the maximal estimate; the total number of employees should be near the lower end of the range of employment estimated for the project. Hence the 1997 estimated de facto daytime population would be:

Golfers on the Country Courses -- 85 percent of maximum (288)	243
Golfers waiting to play -- 85 percent of maximum (48)	41
Golfers at the clubhouses after play -- 85 percent of maximum (16 - 48)	14 - 41
Employees on-site (at any given time) -- 75 percent of all operational staff, with total operational staff around 240	180
Total 1997 de facto on-site population:	478 - 505

4.2 IMPACTS ON KUILIMA RESORT

Kuilima Resort is the area's major prospective employment base. To the extent that the golf course projects have any impact on Kuilima or its market, there would be indirect socio-economic implications for the entire Koolauloa/North Shore area.

The obvious intended impact is to bolster future occupancies by providing a unique product (i.e., a different golf course for each day of the week) that would make Kuilima the resort golfing center of Hawaii. Because golfers are generally an upscale clientele, this would mean Kuilima occupancies would be more "recession-proof," providing more job stability for area workers.

According to the Kuilima legal counsel (personal communication, Alan Nii, January 14, 1989), another intended effect of the four new golf courses would be to strengthen an existing effort to attract more visitors from Europe and the Far East, particularly Japan.

The Resort intends to attract more international trade through dealings with future hotel operators and tour companies who have networks in Europe and Japan. Some discussions of this type are already underway. The golf courses would provide an additional set of marketing tools for that purpose.

The appeal of golf to Japanese visitors has been well documented in Hawaii news media. However, golf is also increasingly popular in Europe, a fact noted by Hawaii Governor John Waihee in his December 1988 promotional trip to Europe.

According to Turtle Bay Hilton General Manager Dieter H. Seeger (personal communication, January 11, 1989), Kuilima now has a small but steady clientele of European golfers. Because a golf course complex of this type is "unheard of" in Europe, he anticipates it would be highly successful in attracting Europeans. He compared it to the success experienced at Vail, Colorado when a large number of additional ski runs were opened despite questions as to "whether that many were really necessary."

He also felt the courses would help the Hilton in its goal of attracting more Japanese visitors. A desirable target mix would be 25 to 30 percent Far East visitors (compared to the current ten percent at the Turtle Bay Hilton).

As noted in Section 4.6, community interviews for this report suggest little concern over a possible increase in Japanese visitors (although there is uneasiness over Japanese investments in Hawaii real estate). Residents generally felt that Japanese visitors would remain at the Resort and not affect the daily lives of people in nearby communities.

4.3 DISPLACEMENT OF ON-SITE HUMAN ACTIVITIES

Malaekahana Site

Currently, some of the Malaekahana site is used for grazing by Gunstock Ranch, located on the makai side of the property, and by MBJ, Inc., which has a lease on the site. Gunstock Ranch has a month to month lease with Campbell Estate for 249 acres and has leased the property since the early 1980's (personal communication, James Dybdal, The Estate of James Campbell, January 19, 1989). Livestock is raised and sold on the ranch. Presently there are 40 horses and 150 cattle on the Ranch (personal communication, Dr. Mack Smith, Gunstock Ranch, January 19, 1989). MBJ leases 372 acres, of which about 175 are in the Malaekahana site.

The Campbell Estate views the MBJ lease as subject to a withdrawal clause, while MBJ views the lease as continuing. MBJ has indicated its view to the Estate (personal communication, Russ Alger, Campbell Estate, January 6, 1989; Mark Luria, President, MBJ, Inc., January 14, 1989). The Kuilima Resort Company is not a party to the discussions between the Campbell Estate and MBJ.

Punamano Site

Minimal use is being made of the Punamano site. Part of the site is leased to Amorient Aquaculture International, Inc. Amorient has attempted to produce various crops on the site, with no financially viable results (letter, Linden A. Burzell, Vice President and General Manager, Amorient Aquaculture International, Inc. to James Dybdal, The Estate of James Campbell, October 14, 1988). Amorient has requested that the project lands no longer be part of their leasehold.

Four small windmills, currently unused, are located on the project site. These are the property of the landowner, which plans to remove them (personal communication, Russ Alger, The Estate of James Campbell, January 6, 1989.)

The Punamano site includes the access road to the Army's Kahuku Training Area and to an Air Force communications center located on a bluff above the site. Access to the Training Area will not be interrupted or diminished by the proposed project. The landowner has already discussed the possible rerouting of electric lines on the site, and the Army has found the proposed rerouting acceptable (personal commmunication, Larry Fushikoshi, Real Estate Department, U.S. Army Engineer District, Honolulu, January 17, 1989).

4.4 IMPACTS ON ADJACENT PROPERTIES AND PROPERTY OWNERS

Golf course development will preserve the open space character of the properties at Punamano and Malaekahana. This land use may be thought to have impacts on nearby land uses and values.

4.4.1 Impacts on Adjacent Properties

The project will have minimal or no impact on current uses of nearby lands. It conceivably could change the context for proposed uses of adjacent properties in a few cases. It is not expected to affect agricultural and military uses of adjacent land.

Farmers and representatives of groups farming near the Punamano site interviewed for this report expect that the proposed development will pose no problem for them (personal communications, Norwood Conners, President, Kahuku Farmers Co-operative, January 16, 1989; Jimmy Inthasone, Consultant, Mutual Assistance Association Center, January 18, 1989). Members of the Kahuku Farmers Co-operative have discussed the project and concluded that they have no objection if their water supply remains adequate, and if no housing is built on-site. They view the project site as of marginal agricultural value.

Properties Near the Malaekahana Site

The land adjacent to the Malaekahana site belongs to the Campbell Estate, except towards Laie, where the property abuts land owned by the Mormon Church. The surrounding land is zoned for agricultural use. Nearby users include:

- o Gunstock Ranch, discussed above;
- o MBJ, Inc., discussed above; and
- o Cackle Fresh Eggs, an egg farm makai of the site, that leases 44 acres from the Mormon Church. The egg farm has leased the property since 1964 and their lease expires in the mid-1990's. The farm has 35 employees. Approximately six to seven acres are sub-leased to Laotian farmers who grow cucumbers (personal communication, Don Anderson, Distribution Manager, Cackle Fresh Egg Farm, January 18, 1989).

Proposed uses of adjacent lands include:

- o A possible golf course on Campbell Estate land makai of the property (discussed in Section 3.1); and
- o Additional housing is needed for Laie's people; the Cackle Fresh site has been discussed in the Laie community -- but not officially designated by Zions Securities -- as an appropriate place for such housing (personal communication, Marvin Stone, Manager, Zions Securities, January 17, 1989);

No definite plans have been announced concerning either proposal.

Properties Near the Punamano Site

Within the Punamano site are two parcels, along the road, which Campbell Estate has retained. No plans for these parcels have been announced (personal communication, Charles Ehrhorn, The Estate of James Campbell, January 13, 1989).

Near the Punamano site are a mix of agricultural, military, and industrial uses:

- o The Kahuku Farmers Co-operative farms 250 acres on the Kahuku side of the property. Currently, seven to eight farmers are growing various vegetable crops. The land was originally leased from Campbell Estate. It is now included in the State's Agricultural Park, and sublet from the State Department of Agriculture (personal communication, Norwood Conners, President, Kahuku Farms Co-operative, January 11, 1989; Paul Schwind, Planning Officer, Department of Agriculture, January 13, 1989).

- o Mauka of the Kahuku Farmers area, the State is developing additional land for an Agricultural Park. Twenty-four parcels of five to ten acres will be leased to farmers when the infrastructure is in place (personal communication, Paul Schwind, Planning Officer, Department of Agriculture, January 13, 1989).

- o On the Kuilima side of the project site (but still mauka of Kamehameha Highway) is land leased by the Campbell Estate to Amorient Aquaculture until 2003, and sublet to several farmers, notably:

  - next to the project site, a farmer uses 90 acres to grow cucumbers, beans, daikon, papayas and squash. The farm has 30 employees. About one third of their leasehold is used at a time as crops are rotated (personal communication, Prasong Sukasiam, You Sukasiam Farm, January 17, 1989).
  - A Kahuku farmer holds a similar subtenancy of over 80 acres, and grows papayas and vegetables (personal communication, John Casuga, January 18, 1989).

