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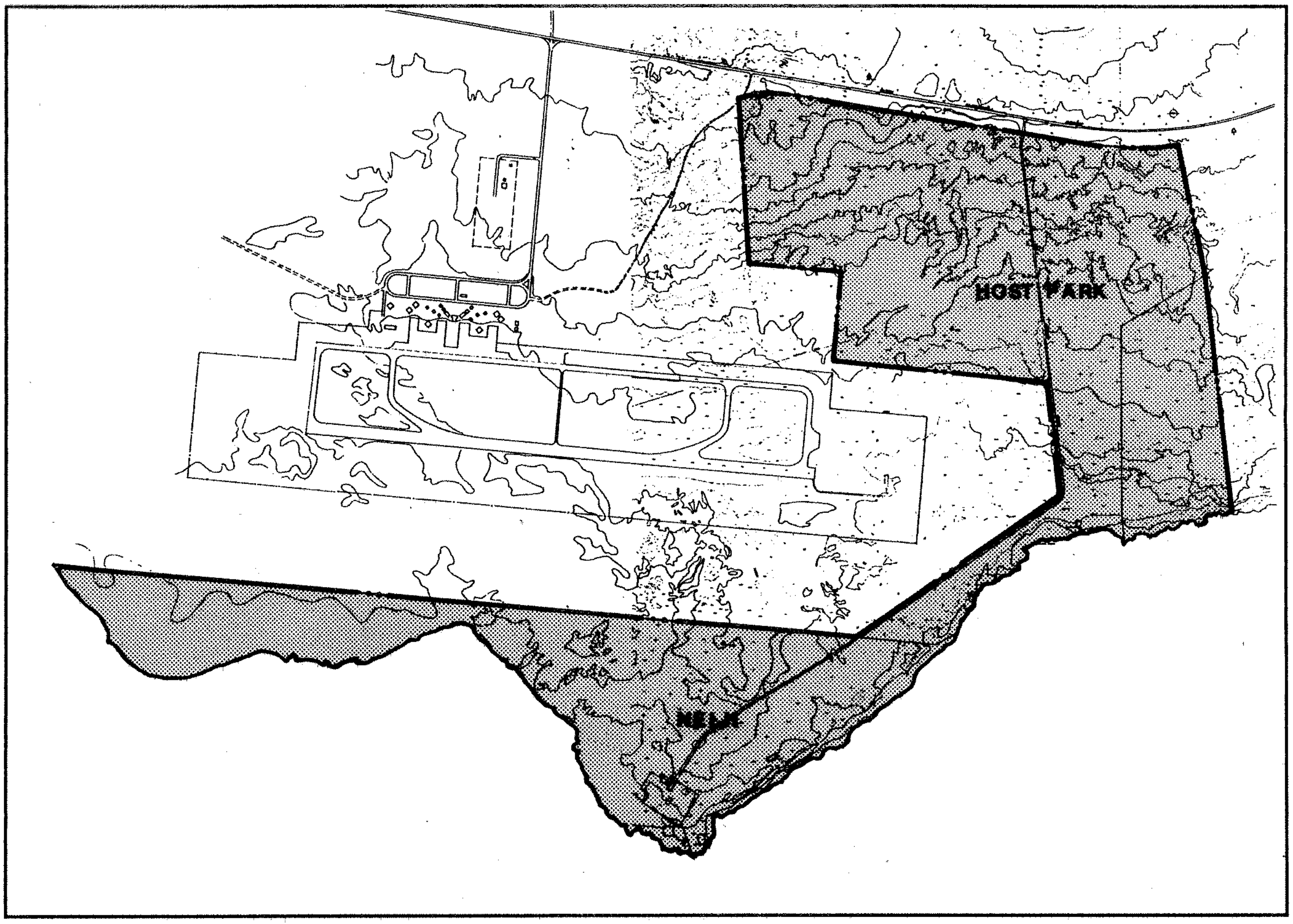

PROJECT DESCRIPTION
AND
ENVIRONMENTAL REVIEW

MODIFICATION OF EXISTING APPROVALS FOR NELH AND HOST PARK

KEAHOLE, NORTH KONA, HAWAII

April 1991

M C M PLANNING

LAND USE - ENVIRONMENTAL - ECONOMIC DEVELOPMENT

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THE
NATURAL ENERGY LABORATORY OF HAWAII
AUTHORITY

Project Description and
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Keahole, North Kona, Hawaii

(T.M.K. 7-3-43: 3 por., 5, 41 & 42;
and, T.M.K. 7-3-9: 23 & 24)

Prepared
by
MCM Planning

April, 1991

SUMMARY AND DETERMINATION

The Natural Energy Laboratory of Hawaii (NELH) at Keahole, North Kona, Hawaii, was established by the State in 1974. The purpose of NELH was to facilitate ocean related research and demonstration energy and aquaculture projects. In 1986, ground was broken on adjacent lands for the first increment of the State's Hawaii Ocean Science and Technology (HOST) Park, a development which was intended to provide sites for the commercialization of research activities initiated at NELH. In 1990, administration of NELH and HOST Park was consolidated into one entity, the Natural Energy Laboratory of Hawaii Authority (NELHA). NELHA also manages the Geothermal Research Park in Puna, Hawaii.

NELHA proposes the following modifications to existing approvals for the lands and facilities at Keahole:

- Subdivision, infrastructure development, and leasing of 83 acres of ocean front land at 'O'oma II, North Kona, Hawaii (TMK: 7-3-09: 23), formerly belonging to Kahala Capital Corporation. This land, which was obtained in 1986 in exchange for 83 acres of the original HOST Park property, must be reclassified from Conservation to Urban by the State Land Use Commission and rezoned to General and/or Limited Industrial by the County of Hawaii before infrastructure can be developed and the parcels leased. A County Special Management Area (SMA) Use Permit must also be obtained;

- Development of some energy and mariculture projects on different sites within the project area than were originally proposed; and,

- Disposal of seawater return flows into small covered trenches on individual properties rather than into a large common trench.

The following accepted environmental impact statements address the development and operation of NELH and HOST Park:

"Environmental Impact Statement for the Natural Energy Laboratory of Hawaii at Keahole Point, Hawaii (Phase I)" (RCUH EIS), Research Corporation of the University of Hawaii, 1976.

"Final Environmental Impact Statement, Development Plan for the Hawaii Ocean Science and Technology Park and Expansion of the Natural Energy Laboratory of Hawaii, Keahole, North Kona, Hawaii" (HTDC FEIS), High Technology Development Corporation, 1985.

"Final Environmental Impact Statement, Alternative Methods of Seawater Return Flow Disposal, Keahole, North Kona, Hawaii" (NELH FSEIS), Natural Energy Laboratory of Hawaii, 1987.

The following accepted EIS addressed the land characteristics and proposed aquaculture uses on the 83-acre parcel obtained by NELHA in the 1986 land exchange:

"Final Environmental Impact Statement, 'O'oma II, North Kona, Hawaii" ('O'oma II FEIS), prepared for Kahala Capital Corporation by Helber, Hastert, Van Horn & Kimura, Planners, 1986. Submitted to the Planning Department, County of Hawaii.

This project description and environmental review evaluates the construction and operating characteristics of the proposed modifications in comparison with previously disclosed actions and environmental effects. The evaluation focuses on whether the proposals would introduce modifications to the extent that: (a) new or different environmental impacts are anticipated; (b) the intensity of environmental impacts would be increased; or (c) if new circumstances or evidence have brought to light different or more intense environmental impacts not previously addressed.

Based on the accompanying review, it was determined that all of the actions and environmental effects associated with the proposed modifications were previously disclosed and all of the potential adverse impacts are **within the same range** as those addressed in previously accepted environmental statements.

TABLE OF CONTENTS

		Page
Summary and Determination		S-1
List of Figures		ii
I:	**INTRODUCTION**	
	A. BACKGROUND AND PROPOSED ACTIONS	1
	B. REGIONAL SETTING	5
	C. OVERVIEW OF HOST/NELH ACTIVITIES	5
	D. ENVIRONMENTAL COMPLIANCE	8
II:	**ENVIRONMENTAL REVIEW OF LAND EXCHANGE PARCEL**	
	A. DESCRIPTION OF THE PARCEL	9
	1.0 Background	9
	2.0 Development Plan	9
	B. ENVIRONMENTAL REVIEW	12
	1.0 Previous Assessments	12
	2.0 Access Roads	12
	3.0 Anchialine Ponds	13
	4.0 Archaeological Resources	13
	5.0 Shoreline Access/Recreation	13
	C. ENVIRONMENTAL MONITORING	15
III:	**ENVIRONMENTAL REVIEW OF NEW PROJECT LOCATIONS**	
	A. DESCRIPTION OF THE PROJECTS	17
	B. ENVIRONMENTAL REVIEW	17

IV: ENVIRONMENTAL REVIEW OF MODIFICATION OF SEAWATER DISPOSAL SYSTEM

A. DESCRIPTION OF THE EXISTING SYSTEM................22

Table 1.0 Seawater Return Flows at NELH...........23

B. PROPOSED MODIFICATIONS OF APPROVED METHODS OF DISPOSAL..............................24

C. ENVIRONMENTAL REVIEW..............................24

APPENDIX A: DESCRIPTION OF CEMP AND SUMMARY OF RESULTS....A-1

List of Figures

No.		Page
1.	Project Location	2
2.	NELHA Keahole Properties	3
3.	Land Exchange Parcels	4
4.	Tax Map Keys: NELHA Keahole Properties	6
5.	Land Use and Zoning	7
6.	HOST Park Master Plan	10
7.	'O'oma II Development Concept	11
8.	Archaeological Sites on Exchange Parcel	14
9.	Location of Monitoring Wells & Sampling Sites	16
10.	NELH: Land Use and Ocean Water Plan	18
11.	Proposed Location of New OTEC Plant	19
12.	Ocean Use Corridor	21

I: INTRODUCTION

A. BACKGROUND AND PROPOSED ACTIONS

The Natural Energy Laboratory of Hawaii (NELH) was established by the State in 1974 for ocean related research and demonstration energy and aquaculture projects. In 1986, ground was broken on adjacent lands for the first increment of the State's Hawaii Ocean Science and Technology (HOST) Park, a development which was intended to provide sites for the commercialization of research activities initiated at NELH.

Until 1990, the properties, which are located at Keahole, North Kona, Hawaii (Figure 1), were separately administered, although their missions were complementary. The 1990 State Legislature (Chapter 227D, HRS) consolidated management of NELH and HOST Park lands and facilities under a single administrative organization -- the Natural Energy Laboratory of Hawaii Authority (NELHA). Figure 2 shows the Keahole property presently managed by NELHA; NELHA also manages the Geothermal Research Park at Puna, Hawaii.

NELHA proposes the following modifications to existing approvals for the lands and facilities at Keahole:

- Subdivision, infrastructure development, and leasing of 83 acres of ocean front land at 'O'oma II, North Kona, Hawaii (TMK: 7-3-09: 23). This land, which was obtained from Kahala Capital Corporation in 1986 in exchange for 83 acres of the original HOST Park property (Figure 3), must be reclassified from Conservation to Urban by the State Land Use Commission and rezoned to General and/or Limited Industrial by the County of Hawaii before infrastructure can be developed and the parcels leased. A County Special Management Area (SMA) Use Permit must also be obtained;

- Development of some energy and mariculture projects on different sites within the project area than were originally proposed; and,

- Disposal of seawater return flows into small trenches on individual properties rather than into a large common trench.

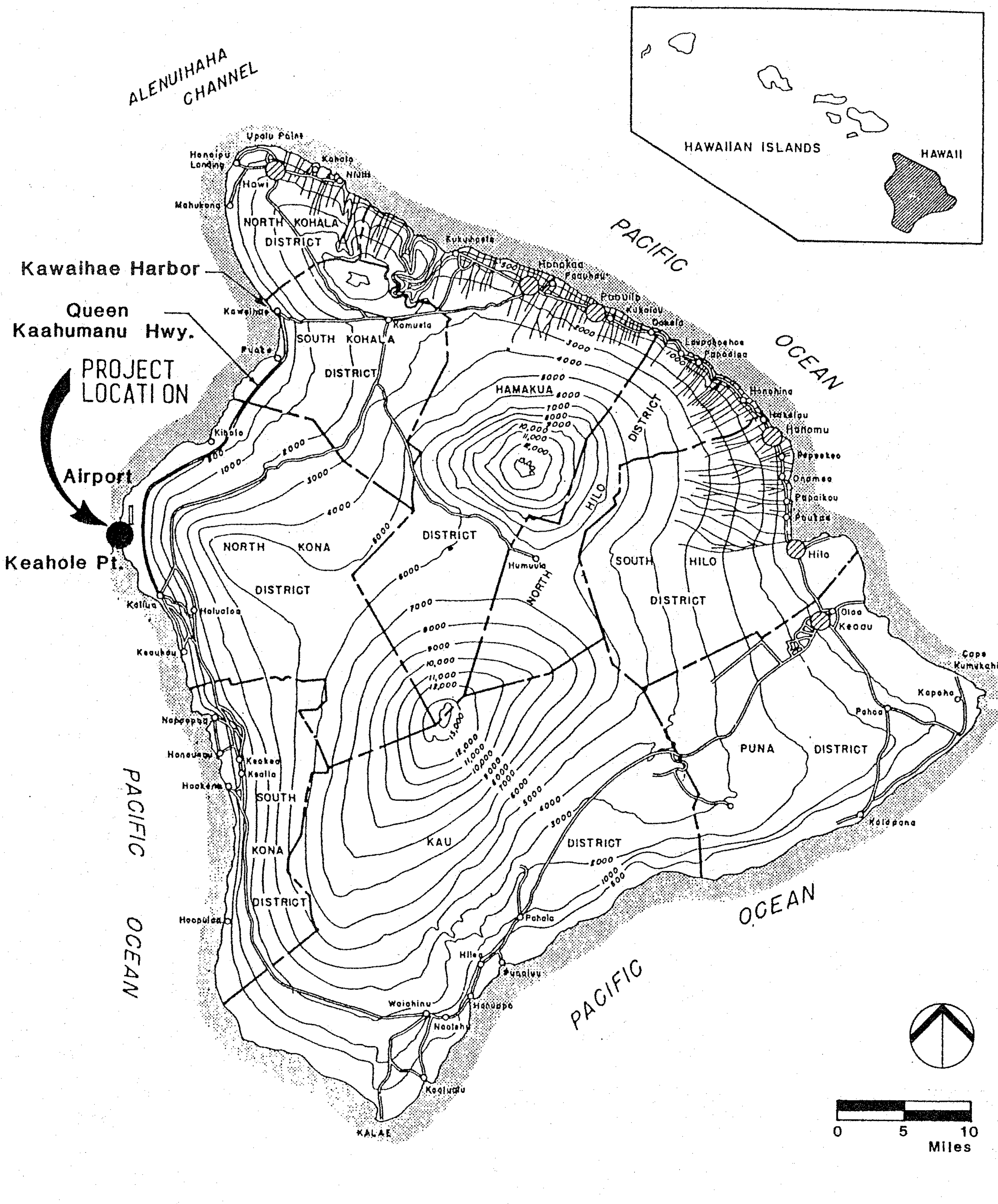


Figure 1
PROJECT LOCATION

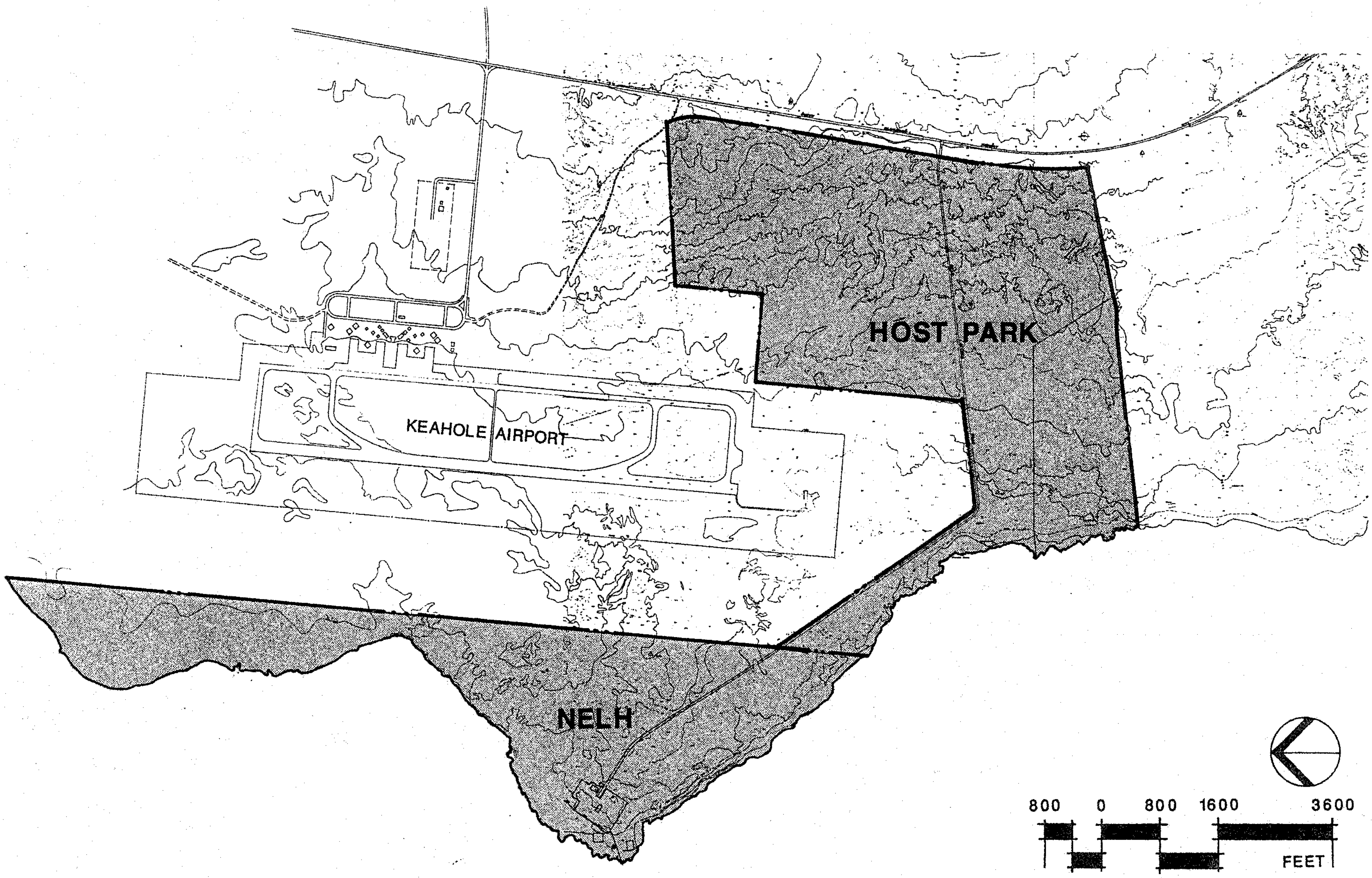


Figure 2
NELHA KEAHOLE PROPERTIES

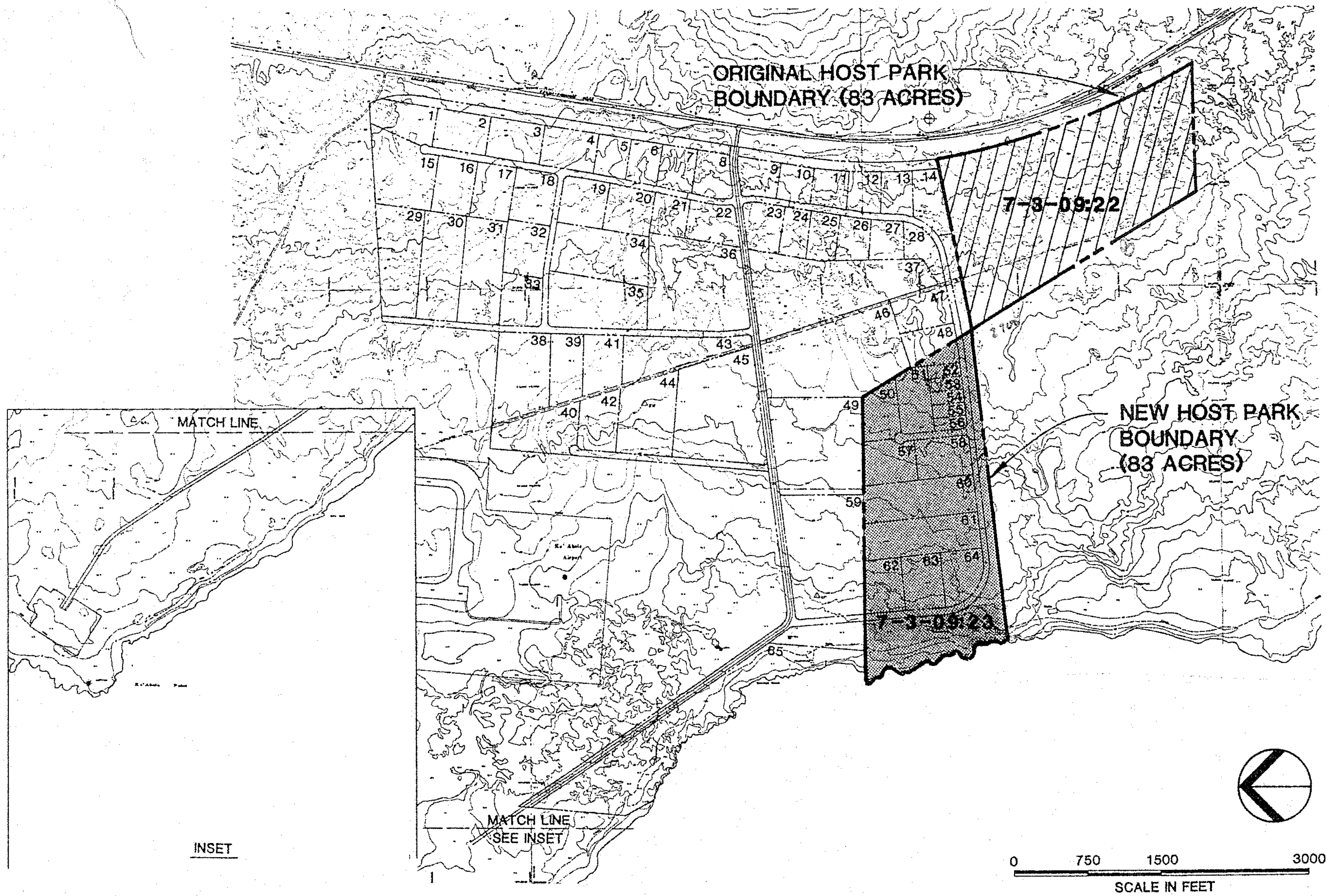


Figure 3
LAND EXCHANGE PARCELS

SOURCE: R. M. TOWILL CORPORATION

This report describes these modifications and compares their potential adverse impacts with those disclosed in previously approved environmental impact statements.

B. REGIONAL SETTING