  - The Tongan Society of America uses about 37 acres of the Campbell Estate land for growing subsistance crops of traditional Tongan foods, materials for traditional cultural goods, and commercial crops of yams and sweet potatos are also raised (personal communication, Emil Wolfgramm, Tongan Society of America, January 19, 1989).

- Mauka of the project site is the Army's Kahuku Training Area. The Training Area covers 7912 acres of land leased from Campbell Estate. It is the only general training area on Oahu for active and reserve forces. It is used by the Army, Army Reserves, Marines and National Guard for infantry training. Live ammunition is not used (personal communication, Catherine Manning, Real Estate Officer, Western Command, U.S. Army, January 17, 1989). The Army's lease for this area expires in 1991 (personal communication, James Dybdal, The Estate of James Campbell, January 19, 1989). Renewal is expected. The Army has an easement on the road through the project site. The project will guarantee the Army continuing access to the Training Area.

- The Air Force has a communications station on a bluff overlooking the site, near the Kuilima Resort's proposed new sewage treatment plant. The station occupies 9 acres; its current lease ends in 1997 (Chuck Ehrhorn, The Estate of James Campbell, January 19, 1989).

- The Hawaiian Electric Renewable Energy System, Inc. uses a portion of the mauka property. It has 16 wind turbines, currently generating an average of four megawatts of electricity daily. It has plans for expansion into the mauka portion of its leasehold away from the project site should oil prices increase (personal communication, Dan Suehiro, Manager, Hawaiian Electric Renewable Energy System, Inc, January 19, 1989).

The major land uses makai of the highway near the project site are the Kuilima Resort and the aquaculture area in which Amorient leases 382 acres.

The proposed use of the sites for golf courses would not affect nearby agricultural activities, because:

- The Punamano land is marginal for agricultural purposes, and not a suitable area for expanded agriculture. Amorient has attempted to raise several crops on the project site over the years, with no viable result (Linden A. Burzell, Vice President and General Manager, Amorient Aquaculture International, to James Dybdal, October 14, 1988).

- There is land available in the area for agricultural use, at the State Agricultural Park.

- A major constraint on agricultural use of land in the general area independent of the project, is the Campbell Estate's policy of not allowing tenants to build any houses except for minimal storage and shelter facilities on its lands. Often people express interest in acquiring farm lots of about five acres with a house on-site, but the Estate does not allow these (James Dybdal, Estate of James Campbell, January 9, 1989).

4.4.2 Regional Property Values and Taxes

As noted in the subsequent Section 4.6, concern over golf course impacts on other landowners' property values and taxes was often mentioned as a potential issue in interviews conducted for this report.

There are no residential areas directly adjacent to any of the proposed golf course sites. Tax rates for adjacent agricultural lands -- as noted below -- will be unaffected.

The major issue, therefore, involves impacts on residential properties located throughout Koolauloa and the North Shore -- i.e., from one to ten miles away from the various proposed Country Courses at Kahuku. Values for these properties (as for most Oahu real estate) are already rising, and may rise even more due to the already-approved Kuilima Resort expansion. The question is whether golf courses would <u>further</u> affect values.

Because a multi-golf course complex as large as the proposed Country Courses would be unique to Hawaii, there are no exact precedents to research. So it is impossible to predict effects with total certainty. However, the following analysis suggests no <u>direct, immediate</u> impacts. The situation regarding <u>long-term, indirect</u> effects is more cloudy.

Basically, there are two ways that golf course construction might affect off-site property taxes:

- Just by being built, <u>if</u> property tax assessment policies automatically assumed the construction of golf courses increases value of nearby properties. As discussed below, this is not usually the case.

- By increasing demand for real estate (either through worker inmigration or more exposure of the area to out-of-state investors and second-home buyers), which could result in either:

  - pressure to urbanize more land, and/or

  - higher costs (and taxes) for the existing limited supply.

4.4.2.1 Tax Assessment Policies

As part of socio-economic research for several other recent Oahu golf course proposals, Community Resources, Inc., reviewed City and County tax assessment policies. Based on interviews with officials in the City and County Finance Department's Real Property Assessment Division:

- Golf courses are not considered a valuable amenity for agricultural-zoned land in active agricultural use. Therefore, building golf courses next to agricultural lands being actively farmed or grazed will not affect the property taxes of these lands (or similar lands further away).

  If "agriculture-" or "country-"zoned land is really being used for residential purposes only, not agriculture, the assessed value <u>could</u> be affected by nearby new improvements (such as golf courses or even substantial upgrading of houses on the same street). However, this would happen only if the improvements were immediately adjacent or in the same immediate neighborhood (not a mile down the road). There are no such properties adjacent to the proposed Country Courses at Kahuku.

- For truly residential areas, building a golf course <u>immediately</u> beside existing homes would affect the assessed values of the houses nearest the course (and particularly those with a golf course view). It would not usually, as a matter of policy, affect values for houses well removed from any golf course view.

- In general, residential properties are assessed by a "market" approach. This means looking at recent sales prices of comparable land in the same immediate neighborhood, if possible -- or, if not possible, at sales prices in other nearby neighborhoods judged to be economically and physically similar. "Neighborhoods" are relatively small areas, often defined by geographical boundaries or socio-economic differences. For example, increased sales prices for beachfront homes at Malaekahana would have no impact on assessed values in Kahuku or most of Laie.

In sum, constructing the proposed Country Courses at Kahuku should not result in immediate, direct increases in assessed values and property taxes for adjacent agricultural lands or residential lands further away. (Arguably, the one exception might be beachfront property at Malaekahana Bay. Many of these properties are owned on an investment basis, and there are few if any permanent residents.)

Assessed values and taxes will be affected only if there are actual increases in sales prices. The next sub-sections address this question of indirect impact through (1) interviews with area realtors, and (2) reported analysis of statistical data on Oahu real property values.

4.4.2.2 Realtor Expectations

In an attempt to determine whether a consensus existed among Koolauloa/North Shore real estate professionals, Community Resources, Inc. interviewed 11 area realtors and property managers (listed in Table 17) in January 1989. Initial real estate informants were asked to suggest other people until a fairly complete list had been established.

Major points emerging from these interviews:

- There was general agreement that real estate prices in Koolauloa and the North Shore -- particularly beachfront properties -- have risen sharply in the last year or two. The major reason suggested was lack of new supply in the face of increasing demand.

  Japanese investment was <u>not</u> seen a major direct factor. Except for a few high-profile purchases in the Pupukea area, the North Shore has attracted little interest from Japanese, who have concentrated on Kahala, Waikiki, and a few parts of East Honolulu. However, some people did think that Kahala "displacees" may have moved to Kailua and similar places, and Kailua "displacees" to the North Shore.

- Almost all expected the scheduled Kuilima expansion in the early 1990's to further increase area values. However, some thought this would be primarily due to increased area exposure to out-of-state purchasers interested in beachfront and "view" properties, while others thought the greater impact would come from new workers competing for limited residential stock in areas such as Kahuku, Hauula, and Sunset.

  A few realtors pointed out that Kuilima impacts could be <u>delayed or masked</u> by other important factors. Interest rates and general economic conditions will have a powerful effect on the real estate market, and prices could stabilize or even drop despite Kuilima expansion in the early 1990's if the overall economy weakens.

TABLE 17: LIST OF REALTORS AND MANAGERS INTERVIEWED ON PROPERTY VALUE IMPACTS

Name	Title/Organization
Marianne Abrigo	Principal, Marianne Abrigo Properties
India Andrews-Noe	President, Mokuleia Management, Inc.
Sandy Bell	Principal, Sandy Bell Realty, Inc.
Delores Cerny	Independent Broker
Barbara Evert	Realtor Associate, Cooperative Realty
John "Fritz" Hanna	Manager, Marlene Realty
Jacqueline Mansard	Principal, Jacqueline Mansard Realty
Elaine Niimi	Principal, North Shore Realty
Ron Scott	Principal, Gordon Scott Realty, Inc.
Richard Sterman	President and Principal Broker, Richard Sterman Realty
Sam Underwood	Agent, ERA Stott

o Despite agreement on the above points, there was no consensus on further impacts of developing four additional golf courses. A slight majority said they foresaw some likely impacts, while others saw little or no addition to the basic impact from resort expansion.