The 322-acre Natural Energy Laboratory of Hawaii (NELH) and the 547-acre Hawaii Ocean Science and Technology (HOST) Park (Figure 2) have been consolidated under NELHA, which will promote, lease and manage both facilities and act as a facilitator in the transition of on-site businesses from fundamental and applied research to commercialization. The properties are located at Keahole Point, North Kona, Hawaii, west of Queen Kaahumanu Highway, and adjacent to the western and southern boundaries of the Keahole Airport (Tax Map Keys 7-3-43: 3 por., 5, 41 & 42; and Tax Map Key 7-3-9: 23 & 24, Figure 4). The Keahole site was chosen for both NELH and HOST Park because of the nearby availability of clean, cold, nutrient-rich deep ocean water; a warm ocean surface layer not subject to strong seasonal cooling; high, year-round solar radiation with little cloud cover; and accessibility to airports, harbors and highways.

Most of the NELHA lands are situated within the State Land Use Urban District. The 83-acre exchange parcel and about 33 acres of shoreline below the access road within HOST Park are in the State Conservation District. The County of Hawaii General Plan Land Use Pattern Allocation Guide (LUPAG) Map designates the properties "Industrial". The NELHA properties are zoned MG-1a, MG-3a, ML-3a and Open (Figure 5).

The properties are located within the County of Hawaii's Special Management Area (SMA). The shoreline areas are used for various recreation activities including fishing and picnicking.

C. OVERVIEW OF HOST/NELH ACTIVITIES

The major natural asset of the Keahole site for ocean thermal energy conversion research and cold water aquaculture is the steep ocean bottom gradient directly offshore which makes possible the intake of deep, cold ocean water at depths in excess of 2,000 feet by means of relatively short lengths of pipe -- generally in the range of 6,000 to 8,000 feet.

There are presently six cold water pipelines (including a 40-inch system installed as a joint project between NELH and the U.S. Department of Energy) bringing ashore 6°C (43°F) water from about 600 m (2,000 ft.) deep. The total cold water pumping capacity is more than 20,000 gallons per minute.