However, those who did foresee a golf course impact generally agreed on some aspects:

- Golf course impacts would be minor to moderate, compared to overall resort development impacts.

- These impacts would come from additional exposure of the Koolauloa/North Shore area to golfers from Honolulu and out of state. (There was skepticism that Japanese golfers would be induced to purchase land in the area, since Japanese are used to traveling substantial distances to golf. However, a few thought it possible.)

- Therefore, any golf course impacts on property values would be greatest for condominiums at Kuilima itself, for nearby oceanfront lands, and for "view" properties on hillsides. Little if any golf course impact was foreseen for average residential neighborhoods in places like Kahuku, Laie, or along the highway in Sunset Beach.

Realtors did have a consensus that any upscale housing which fronted the golf course could easily find a well-paying market. However, they generally agreed that current City policies and community attitudes would make rezoning for such development difficult in the foreseeable future.

4.4.2.3 Statistical Analyses of Historic Changes in Values

In a November 30, 1988 public presentation to the Lihi-lani community advisory group (for Ohbayashi Hawaii's proposed residential/golf development at Pupukea), Dr. Michael Sklarz of Locations, Inc. reported on original statistical analyses of changes in neighboring land values associated with golf-related developments in Hawaii. Dr. Sklarz is one of Hawaii's leading real estate analysts, producing several weekly and monthly columns for the news media as well as reports on real estate trends for Hawaii realtors.

The exact tables and charts produced by Dr. Sklarz are proprietary and cannot be reproduced here in detail. However, the general conclusions stated in the public meeting were:

- For the North Shore (Waimea/Sunset/Pupukea area), average single-family sales prices for oceanfront homes suddenly soared in 1988, to more than double the 1987 averages. But off-water North Shore residential values -- while rising somewhat the past few years -- have been substantially lower than Oahu-wide average sales values.

  (Thus, while apparently even steeper price hikes for off-water homes may occur as the Kuilima Resort expands, this could also just mean the North Shore values are "catching up" with those for the rest of Oahu.)

- To determine impacts of golf-related developments elsewhere, Dr. Sklarz examined changes over time in middle-class and working-class neighborhood sales prices located very near the developments. (The developments in question were generally golf/residential projects, both on resorts such as Makaha and Wailea and also some non-resort projects.

  In all cases from three different islands, the new upscale golf/residential developments had no apparent impacts on single-family home sales prices in neighboring areas. Values in these neighboring areas did rise in certain years, but at a rate which paralleled islandwide rises and not in any other sudden spurts after the new developments occurred.

  Dr. Sklarz concluded (personal communication, January 9, 1989) that islandwide economic market conditions seemed to far outweigh nearby improvements such as golf courses in affecting values of existing housing stock.

It may be noted that the basic conclusion above somewhat differs from the expectation of many (but not all) North Shore realtors that new Kuilima golf courses could have some impact on real estate values areawide.

However, the apparent difference in conclusion may not be so great. First, the realtors felt the greatest impact would be on special properties appealing to upscale, out-of-state markets (oceanfront or "view" properties) -- not necessarily "average" single-family homes. Second, the realtors felt the impact would occur through exposure of more people to the area. This suggests a long-term, gradual effect, which would merge with other long-term economic factors.

Thus, the long-term impacts of resort golf course on off-site property values remains an issue for further research. But the evidence seems clear in suggesting little immediate or direct impact.

4.5 COMMUNITY GOLF RATES

As noted in the following Section 4.6.2, there is current substantial community interest in resident rates at both the existing Turtle Bay course and the prospective Country Courses at Kahuku.

Table 18 provides current fee structures at Oahu's two resort courses (Turtle Bay and Makaha), various daily fee courses, and the four municipal links. In response to current heavy demand, many non-municipal courses have recently raised their rates.

The table indicates that:

- Looking at Oahu's two resort courses, Kuilima (Turtle Bay) charges higher rates to hotel guests than to residents. At Makaha, hotel guests play more cheaply, although resident rates are lower at limited times.

- In most parts of the island, local golfers pay only $10 to $25 more to play at the nearest private course rather than at the nearest municipal course.

  But -- due to exceptionally low rates at the Kahuku municipal course and lack of an intermediate-priced daily fee course -- study are golfers face a greater apparent difference when shifting from the municipal course to Turtle Bay (about $35). Put another way, they have to pay seven to ten times as much to play golf at Turtle Bay than at Kahuku. Thus, the Koolauloa/North Shore resident golfer perspective on rate differentials is distinctive.

No rates (whether for residents, resort guests, or other visitors) have yet been worked out for the proposed Country Courses at Kahuku. Given current community standards based on Kahuku municipal rates versus cost of resort golf course construction, there is clear potential for continued sensitivity over the rate issue.

Kuilima Resort is currently involved in discussions with the community about possibly establishing <u>community</u> rates for Koolauloa/North Shore residents which would be even lower than rates for Hawaii residents in general. This topic is further discussed in the "Mitigations" Section 4.7.2.

TABLE 18: FEES AT SELECTED OAHU GOLF COURSES

	Total Green and Cart Fees	
	Weekdays	Weekends
RESORT COURSES		
Turtle Bay Hilton & Country Club		
Hawaii Resident (Individual/Club)	$ 40.00	$ 45.00
Hotel Guests	$ 65.00	$ 65.00
Others/Visitors	$ 80.00	$ 90.00
Sheraton Makaha Resort & Country Club		
Hawaii Resident	$ 55.00	$ 55.00
Resident Twi-Night (weekday, early morning or mid-late afternoon)	$ 32.50	N/A
Resident Club Play (Under 12 Players)	$ 55.00	$ 55.00
Resident Club Play (Over 12 Players)	$ 45.00	$ 45.00
Hotel Guests	$ 45.00	$ 45.00
Guests at other Sheraton Hotels	$ 85.00	$ 85.00
Others/Visitors	$ 95.00	$ 95.00
DAILY FEE COURSES		
Hawaii Country Club (All Play)	$ 19.00	$ 25.00
Hawaii Kai Golf Course		
Hawaii Resident	$ 30.00	$ 34.00
Resident Club Play	$ 28.00	$ 32.00
Others/Visitors	$ 50.00	$ 50.00
Mililani Golf Club		
Hawaii Resident (Individual/Club)	$ 25.00	$ 30.00
Others/Visitors	$ 50.00	$ 50.00
Olomana Golf Links		
Hawaii Resident (Individual/Club)	$ 21.00	$ 29.00
Others/Visitors	$ 23.50	$ 30.00
Pearl Country Club		
Resident/Visitors (Individual)	$ 30.00	$ 34.00
Resident Club Play	$ 24.00	$ 28.00
MUNICIPAL COURSES		
Ala Wai, Pali, or Makalena - Resident	$ 9.50	$ 11.50
Above courses - Non-Resident	$ 13.50	$ 17.50
Kahuku - 9-Hole - Resident	$ 1.00	$ 1.50
Kahuku - 9-Hole - Non-Resident	$ 2.00	$ 3.00
Kahuku - 18-Hole - Resident	$ 2.00	$ 3.00
Kahuku - 18-Hole - Non-Resident	$ 4.00	

4.6 PROJECT-RELATED ISSUES AND CONCERNS

This section presents an overview of Koolauloa/North Shore resident issues and concerns relevant to the proposed golf course project, as determined through a series of interviews.

4.6.1 Method

Through a mixture of telephone and in-person interview techniques, roughly 60 residents of Koolauloa and the North Shore were asked to indicate major questions, issues, or concerns relevant to the "Country Courses at Kahuku" project. People were asked both about their own concerns and about issues which they believed other residents would probably raise.

Table 19 lists persons interviewed. All the people interviewed (or "informants") were told that names would be listed but that no individual person would be quoted.

Most informants were selected primarily because of affiliation with major community organizations (although they were speaking as individuals rather than spokesmen for their groups). Some informants were elective office-holders, business leaders, or local golfers. Many informants suggested other people to interview.

Interviews were conducted during the period January 8 - 18, 1989. As of that time, little formal information about the project had yet been presented to the community. Some had heard nothing about the proposal; some had heard rumors (including misinformation); and some were aware in a general way that four or five golf courses were being proposed for Campbell Estate lands. Consequently, the issues and concerns reported here should be considered preliminary and subject to change as more information is disseminated to the community.

Although an effort was made to interview people reflecting a wide variety of interests, the major objective of the process was to identify key issues, and not conduct a scientific opinion survey. The State Tourism Office, in the Department of Business and Economic Development, sampled Koolauloa/North Shore opinion on general tourism issues in August 1988. However, results will not be available until later this year and will not address individual projects such as Kuilima Resort or the proposed new golf courses.

4.6.2 Background Factors Relating to Interviews

Many informants discussed issues and concerns of a more general nature -- i.e., not directly project-related. These issues were summarized in Section 2.5.

TABLE 19: LIST OF THOSE INTERVIEWED FOR COMMUNITY ISSUES AND CONCERNS

(NOTE: Persons interviewed provided their comments as individuals and were not speaking on behalf of their organizations. Organizational affiliations are provided only to indicate the interests and networks of those interviewed.)

KOOLAULOA DEVELOPMENT PLAN AREA

Name	Organization/Affiliation
Junior Ah You	Laie resident
Lilo Aiu	Tournament Chairman, Samoan Golf Club
Raymond "Buddy" Ako	Community Relations Coordinator, Kuilima Resort Board of Directors, North Shore Career Training Corporation
Lea Albert	Principal of Kahuku Elementary and High School
Reb Bellinger	State House of Representatives, House District 15 (Laie - Kahaluu)
Paul Benzmiller	Personnel Manager, Polynesian Cultural Center
Joe Bruey	Vice President, Laie Community Association
Bill Carpenter	Resident of Kuilima West Estates
Robert Comeau	Executive Director, North Shore Career Training Corporation
Norwood Conner	President, Kahuku Farmers Assn.
Lucky Fonoimoana	President, Laie Community Assn.
Pae Galdeira	Planning Coordinator, North Shore Career Training Corporation
Nancy Higa	Supervisor, Kaneohe Applications Office, Department of Human Services

(CONTINUED)

TABLE 19 (CONTINUED)

Don Hurlbut	Director/Treasurer, Kahuku Village Association Director/Vice-President, Kahuku Community Association Secretary/Treasurer, Koolauloa Lions Chair, Kuilima North Shore Strategy and Planning Committee, Transportation Subcommittee
Barbara Kahana	Vice-President, Koolauloa Neighborhood Board #28 Secretary of Board of Directors, Hawaii Styles and Friends
Joseph Kalili	President, Hauula Community Assn. Kunani O Hauula Young Adults
Richard Kimball	Malaekahana Resident
Pete Lakatani	Tournament Chairman, South Pacific Golf Club
Dee Dee Letts	Koolauloa Neighborhood Board #28 President, Kaaawa Community Assn.
Sgt. Kyle Luke	Honolulu Police Department, Kahuku sub-station
Cathleen Mattoon	Koolauloa Neighborhood Board #28 Kahana State Park Advisory Council
Creighton Mattoon	Chair, Koolauloa Neighborhood Board #28 President, Punaluu Community Association
Mike McCartney	State Senate, District 8 (Laie to Kaneohe)
Bob Muirhead	President, Kuilima East Estates Condominium Owner's Association Kuilima/North Shore Strategy and Planning Committee
Dave Naud	Trustee, Kaaawa Community Assn. President, Kaaawa Kitchen Corp. Kahuku Golf Club

(CONTINUED)

TABLE 19 (CONTINUED)

Ida Otaki	Clinic Coordinator, Koolauloa Counseling Center, Department of Health, Mental Health Division Koolauloa Community Council (social service providers organization)
Mike Padeken	President, Hui O Luana (Kaaawa) Golf Club
Margaret Perry	Operational Clerk, Kahuku Municipal Golf Course
John Primacio, Jr.	Chair, Kuilima North Shore Strategy and Planning Committee General Manager, Kahuku Housing Corporation Director, Kahuku Community Assn. Business Agent, Kahuku Village Association
Ron Scott	Koolauloa Neighborhood Board #28 Board of Directors, Kahuku Community Association Board of Directors, North Shore Strategy and Planning Committee
Dieter H. Seeger	General Manager, Turtle Bay Hilton Hotel and Country Club
Seiko Shiroma	President, Kahuku Housing Foundation, Inc. Director/Treasurer, Kahuku Housing Corporation Treasurer, Kahuku Methodist Church Chair, North Strategy and Planning Committee, Parks and Recreation Sub-Committee
Marvin Stone	Manager, Hawaii Division, Zions Securities Corp.
Lance Suzuki	Kahuku Lokahi Youth Athletic Club Professional Golfer
Mike Tejada	President, Kahuku Lokahi Youth Athletic Club
Danilo Vendiola	Athletic Chairman, Kahuku Lokahi Youth Athletic Club

(CONTINUED)

TABLE 19 (CONTINUED)

Mike Vincent	Koolauloa Neighboorhood Board #28 Laie Community Association
Helene Wood	Kuilima Golf Club Resident of Kuilima East Estates
Jimmy Zane	Vice-President, Hauula Community Association Vice President, Koolauloa Youth Athletic Club Koolauloa Community Council Chair, Kuilima/North Shore Strategy and Planning Committee, Employment Sub-Committee

NORTH SHORE DEVELOPMENT PLAN AREA

Name	Organization/Affiliation
Meryl Andersen	Chair, North Shore Neighborhood Board #27 Liliokalani Church Waialua Community Association
Jimmy Awai	Koolauloa Neighborhood Board #28 Aide to Senator Gerald Hagino
Michael Barnette	Organizing Committee, Pupukea Highlands Community Association
Laura Bolles	Waialua/Haleiwa Business Assn.
Peter Cole	Sunset Beach Community Association
Richard Funai	North Shore Neighborhood Board #27 Advisor and Treasurer, Haleiwa Community Association Kuilima/North Shore Strategy and Planning Committee
Fern Hayes	North Shore Neighborhood Board #27 President, Sunset Beach Community Association Board of Directors, Kahuku Hospital Board of Directors, Kuilima/North Shore Strategy and Planning Committee

(CONTINUED)

TABLE 19 (CONTINUED)

Gerald Hagino	State Senate, District 7 (Wahiawa-North Shore)
Jim Hoffman	President, Sunset Hills Community Association
Millie Keawe	Kuilima/North Shore Strategy and Planning Committee Neighborhood Watch
Wilbert Kishinami	North Shore Neighborhood Board #27 Trustee, Waialua Community Assn. Waialua Golf Club
Joe Leong	State House of Representatives, District 4 (North Shore to Kahuku)
Rene Mansho	Member, Honolulu City Council (Central Oahu, North Shore-Laie)
Sidney Medeiros	Unit Supervisor, Wahiawa Unit, Division of Adult and Family Services
Charles Merlet	Planning Chair, Sunset Beach Community Association
Claude Ortiz	Pupukea Highland Community Assn. Community Relations Representative, Ohbayashi Hawaii, Inc.
Peggy Paty	North Shore Neighborhood Board #27 Waialua United Church of Christ
Robert Reeves	North Shore Neighborhood Board #27 Commissioner, Haleiwa Design District Commission Director, Kuilima/North Shore Strategy and Planning Committee Pupukea Community Association Sunset Beach Community Association
Troy Smith	North Shore Veterinary Clinic
Ed Tseu	President, Pupukea Highlands Community Association Sunset Beach Community Association

Additionally, certain <u>background issues about Kuilima Resort</u> (independent of, but arguably relevant to, the new golf course proposal) emerged from the interviews:

- **Golf Rates at Existing Course:** Kuilima Resort recently eliminated some old, very low rates granted to original golf club members dating from the course's development in the early 1970's. Most of these members were part-time condominium residents, but a few were local area residents.