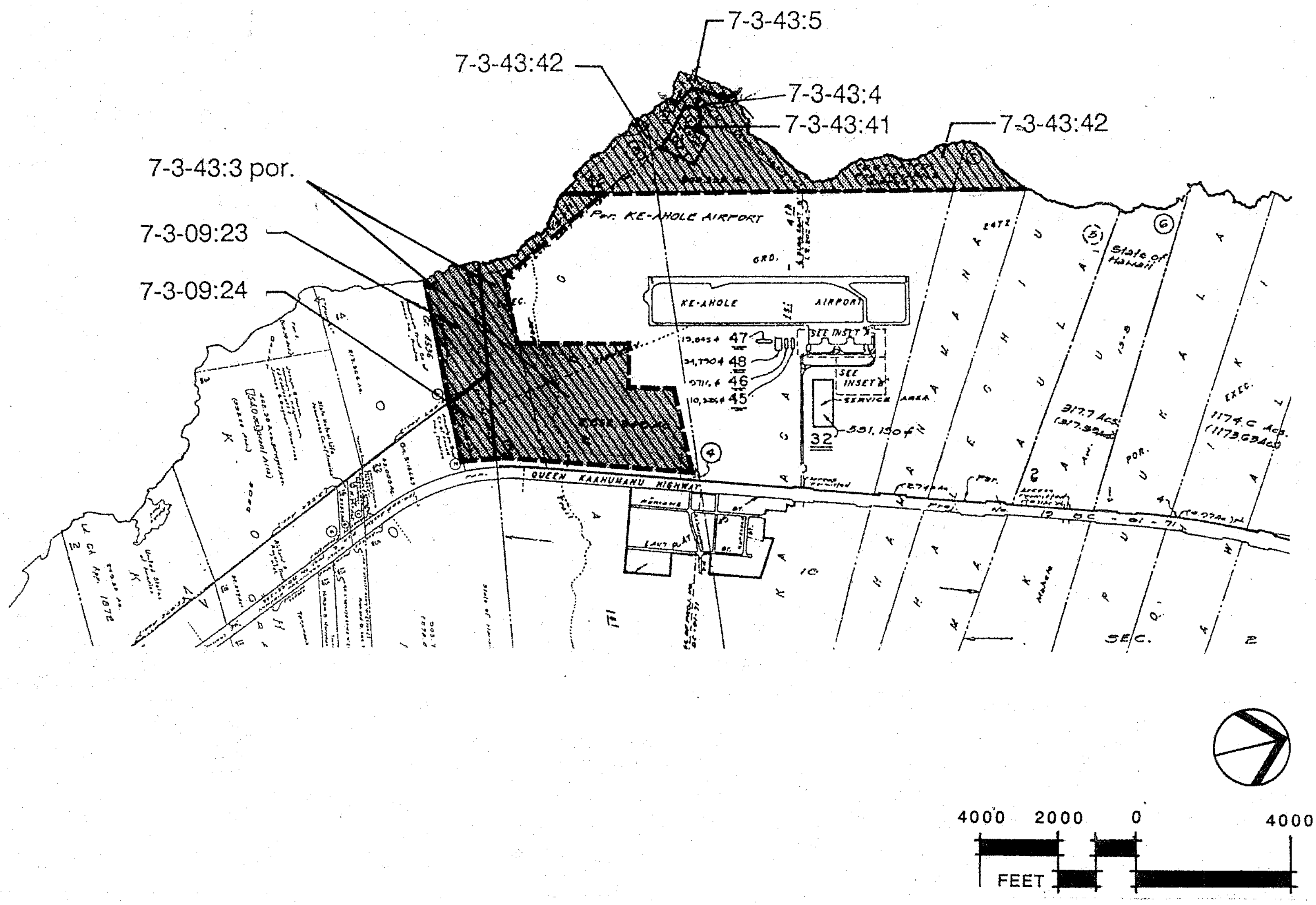


Figure 4
TAX MAP KEYS: NELHA KEAHOLE PROPERTIES

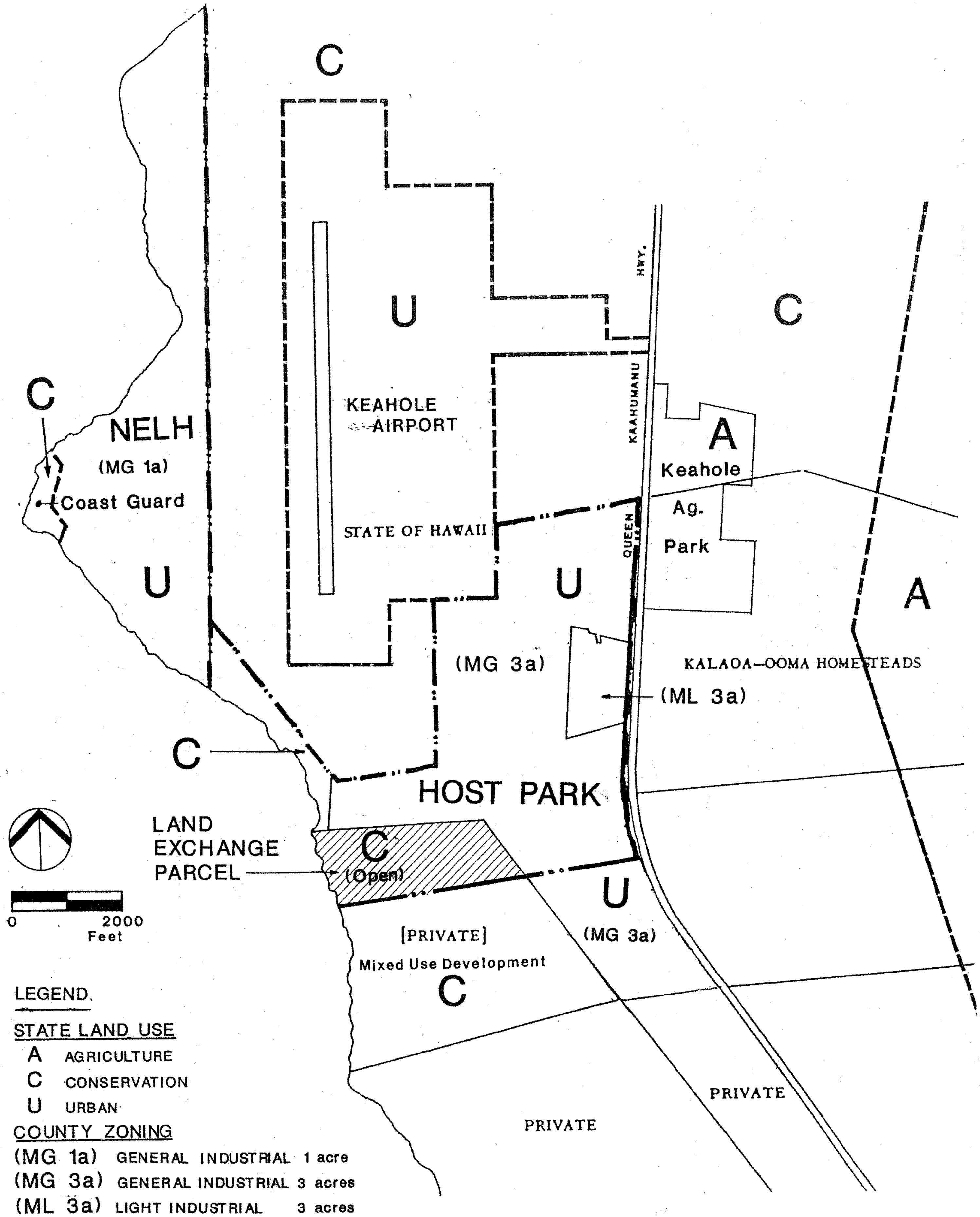


Figure 5

LAND USE AND ZONING

Existing activities on the sites include twelve (12) aquaculture enterprises and four (4) energy projects, including Ocean Thermal Energy Conversion (OTEC).

D. ENVIRONMENTAL COMPLIANCE

The cumulative impacts of long-term operation and expansion of NELHA operations were evaluated in three previously-accepted environmental impact statements:

> "Environmental Impact Statement for the Natural Energy Laboratory of Hawaii at Keahole Point, Hawaii (Phase I)" (RCUH EIS), Research Corporation of the University of Hawaii, 1976.
>
> "Final Environmental Impact Statement, Development Plan for the Hawaii Ocean Science and Technology Park and Expansion of the Natural Energy Laboratory of Hawaii, Keahole, North Kona, Hawaii" (HTDC FEIS), High Technology Development Corporation, 1985.
>
> "Final Environmental Impact Statement, Alternative Methods of Seawater Return Flow Disposal, Keahole, North Kona, Hawaii" (NELH FSEIS), Natural Energy Laboratory of Hawaii, 1987.

The following accepted EIS addressed the impacts of land development and proposed aquaculture uses on the adjacent 83-acre parcel obtained by NELHA in the 1986 land exchange:

> "Final Environmental Impact Statement, 'O'oma II, North Kona, Hawaii" ('O'oma II FEIS), prepared for Kahala Capital Corporation by Helber, Hastert, Van Horn & Kimura, Planners, 1986. Submitted to the Planning Department, County of Hawaii.

The HTDC FEIS and the NELH FSEIS both evaluated environmental effects based on "worst case" conditions at full development. The full-development scenario previously assessed would not change as a result of any of the actions described in this report. The impacts evaluated for the land exchange parcel are similar to those that would occur under NELHA management.

II: ENVIRONMENTAL REVIEW OF LAND EXCHANGE PARCEL

A. DESCRIPTION OF THE PARCEL

1.0 Background

By Exchange Deed and Agreement for Exchange dated December 30, 1986, 83 acres of HOST Park land located in the upper portion of the site were exchanged for 83 acres of ocean front property belonging to Kahala Capital Corporation (Figure 3). The new parcel, which is undeveloped, has been incorporated in the HOST Park Master Site Plan (Figure 6). The newly-acquired 83 acres is presently in the State Land Use Conservation District and is zoned "Open" by the County of Hawaii (Figure 5). Before the property can be subdivided and leased, it must be reclassified to Urban by the State Land Use Commission and rezoned by the County to a general industrial category, probably MG-1a. A County of Hawaii Special Management Area Use Permit (SMA) will also be required.

2.0 Development Plan

- **Proposed Uses:** The use proposed by NELHA is similar to what was previously proposed for the area by Kahala Capital Corporation ('O'oma II FEIS). The original development concept included open space and a beach park along the coast and approximately 50 acres of high technology/aquaculture uses to complement the adjacent facilities (Figure 7). The development concept for the parcel in the revised HOST Park master plan is essentially the same (Figure 6).