  At roughly the same time, the Resort considered the possibility of privatizing the existing course. Talks were held with the Recreation Subcommittee of the Kuilima/North Shore Strategy & Planning Committee (K/NSSPC) to determine acceptable local resident access and fees if the course were otherwise open only to private members. The Resort decided not to privatize the course for the time being, although talks with the K/NSSPC are still ongoing in order to determine a standard area resident rate applicable to all local clubs and/or golfers.

  Interviews indicated awareness (but sometimes with misinformation) about these events. Many people believed that Kuilima rates for residents had gone up substantially or had even been eliminated completely.

- **New Owners from Japan:** There were frequent references during the interviews to the fact that the Resort was under new ownership, based in Japan. Most people said the Japanese nationality of the owners was of no concern, except as it fit into a larger uneasiness about the magnitude of all Japanese investment in Hawaii.

  However, some people were uncomfortable about the fact that the former owner, Prudential Insurance, was gone. A sense of communication had been established with Prudential, and residents were still going through a period of "feeling out" Asahi Jyuken Hawaii.

- **Desire for Written Understanding Between Resort and Community:** Residents expressed a desire for future Resort commitments to be written on paper in great detail. This was partly because of the recent ownership change, which left people uneasy about the future of more informal understandings between Prudential and the communities.

  It was also partly due to different expectations about the timing of Resort development of public parks and beach rights-of-way. The Unilateral Agreement with the

City and County (i.e., zoning conditions) specifies that the Resort will convey park lands and develop access as adjacent property is actually developed. Many community residents had expected more immediate recreational development -- especially at Kawela Bay, which has been sealed off to resident access pending future development. While most informants understood the Resort actually is living up to the written Unilateral Agreement, there was still some feeling that such written documents should be given more thorough community review in future.

- **Resident Desire for Economic Success at Kuilima:** Because of the Resort's longstanding community involvement program, many residents feel a sense of "ownership" and a desire to see the Resort succeed and provide local jobs. These longtime supporters voiced some concern over the three previously-listed issues, but said their basic commitment was not affected.

  Among "anti-growth" factions, a few hoped Kuilima would not succeed. But most accepted Resort expansion as now inevitable. Given that growth will occur, they wanted the project to be successful and of high quality, rather than a blight in the region.

4.6.3 Concerns and Issues Relative to Proposed Golf Courses

4.6.3.1 Overview

Given the very preliminary information about the proposed golf courses, there were few strong supporters (except among some local golfers) at the time of the interviews. Initial opposition came from most informants in groups or areas historically concerned with protecting current area character. However, many others -- particularly nearby farmers and community leaders in Kahuku and Laie -- indicated they would be "open" to the project if key environmental questions can be answered and some types of community benefits can be worked out.

Two tables summarize the issues and concerns. First, Table 20 briefly describes issues and clusters them according to rough frequency of mention. However, some different issues seem to be related to the same underlying themes. Therefore, Table 21 attempts to relate individual issues to underlying themes. (Note that themes are somewhat overlapping, since some issues relate to several themes.)

TABLE 20: LIST OF ISSUES AND CONCERNS BY APPROXIMATE FREQUENCY

(NOTE: Both issue categories and frequency estimates must be derived on a somewhat judgmental basis. Therefore, no exact counts of numbers of mentions are given. Some groups of issues appear to deal with common underlying themes. This table treats issues separately, while the next table relates issues to themes.)

Issue	Comments	Particularly Concerned Groups
PRIMARY (MOST FREQUENTLY MENTIONED) ISSUES		
Traffic/Highway Congestion	Some assume major impact; others more doubtful there is real impact.	All areas and types of people.
Golf Rates for Residents	Accessibility and affordability. Desire for youth to benefit.	Golfers unanimously concerned, but many others in community, too.
Project Benefits for Community vs. "Outsiders"	General feeling that project per se is for others ("rich golfers," "the Japanese".) But some people assume givebacks could be worked out.	Koolauloa residents little more likely to ask "How can community benefit?", while Sunset residents more likely to assume no possible benefit.
Using Agricultural Land for Golf; Impacts on Nearby Ag Land	Some assume negative impacts; others just want answers, reassurances.	Area-wide issue, but a little stronger in Kahuku and Sunset areas.
Amount of Water Required	Partially related to ag concerns. Some objections to golf course use of water; some just question if there will be impacts on other users.	All areas, but a little stronger in Sunset area.
Potential Environmental Pollution	Herbicide/pesticide/fertilizer impact on groundwater, ocean. Again, some are certain of problems; some just want trustworthy information.	All areas, but a little stronger in Sunset area.
STRONG SECONDARY ISSUES		
General Growth/Impact on "Country" Feeling	Usually a negative reaction: "The issue is change -- period."	Strongest in Sunset, Kaaawa, Punaluu.
Preservation of Open Space/Views	Usually a positive reaction. But some don't like golf course looks.	Little stronger in Koolauloa.
Jobs (Both Positive & Negative)	Positive: Area needs nearby jobs. Negative: Too few, low-paying.	Lower-income people more positive; upper-income, more negative.
Property Values/Taxes, Foreign Investment	Fear that golf courses will lead to higher taxes.	All areas, but a little stronger in Sunset area.
Need for More Community Contact/ Information	Dissatisfaction with lack of organized community effort to date.	Strongest among those who are open to negotiating community give-backs.
"Too Many Golf Courses!"	Questions as to true need/demand.	Strongest in Sunset, Kaaawa, Punaluu.

(CONTINUED)

(TABLE 20 CONTINUED)

Issue	Comments	Particularly Concerned Groups
OTHER SECONDARY ISSUES		
Housing Shortage	Related to community benefits: "We need housing, not golf courses!"	Strongest in Koolauloa.
Intrusion of Resort into Laie	Sense that Laie/Malaekahana course bringing "outside" into Laie.	Koolauloa people -- though Laie residents themselves might accept if there are clear community benefits.
Potential for Further Development Around Golf Courses	Fear of eventual upscale housing on nearby land, especially at Punamano.	General -- No particular group.
Helping Kuilima Success	Recognition that golf courses could benefit resort marketability.	Business people; some Sunset and Kahuku community people.
Meets Local Demand for Golf	Recognition of heavy local demand (contingent on affordability).	Golfers; some others.
OCCASIONALLY MENTIONED ISSUES		
Attraction of More Japanese Visitors	Usually considered not important, compared to investment/tax impacts.	General -- No particular group.
Population Growth	Related to assumption that courses would generate later housing.	Comment usually from Sunset area.
Strains on Social Services	Related to assumed new housing.	Social agencies.
More Social Division Into "Have's" Vs. "Have-Not's"	Related to community benefits.	Usually more secure/affluent.
More Crowding of Kahuku Muncipal Golf Course	Fear that more golfers will be attracted to area, then "overflow" to cheaper Kahuku course.	Some golfers.
Lifestyle Impacts	Changes in pace, way of life.	Very few mentions, at least in these terms.

TABLE 21: RELATIONSHIP OF ISSUES AND CONCERNS TO UNDERLYING THEMES

	FREQUENCY/ IMPORTANCE	AREA CHARACTER	ECOLOGY IMPACT	INFRA-STRUCTURE	ECONOMIC IMPACT	COMMUNITY BENEFITS	GOLF/REC-REATIONAL
Using Agricultural Land for Golf; Impacts on Nearby Ag Land	Primary	+++	++		+		
General Growth/Impact on "Country"	Strong 2nd	+++	+	+			
Preservation of Open Space/Views	Strong 2nd	+++				+	
"Too Many Golf Courses!"	Strong 2nd	+++	+			+	
Intrusion of Resort into Laie	2nd	+++				++	
Potential for Further Development Around Golf Courses	2nd	+++	+		+		
Population Growth	Occasional	++		++			
Lifestyle Impacts	Occasional	++				+	
Potential Environmental Pollution	Primary	++	+++				
Amount of Water Required	Primary	++	++	++			
Traffic/Highway Congestion	Primary	++		+++			
Strains on Social Services	Occasional			+++			
Property Values/Taxes, Foreign Invest.	Strong 2nd	+		+	+++	++	
Jobs (Both Positive & Negative)	Strong 2nd				+++	++	
Helping Kuilima Success	2nd	++			+++	+	
Project Benefits for Community vs. "Outsiders"	Primary	+				++	++
Need for More Community Contact/ Information	Strong 2nd	+	+	+		+++	++
Housing Shortage	2nd					+++	
Attraction of More Japanese Visitors	Occasional	+			+	+	
More Social Division Into "Have's" Vs. "Have-Not's"	Occasional					++	
Golf Rates for Residents	Primary				+	++	+++
Meets Local Demand for Golf	2nd						+++
More Crowding of Kahuku Muncipal Golf Course	Occasional						+++

Six broad themes were detected:

- <u>Implications for Area Character</u> -- This touches on concerns about the "country" North Shore feeling, general growth and change, agricultural protection, and visual aspects.
- <u>Impacts on Ecology</u> -- Includes water use and concerns over impacts of pesticides, herbicides, and fertilizers.
- <u>Infrastructure</u> -- Primarily traffic congestion, but also social services and drinking water.
- <u>Economic Impacts</u> -- Jobs, property values/taxes, and help for Kuilima success.
- <u>Community Benefits</u> -- Socio-political themes: Who is this project serving? Are there, or could there be, any community "givebacks?"
- <u>Golf/Recreational</u> -- How will this serve the needs of local <u>golfers</u> in particular?

Two of these themes -- Area Character and Community Benefits -- appear particularly critical. All but a few of the individual issues seem related, to some degree, to one of these two themes (see Table 21). Furthermore, few issues seem strongly related to both themes, so that the themes do not overlap much.

In Section 2.4, a distinction was made between people who primarily identify with Koolauloa or the North Shore as "country" and those who live in particular "communities" requiring economic bases to survive.

Area Character issues (as discussed at more length below) go to the heart of the reasons that many people <u>not</u> born in the area chose to live there. Thus, these issues were most often raised by people in "country" areas -- Sunset, Punaluu, or Kaaawa. However, Kahuku and Laie residents also seek assurances about compatibility with agriculture and visual impacts. For the most part, people who raised these issues could support the golf courses only if satisfied the courses <u>will not</u> much change valued aspects of area character.

Community Benefit issues ("Is this just for rich outsiders, or is there something in it for our people?") were voiced more often by informants in traditional "communities" with town centers and a history of shared employment bases -- Kahuku, Hauula, Waialua, etc. While some people raising these issues were already convinced that golf courses would not benefit them, more indicated an interest in exploring possible give-backs.

These people said they might support golf courses if they will provide such benefits.

For the Laie/Malaekahana golf site, Laie residents responded strongly on both these major two underlying themes. Laie is an entire community with a particularly unique character, and Laie residents are not at all sure this character encompasses golf course development, even at the very edge of their community. On the other hand, Laie has strong community needs (such as affordable housing), and community leaders expressed cautious willingness to consider trade-offs if the needs were met in a significant way.

4.6.3.2 Issues Pertaining to Area Character

Among people who moved to Koolauloa or the North Shore as adults, a repeated comment during these interviews was: "We chose to live here because we liked it the way it was. And we've been fighting ever since to protect it." These informants often stressed that they had deliberately paid a price -- long commutes or foregone economic opportunities elsewhere -- to live in the "country." They have a commitment to hold on to the characteristics for which they re-shaped their lives. As one said, "The issue is change -- period."

People born in the area are often more willing to compromise to get more jobs and community stability, but they also value the rural character. (Some informants said that traditionally "pro-growth" residents are becoming more concerned with growth management and environmental impacts.)

Golf course Impacts on Agriculture thus comprised one of the most frequently raised issues. It was a concern both to the "country" residents who value rural scenery and also to those community residents who know the farmers personally. (As discussed earlier, however, crop farmers themselves are generally not opposed to the golf courses -- so long as their water supply is not affected and there is no housing around the courses.)

Also frequently raised (in a strong secondary way) were:

- General Growth/Country Impacts -- The issue which really identifies the theme was most often articulated in the Sunset area, as well as Punaluu and Kaaawa.

- Open Space/Views/Aesthetics -- For the most part, golf courses were seen in a positive light, as being much preferable to urban development above the highway. There were some questions about how well the landscaping would blend with the mountain background. And a few said they rejected golf courses as "citified greenery" not appropriate to the area.

- "Too Many Golf Courses!" -- Citing recent newspaper articles, some informants said they felt all of Oahu is being overwhelmed with new golf course proposals. (See Section 3.1 for analysis.) For Kuilima or the North Shore generally, other people simply felt the number of proposed courses was excessive: "What's the need?" (See Section 4.2 for discussion of golf course implications for overall Kuilima Resort.)

Two other issues were purely secondary in terms of the overall frequency of mention. However, they are potentially more important in particular places or circumstances:

- Intrusion into Laie -- While this issue was "secondary" in a regional context, it may be primary for Laie itself. Community leaders feel Laie is unique and distinctive; they do not feel golf courses are compatible with their community. (It should be noted that Laie golfers did not always share this sense of incompatibility.) However, the Laie reaction is also strongly tied to the community benefits theme, as discussed later.

- Potential for Further Development by Golf Courses -- Most informants accepted the fact that Kuilima Resort is not proposing any houses or condominiums around the Country Courses. However, a few suspected either Kuilima or Campbell would later try to build such housing. (NOTE: Kuilima does not own any of the adjacent land. Any effort by landowners to acquire housing for residential development would require full-scale public hearings.)

Some issues discussed below under other themes also pertain somewhat to the Area Character theme -- e.g., environmental pollution, traffic, and even the success of Kuilima (since few people want the resort to expand but then fail and deteriorate).

4.6.3.3 Impacts on Ecology

Concerns about Potential Environmental Pollution represent the strongest ecological issue; this was particularly frequently mentioned by North Shore informants. Informants say people worry about impacts of herbicides, pesticides, and fertilizers on both groundwater purity and the ocean environment by the coast. There is distrust of studies which indicate minimal impact, since people intuitively perceive there "must" be an effect.

The Amount of Water Required for golf courses was another very frequently mentioned issue. However, people sometimes were concerned about irrigation water for farmers and sometimes with drinking water. (The Sunset area is particularly affected by an inadequate drinking water delivery system.) Thus, the issue has to do with a number of underlying themes -- Ecology, Area Character (i.e., agriculture), and Infrastructure.

It should be noted that water represents the major question raised by farmers in the Punamano area. If the golf courses do not strain this resources, they would be acceptable.

4.6.3.4 Infrastructure (Traffic)

Although there were a few comments about strains on schools or other services from assumed population growth, the dominant issue here was Traffic Congestion on Kamehameha Highway.

Traffic was the single most frequently mentioned issue/concern in the interviews. However, it may not be the most important. It was usually listed in an automatic way: "Traffic is an issue, of course." And some people doubted that golf courses would really generate much additional traffic. However, the project traffic studies are likely to be of particular community interest. (NOTE: Preliminary estimates are that half the golf course use would be by Kuilima Resort, so that traffic impacts will in fact be relatively minimal.)

4.6.3.5 Economic Impacts

Economic issues were not among the very most frequently mentioned, but several fell in the "Strong Secondary" frequency category:

- Property Values/Taxes -- Usually although not always linked to foreign investment, this issue represented the greater economic apprehension. There was a general belief that golf course development would affect Koolauloa/North Shore property values and taxes, but there was considerable uncertainty as to how widespread the effect would be or exactly why it would occur.

  (NOTE: The analysis in Section 4.4.2 suggests that -- despite realtor perceptions of likely impact -- overall Oahu-wide market conditions rather than any particular nearby development will determine off-site property values.)