- **Subdivision:** Lots developed in the first increment of HOST Park ranged in size from 3 to 20 acres. Recent trends in market demand indicate the need for one-acre lots to accommodate small ocean water users and for a mix of lot sizes to allow businesses to expand incrementally. The parcel is proposed to be subdivided into fourteen lots: five of one acre; seven of 5 acres; and two ten acre parcels. NELHA will lease the lots to approved tenants, who will construct their own on-site improvements in conformance with NELHA standards.

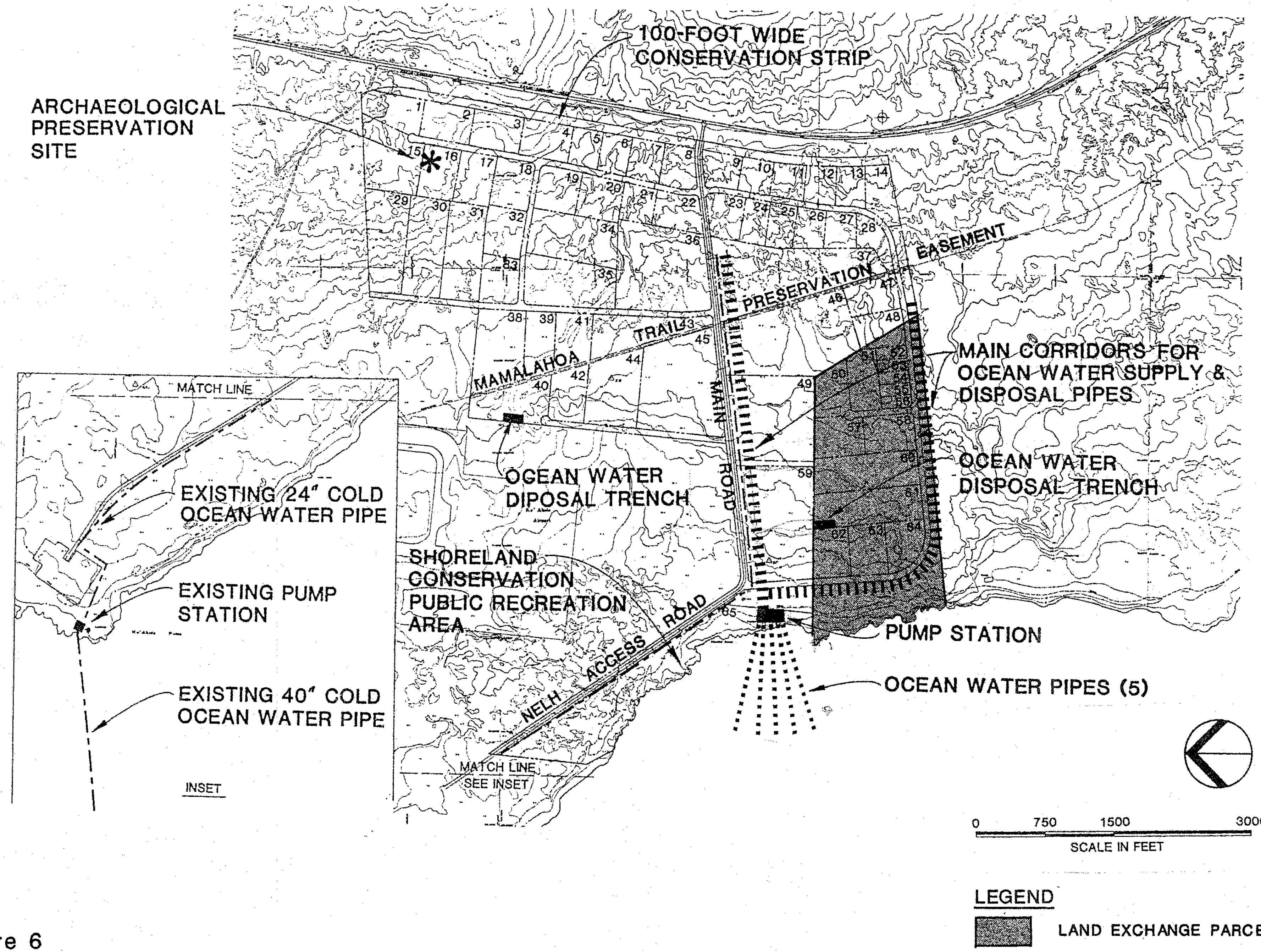
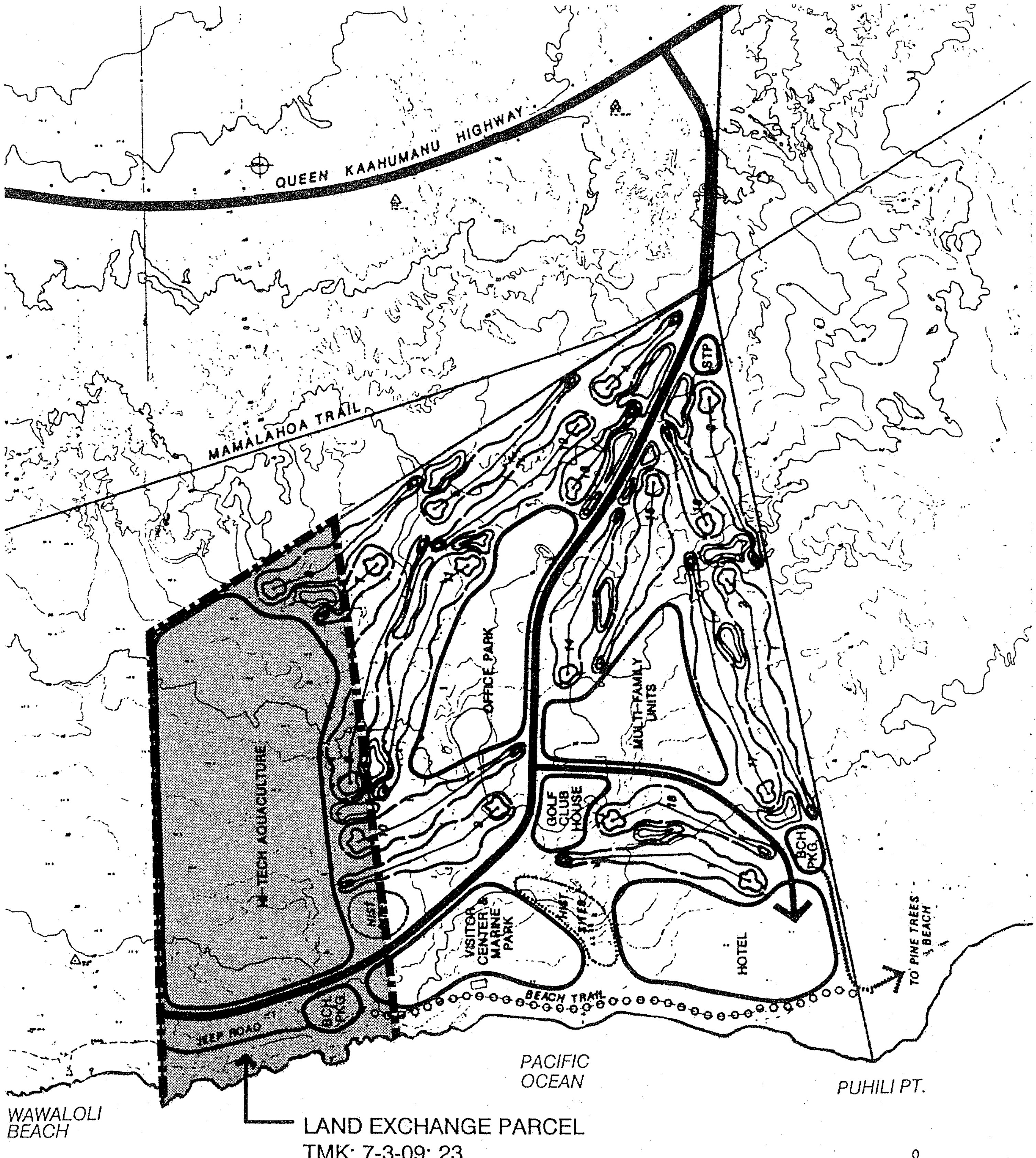


Figure 6
HOST PARK MASTER PLAN (JUNE 1989)

SOURCE: R. M. TOWILL CORPORATION



Source: 'O'oma II EIS, Sept. 1986,
Helber, Hastert, Van Horn & Kimura

Figure 7
'O'OMA II DEVELOPMENT CONCEPT

- **Infrastructure:** NELHA proposes to extend the ocean water distribution system to service the parcel. Other basic infrastructure to be constructed with State funds includes a secondary access road, power and potable water mains, and a seawater return flow network and disposal trenches. Tenants will also be responsible for providing domestic sewage disposal systems that meet State Department of Health requirements.

B. ENVIRONMENTAL REVIEW

1.0 Previous Assessments

The accepted FEIS for the 'O'oma II development evaluated the potential impacts of aquaculture and shoreline recreation uses on the 83-acre parcel. The proposed uses of the parcel under the revised HOST Park Master Plan are essentially the same as those proposed in the 'O'oma II development concept; they were fully disclosed in that statement.