- Job Opportunities -- Jobs at golf courses were fairly often mentioned, but in different ways. About half the people mentioning jobs stressed that the area still needs nearby jobs to reduce commuting and youth unemployment. The other half felt that golf courses provide few and low-paying jobs. Informants' socio-economic status was strongly related to which view was taken, with middle- or upper-income people more likely to feel negative about golf course jobs; lower-income areas were more positive.

(NOTE: See Section 4.1 for employment impact analysis.)

4.6.3.6 Community Benefits (Socio-Political Impacts)

Along with Area Character, Community Benefits (or their perceived lack) comprised one of the two themes which seemed to underlie more issue than any other.

One of the most frequently mentioned of all issues had to do with how much the proposed project was for the Benefit of Community vs. "Outsiders" (with outsiders alternatively characterized as tourists, the rich, Japanese, or rich Japanese tourists). The basic question was: "Who does this project serve?" Some informants had already concluded there would be no community benefit: "We're not golfers."

Many others, however, were open to the possibility of negotiating community benefits. There was substantial awareness of Kuilima's track record in exploring ways for community residents to benefit from resort development. Given this history, many informants felt comfortable suggesting ideas for community "give-backs." Specific suggestions will be discussed in Section 4.7 on "Mitigations."

Issues mentioned with secondary frequency included:

- Need for More Community Contact/Information -- Given Kuilima's history of community outreach, many informants were puzzled at the lack of community contact to date. Some were annoyed, believing this represented a return to "the old days when developers felt they didn't have to talk to anyone." Others simply assumed the process had not yet begun and would eventually result in answers to their questions; however, they stressed the need to start soon due to rumors and misinformation in the area.

  (NOTE: At the time of the golf course permit applications, the Kuilima North Shore Strategy and Planning Committee -- the main community-Resort forum for communication -- was focused on other topics. As of this writing, Kuilima planned to initiate a community involvement program on the golf course proposal in February 1989.)

- Housing Shortage -- The issue was usually expressed as: "Our community doesn't need golf courses; it needs affordable housing!" The idea was not that the proposed golf course sites should be used for low-cost housing;

rather, it was a particular form of the more general concept that community support will go to projects that benefit needs of the community itself. In Laie, some residents felt that the Laie/Malaekahana course could be built in conjunction with community-oriented housing.

A variety of other issues had at least incidental relationship to the Community Benefits. These would include all of the Economic issues -- as well as golf rates for residents (below).

4.6.3.7 Golf/Recreational

The issue of Golf Rates for Residents (including frequency of access as well as affordability) was *the* major concern for area golfers and was the second most frequently mentioned topic by informants overall. The fact that non-golfers as well as golfers brought up the issue reflects (1) the fact that this issue strongly overlaps with the "Community Benefits" theme (above), and (2) sensitivities and rumors about Kuilima's pricing policies for resident golfers.

Some concern was expressed that, even if Kuilima itself charges fair and reasonable rates to residents, the courses would eventually be sold to others who would greatly escalate fees.

(NOTE: Community rates were discussed in Section 4.5. The Honolulu City Council has established a precedent of using zoning conditions to assure affordable golf for residents, no matter who owns or operates a golf course in the future.)

Secondary issues for this theme included: (1) Meeting Local Demand for Golf -- Most area golfers emphasized that both current North Shore courses (at Turtle Bay and the Kahuku Municipal Course) are extremely crowded. (2) Feared Crowding at Kahuku -- A few people feared that the new Kuilima courses would attract so many more golfers that some would inevitably "spill over" to the much cheaper Kahuku course.

4.7 MITIGATIONS

The foregoing impact discussion suggests the possibility of mitigations in three broad areas:

- Labor supply development;
- Special rates for community golfers; and
- Other possible community benefits (suggested by residents themselves).

4.7.1 Labor Supply Development

Section 4.1 established that Kuilima Resort expansion alone, with or without additional golf courses, is likely to absorb all currently available labor supply. However, Census figures indicate several thousand residents are commuting long distances to work. The challenge will be to (1) successfully match commuters with desired nearby jobs -- whether at golf courses or other Resort components; and (2) train pockets of labor supply (e.g., people lacking basic skills or displaced farm/plantation workers).

The mechanism for such programs is currently being put in place and can easily be extended to accommodate golf course labor supply needs.

Prior to obtaining zoning approvals in 1986, Kuilima began working with community representatives on plans for a job training program. This commitment was formalized by the City Unilateral Agreement (i.e., zoning conditions), which also required Kuilima to contribute $500,000 for training purposes.

Work on the training program was temporarily suspended while the resort underwent change of ownership. However, as of January 1989, members of the Kuilima/North Shore Strategy and Planning Committee (K/NSSPC) were working with Resort consultants and attorneys to finalize an application to the Internal Revenue Service for creation of a non-profit corporation ("Resort Training, Inc.," or RTI), which will utilize the $500,000 and any future funds which may be obtained for training purposes.

According to the most recent draft "Action Plan" (Kuilima Development Company and North Shore Career Training Corporation, 1988), the non-profit RTI Board of Directors would be comprised primarily of resort employers, for two reasons:

(1) To assure that the training program meets actual employer needs, in order to improve the odds that residents will actually be placed in available jobs; and

(2) To give employers a sense of involvement and control, in hopes that some may contribute additional funds to the existing $500,000 from Kuilima Resort.

The intent is to expand the RTI Board of Directors as new employers come on line at the Resort. Thus, future operators of the Country Courses at Kahuku (whether individually or on a joint basis) could be represented on the Board.

There will also be community representation on the RTI Board of Directors. RTI programs will be contracted out on an annual basis, to assure performance and accountability. It is currently expected that the initial contractor will be the North Shore Career Training Corporation (NSCTC). The NSCTC -- funded in part by Kuilima and the Campbell Estrate --has been providing job training services to Koolauloa/North Shore residents since 1978.

Among the specific programs and activities envisioned in the Kuilima job training "Action Plan" are:

- o Community outreach and education programs designed to increase awareness of residents -- particularly commuters -- about upcoming new employment opportunities.
- o Basic skills and work habit training to increase employability of young people and the "hard-core" unemployed.
- o Assistance to employers in upgrade training, to assure resident advancement along career ladders.
- o Construction phase liaison, to assure area contractors of opportunity for contracts and area construction workers of employment close to home.

4.7.2 Community Golf Rates

Section 4.6.3 established that accessibility and affordability of new courses for area golfers make up one of the biggest community concerns regarding the project. And Section 4.5 pointed out that Koolauloa/North Shore golfers face an unusual price differential for Oahu, since their choice is currently limited to an extremely inexpensive nine-hole municipal golf course or a more expensive resort course. That is, no intermediate-priced daily fee course is now in the area.

As of this writing, Kuilima Resort is still holding talks with the community's K/NSSPC Recreation Sub-Committee to explore the possibility of establishing some type of community rate -- only for golfers or golf clubs from the Koolauloa/North Shore area -- below the overall rate for Hawaii residents.

The K/NSSPC has invited representatives from various area golf clubs to participate in these discussions.

If successful, the outcome would effectively give local golfers a North Shore golfing option -- at least for certain times and conditions -- similar in pricing to the daily-fee courses available in other parts of the island.

The current discussions apply only to the existing Turtle Bay golf course. However, they provide an obvious framework for extending to future courses. Rates at future courses might have to be separately determined to account for actual construction and operational costs for these new courses.

Even if no community rate is established, the Honolulu City Council has set recent precedents in requiring golf course developers to guarantee permanent rate reductions for all Hawaii residents. Kuilima Resort anticipates negotiating with the City to establish some such commitment for general "kamaaina" rates.

(NOTE: One action endorsed by some community golfers would be to have Campbell Estate build a new 18-hole municipal course at the other potential Laie/Malaekahana golf site, in exchange for the City returning the smaller nine-hole Kahuku site. This possibility is not further explored here for several reasons. First, it is not an action which could be taken by the present applicant, Kuilima Resort. Second, it may be a highly controversial idea. While some golfers would like the 18-hold options, others are very loyal to, and protective of, the current Kahuku course. They say it is the only affordable course next to the ocean, and they like the fact that carts are not required so that more exercise is possible.)