Although the land exchange resulted in new boundaries for HOST Park, it did not result in a greater range or intensity of uses. The exchange did not alter the full development scenario or the "worst case" impacts evaluated in the previously accepted HTDC FEIS and NELH FSEIS. The impacts of construction and operation of facilities on the exchange parcel would be in the same range as those previously disclosed for long-term expansion of NELHA.

2.0 Access Roads

Access to the new 83-acre increment is hampered by existing infrastructure improvements. There are only a few areas where the existing 24-inch ocean water transmission pipe was completely buried and can support a new secondary road crossing. In most places, the pipe was partially buried within a berm feature for pipe protection. Although there is a buried section of pipeline near the Mamalahoa Trail, it is not wide enough for a secondary road.

Because the archaeological mitigation plan for HOST Park precludes crossings of the Mamalahoa Trail, a new secondary road and pipe corridor will be constructed to avoid the trail. The impacts of constructing and using the new road and pipeline corridor are within the range previously disclosed in accepted EISs.

3.0 Anchialine Ponds

According to the previously-accepted 'O'oma II FEIS, there are no anchialine ponds on the parcel.

4.0 Archaeological Resources

Several archaeological surveys have been conducted on the 83-acre parcel. These are summarized with recommendations for preservation in the 'O'oma II FEIS . Seven sites were either recommended for preservation or had preservation potential pending further investigation; eight other sites require additional data recovery before site disturbance, although the need for permanent preservation was not indicated. Archaeological sites on the property are shown on Figure 8. Some of the sites recommended for preservation or additional data recovery are in or near the proposed roadway and pipe corridor.

NELHA, in cooperation and coordination with the State Historic Preservation Division, will develop an archaeological preservation and data recovery plan for the area. Historic Preservation Review (Chapter 6E, HRS) and mitigation will be necessary before the parcel can be developed.

5.0 Shoreline Access and Recreation

The intertidal bench fronting most of the 83-acre parcel is popular for shore fishing, but access to the open ocean is restricted in most areas by the rocky shoreline. The exception is a small sandy beach which extends seaward from the northern boundary of the parcel. A jeep trail runs along the coastal portion of the parcel. The previous development concept included a shoreline corridor which would remain open to the public. Land use would remain the same under the NELHA master plan, so the effect on public access is no different from that already disclosed in the 'O'oma II FEIS.

The approved shoreline management plan, presently being implemented by NELHA, will be expanded to include the additional coastal area. The entire shoreline area will be preserved undeveloped, except for ocean water supply systems and possible additional public facilities. Coastal areas will remain open for public use except during specified times (HTDC FEIS, p. viii, IV-74).

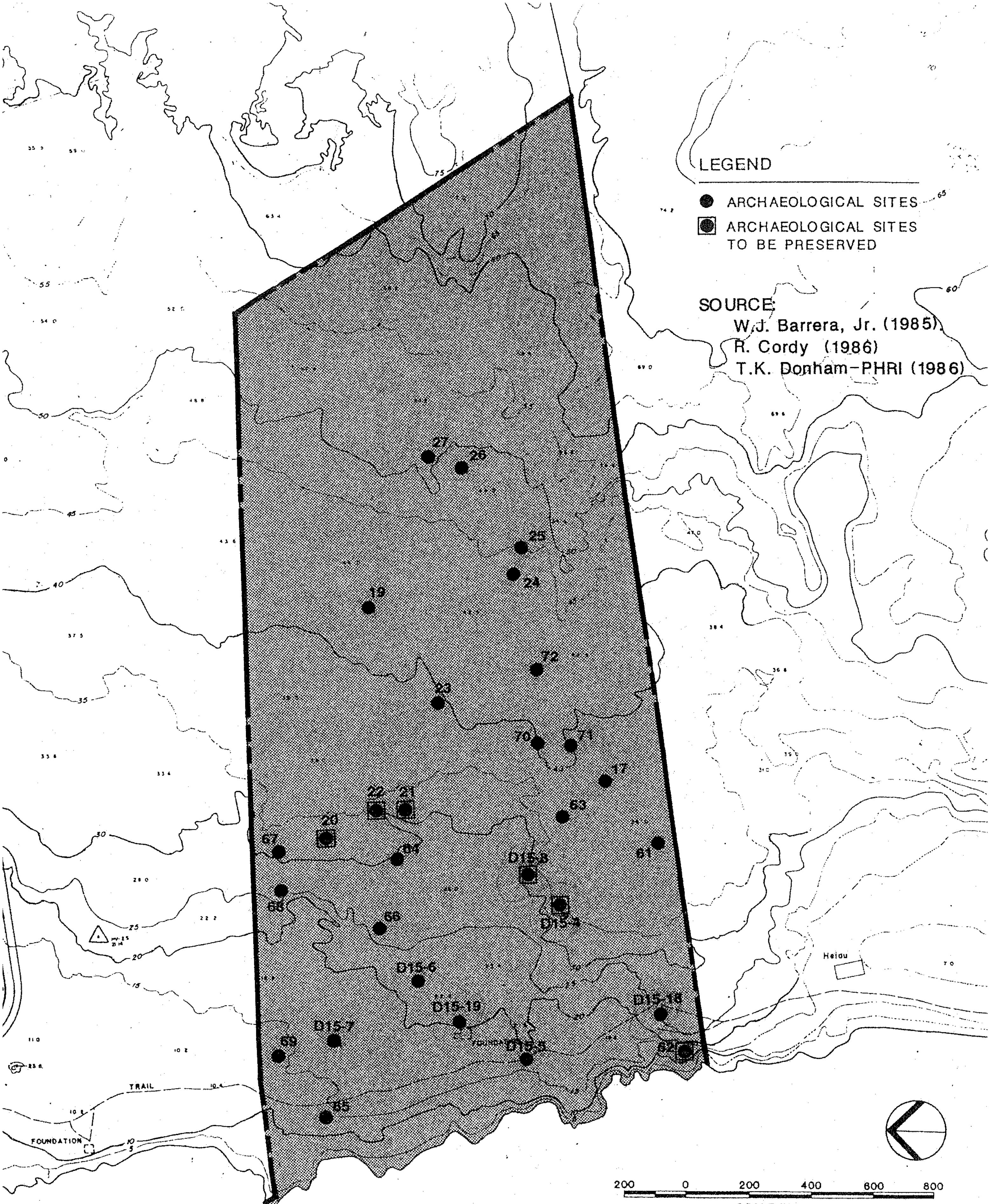


Figure 8

ARCHAEOLOGICAL SITES ON EXCHANGE PARCEL

C. ENVIRONMENTAL MONITORING

Seawater return flow from NELHA activities percolates into the brackish groundwater, dispersing and diffusing to a certain extent before seeping into anchialine ponds and coastal waters. An environmental monitoring program was implemented to provide an "early warning" of any unacceptable changes in these ecosystems. Alternative disposal methods could be instituted if adverse impacts become evident (HTDC FEIS, p. IV-39,40; NELH FSEIS, p. II-6, IV-13-47).

The Cooperative Environmental Monitoring Program (CEMP) serving NELHA does not include any monitoring stations within or fronting the 83-acre land swap parcel, but two of the sites where baseline marine biological surveys were conducted for the 'O'oma II FEIS lie offshore of the parcel. The ends of transect lines at depths of 20, 30 and 60 feet were permanently marked with metal stakes at both sites so that replicate surveys can be conducted in subsequent years to collect time series data about changes in marine biota structure. Figure 9 shows the location of existing monitoring wells and sampling sites. The NELH CEMP will be expanded to include monitoring wells on the new parcel as funds become available. Appendix A presents a description of the program and a summary of the results of the monitoring program to date.