4.7.3 Community Suggestions for Other Potential Benefits

In the course of the community interviews discussed in Section 4.6, several other potential "give-backs" were suggested by various residents. As of this writing, none have been formally presented to Kuilima Resort, and Kuilima thus has no official response. However, some or all of the following may become the focus of discussions during subsequent Resort-community dialogue.

(1) **Affordable Housing by Laie/Malaekahana Site:** Housing is one of Laie's most pressing needs. Some Laie residents express tentative interest in working with Kuilima and/or Zions Securities Corp. to develop affordable housing on Zions properties to the Laie side of the proposed new course. It is recognized that such housing would need to be screened from immediate golf course views, both to protect the natural setting for golfers and to prevent the houses from being re-sold and/or taxed at "golf course view" rates. City zoning approvals would be needed.

According to Zions' Hawaii Division Manager (personal communication, Marvin Stone, January 11, 1989), Zions might consider such a development, even though more financial return could be made from an upscale project near a golf course. He said Zions differs from other landowners and developers because its principal mission is to serve the Laie Temple and campus of Brigham Young University, not to maximize profit.

(2) **Other Recreational Facilities or Contributions:** A number of fairly general suggestions involved the common theme that resort golf courses are for adult visitors, but the community needs other facilities -- particularly for youth. Some of the ideas set forth included:

- o community picnic facilities near one of the golf courses;
- o contribution of cash or other resources to develop a recreational center for teen-agers in Koolauloa;
- o facilitating development of Kahuku District Park or one of the other planned Kuilima beach parks, prior to the present schedule;
- o making golf course time available to area high school, college, or other youth golf teams.

(3) **Specific Proposals for Education/Training Contributions:** These included ideas such as scholarships or upgrade training to assure that residents will be promoted to supervisory jobs. (Such proposals could easily fit into the previously-discussed Kuilima job training program.)

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APPENDIX S

PROPOSED COUNTRY COURSES AT KAHUKU:
IMPACT ON STATE AND COUNTY FINANCES

PREPARED FOR:

Kuilima Resort Company

PREPARED BY:

Decision Analysts Hawaii, Inc.

February 1989

Contents

Executive Summary

The proposed Country Courses at Kahuku would be comprised of four 18-hole golf courses, two driving ranges, practice putting greens, four clubhouses, and associated improvements.

After the project is approved, the County would net approximately $117,800 in rollback taxes which are triggered when land which has been assessed and taxed at its agricultural value is developed. Upon full development of the project, the County would net over $286,000 per year.

The State would net about $1.3 million from taxes on construction expenditures and, at full development, would net over $440,000 per year from taxes on operations.

Proposed Country Courses at Kahuku: Impact on State and County Finances

INTRODUCTION[1]

The proposed Country Courses at Kahuku would be comprised of four 18-hole golf courses, two driving ranges, practice putting greens, four clubhouses, parking areas, maintenance areas for each course, access and circulation roadways, wastewater collection systems, storm-water runoff control, a potable water supply and fire protection system, a non-potable irrigation water system, and other utilities systems. A golf course, clubhouse, and maintenance area would be located on 228 acres at *Malaekahana* on a site between Laie and Kahuku and mauka of Kamehameha Highwa; and the other three golf courses and improvements would be located on 638 acres at *Punamano*, mauka of the Turtle Bay Resort. Three of the four clubhouses would be small, ranging in area from 10,000 to 14,000 square feet. Each would have a snack bar, pro shop, small locker room, lounge area, administration area, starting area, and small kitchen. The fourth clubhouse would be larger at 20,000 square feet, and would have, in addition to the above areas, small meeting rooms and a restaurant.

The impact of this project on State of Hawaii and City & County of Honolulu finances is summarized below, with all values expressed in 1988 dollars.

COUNTY REVENUES AND EXPENDITURES

Current Revenues[2]

Currently, the property tax on the *Malaekahana* site is $686 per year. The tax is low because the property is used for grazing, which qualifies it for a property tax assessment based on the agricultural value of the land, rather than its market value.

For the *Punamano* site, the property tax is $16,109 per year. In this case, the land is fallow, so it does not qualify for the low agricultural assessment.

Projected Revenues[2]

When land assessed and taxed at its agricultural value is developed, the action triggers "rollback" taxes which recover 10 years of back taxes based on the difference between taxes computed on the market assessment and the agricultural assessment, plus a penalty of 10 percent. Development of the *Malaekahana* site would trigger the rollback tax. For 1988, the tax would have been $12,684 if based on its market, rather than its agricultural, value. Subtracting the actual tax of $686 gives an avoided tax of $11,998 for 1988. After adjusting for inflation, the 10-year rollback tax—including the 10-percent penalty—amounts to an estimated $117,800.[3]

Upon full development, the property assessment would be about $33.7 million. This is based on the property assessments for the golf course at the Turtle Bay Resort of $425,000 per hole and $522,000 for the clubhouse. Each driving range is assumed to have the same value as one "hole." The Turtle Bay clubhouse has an area of about 13,000 square feet, with facilities similar to those of the proposed small clubhouses. The assessment of the larger clubhouse, which includes a restaurant and small meeting rooms, is estimated at $700,000, based on an area adjustment. Values of other improvements (maintenance area, parking, roads, water systems, sewers, drainage, etc.) are not estimated.

Property taxes on the four golf courses would exceed $303,000 per year, based on a tax rate of $9 per $1,000.[4]

Additional revenues to the County would be derived from miscellaneous taxes and user fees. In addition, revenues would be derived from County taxes paid by employees of the golf courses. However, these taxes would be offset by corresponding government expenditures on facilities and services provided to these residents.

Projected Expenditures

No significant County expenditures are anticipated for infrastructure development, facilities or services in support of the golf courses, since these items would be paid by the developer, operator, and/or users.

Projected Net Increase in Revenues

Based on the above, the County would net approximately $117,800 in rollback taxes after the project is approved. Upon full development, the County would net over $286,000 per year.

STATE REVENUES AND EXPENDITURES

Current Revenues

Current economic activity at the property proposed for development is at a low level: the *Malaekahana* property is used for grazing, and no economic activity takes place on the Punamano property. Correspondingly, State revenues are negligible.

Projected Revenues[1,5]

Construction

The State would derive an estimated $1.3 million in general excise taxes on construction expenditures for the four golf courses and related facilities. This estimate is based on 4 percent of the construction value, which is approximated by the $33.7 million property assessment.

Operations

At full development, revenues from golf operations, the pro-shops, and restaurants are estimated at $11 million per year. This is based on an estimated 150 rounds of golf per day for each of the four golf courses, and an average expenditure of $50 per golfer. The 4-percent general excise tax on this amount is $440,000 per year. Additional revenues to the State would derive from corporate income taxes, taxes paid by suppliers, and miscellaneous taxes and user fees.

Further State revenues would be derived from income taxes paid by employees of the golf courses and excise taxes on their expenditures. However, these taxes would be offset by corresponding government expenditures on facilities and services provided to support these residents.

Projected Expenditures

No significant State expenditures are anticipated for infrastructure, facilities or services to support the golf course operations since these items would be paid by the developer, operator, and/ or users.

Projected Net Increase in Revenues

Based on the above, the State would net about $1.3 million from taxes on construction expenditures and, at full development, would net over $440,000 per year from taxes on operations.

COMBINED NET REVENUES TO THE STATE AND COUNTY.

In summary, the County would net approximately $117,800 in rollback taxes after the project is approved, and the State would net about $1.3 million from taxes on construction expenditures. Upon full development, the State and County would net over $700,000 per year from taxes on operations.

REFERENCES

[1] Information provided by Group 70.
[2] Existing property assessments and taxes provided by Campbell Estate.
[3] Inflation factor derived from Department of Planning and Economic Development, *The State of Hawaii Data Book 1987*, p. 408.
[4] Tax rate from Department of Planning and Economic Development, *The State of Hawaii Data Book 1987*, p. 305.
[5] Expenditures per day estimated by Decision Analysts Hawaii, Inc.