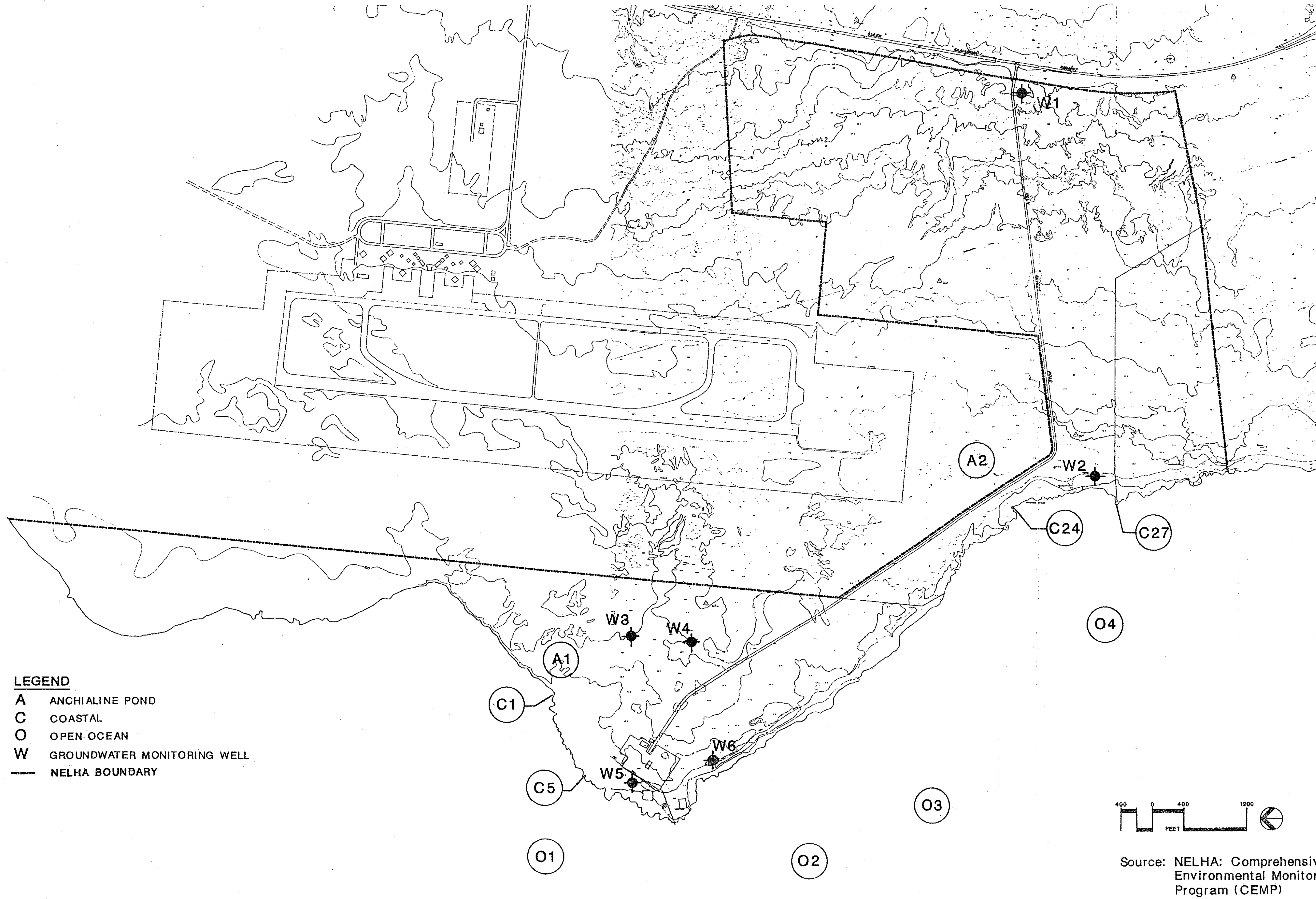


Figure 9

LOCATION OF MONITORING WELLS AND SAMPLING SITES

III: ENVIRONMENTAL REVIEW OF NEW PROJECT LOCATIONS

A. DESCRIPTION OF THE PROJECTS

Until they were merged under NELHA by the 1990 State Legislature, NELH and HOST Park were managed as separate facilities. The original separation between research activities (targeted for NELH) and commercial activities (targeted for HOST Park) has become less distinct over time. The 1987 NELH Land Use and Ocean Water Plan is shown on Figure 10; the 1989 HOST Park Master Plan is on Figure 6.

On-site commercialization of several successful research projects has occurred on the NELH site, where four companies are producing abalone, salmon, flounder, macroalgae and microalgae. Conversely, one OTEC demonstration plant, originally considered for NELH, is now proposed for a site in the original HOST Park area (Figure 11).

B. ENVIRONMENTAL REVIEW

"Worst case" conditions at full development of NELH and HOST Park were evaluated in the HTDC FEIS and the NELH FSEIS. The impacts of some activities were assessed based on their general locations at NELH or HOST Park. New locations for certain activities, however, will not generate any impacts that are different or more intense than those previously disclosed:

- The types of activities (OTEC, mariculture) and their operational characteristics and land uses have not changed or intensified from those previously assessed;

- The specific locations of activities do not alter the basic infrastructure development plan or the effects of construction on the site e.g., scenic views, archaeological resources, terrestrial biota, anchialine ponds). Archaeological mitigation will continue to be required before tenants improve individual lots for specific activities.

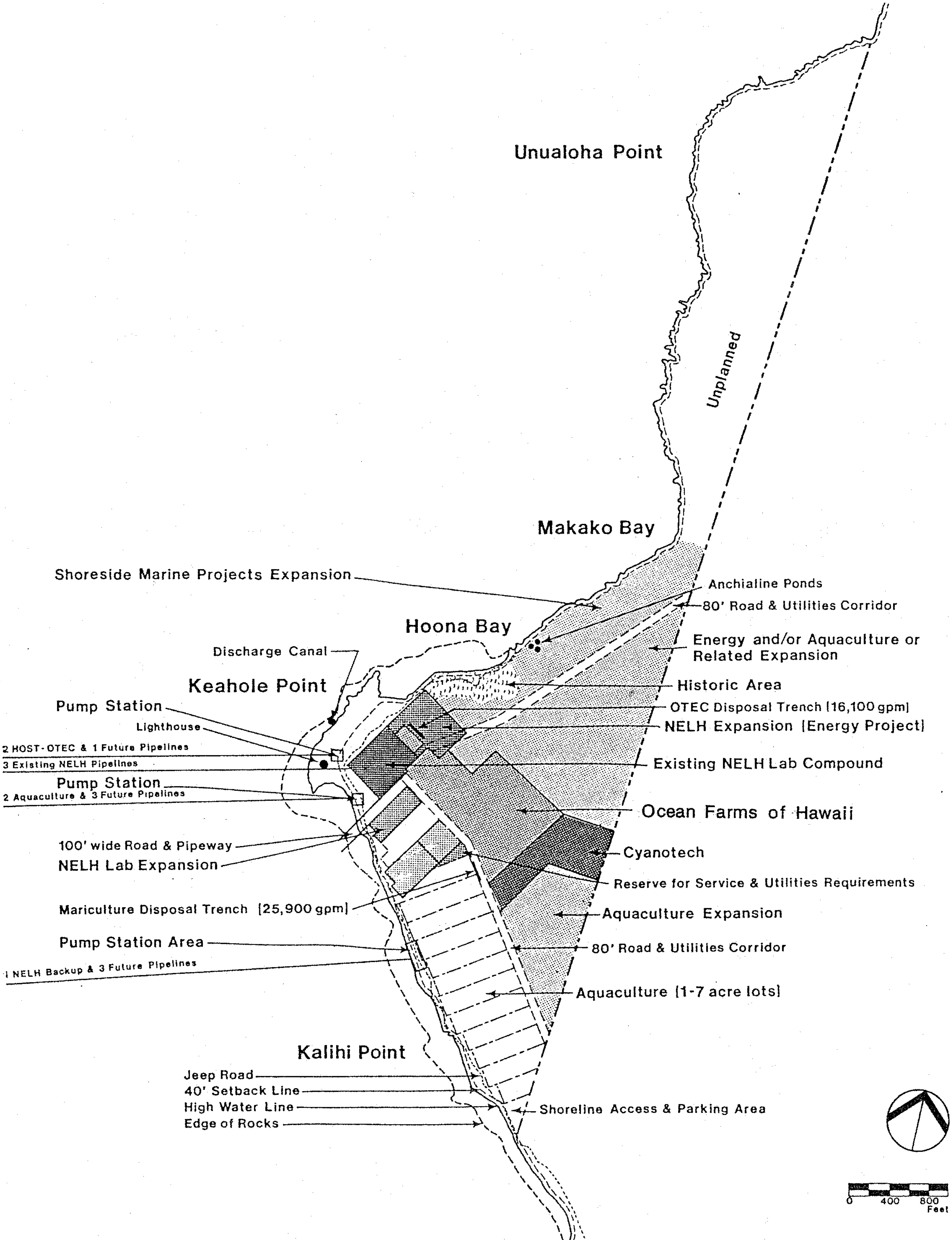


Figure 10

NELH: LAND USE AND OCEAN WATER PLAN (1987)

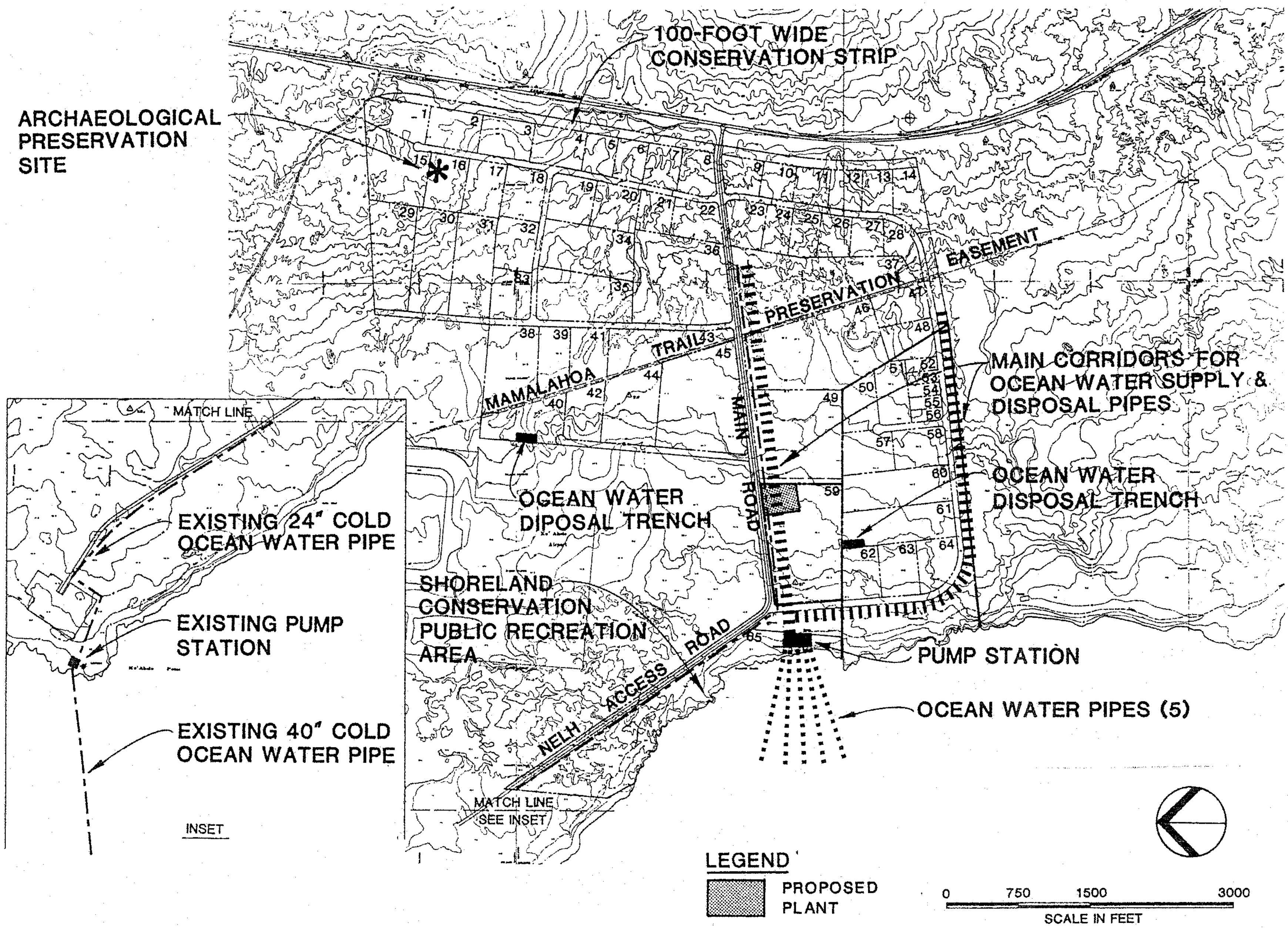


Figure 11

PROPOSED LOCATION OF NEW OTEC PLANT (500 kW–1MW)

SOURCE: R.M. TOWILL CORPORATION

- Seawater return flow volumes and characteristics from OTEC and all types of mariculture operations were disclosed in previously-accepted EISs. New locations for activities will not alter return flow volumes or characteristics, and the Cooperative Environmental Monitoring Program will continue as the primary mitigating measure to provide early warning of any adverse impacts on anchialine pond or nearshore ecosystems.

For example, the cost of pumping seawater has been shown to be a significant factor in determining whether or not fledgling aquaculture businesses at NELH succeed or fail. To help reduce this cost, NELHA is proposing to install OTEC plants to power the pumps for any new seawater system. All seawater from these new systems will first be used to produce electricity before being used for aquaculture. These plants will be located on shore in proximity to the offshore corridors shown on Figure 12. These actions will not increase the previously approved number of pipes, intake flows or disposal volumes.

The first of these plants, a 500 kW - 1 MW plant which would be privately-funded, would be designed so that it would only use as much seawater (above a necessary minimum) as is needed for aquaculture use at any particular time. In other words, at full power (1 MW) the estimated seawater requirement of the OTEC plant is 50,000 to 70,000 gpm. If less seawater is needed for aquaculture, the plant will operate at reduced power. This will enable NELHA to provide seawater to the HOST Park lots at a more reasonable cost than pump stations run by conventionally-generated power. NELHA is also considering an OTEC plant for the existing systems in the NELH area.

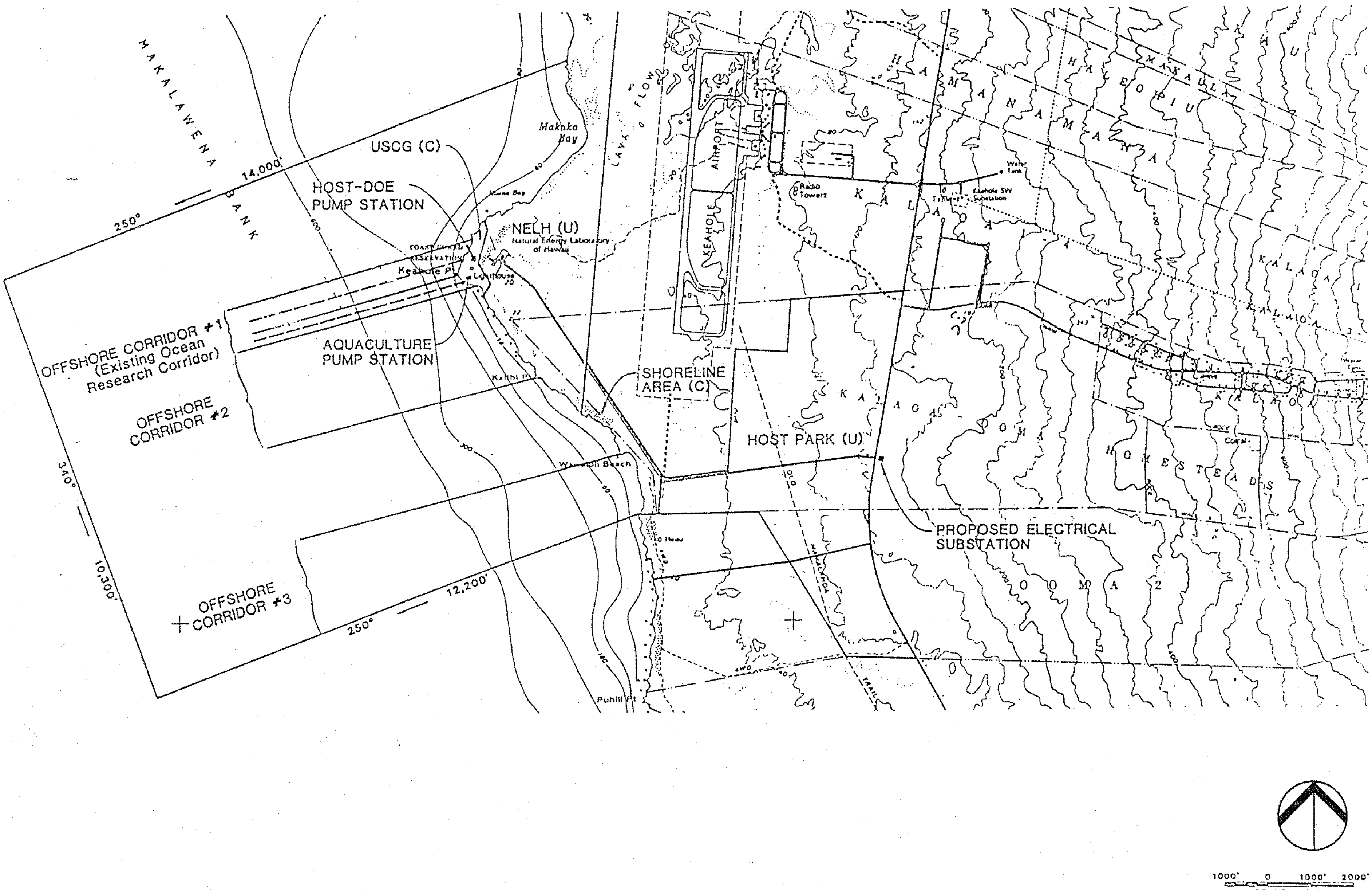


Figure 12
OCEAN USE CORRIDOR

IV: ENVIRONMENTAL REVIEW OF MODIFICATION OF SEAWATER DISPOSAL SYSTEM

A. DESCRIPTION OF THE EXISTING SYSTEM

Among the actions assessed in the HTDC FEIS, was the disposal of seawater return flow from mariculture operations through shallow surface trenches or deep gravity-injection wells (Ibid. p. 35-37). It was estimated that trenches totalling about 245 feet in length would be required for disposal of 100,000 gpm of seawater return flow at full development of the HOST Park and trenches totalling from 175 to 350 feet would be required at NELH to dispose of 25,900 gpm of mariculture return flows (HTDC FEIS, p. IV-36). (At that time a deep ocean outfall was proposed for disposal of 16,100 gpm of seawater return from OTEC experiments).

The HTDC FEIS discussed two general alternative locations for seawater return flow disposal trenches. The primary distinction was trench distance inland and associated travel times through the ground before seepage into coastal waters. It was stated that "the exact location will be determined in the detailed planning and design phase...." (HTDC FEIS, p. IV-35).

The ocean outfall for seawater return from OTEC experiments could not be funded and alternative methods of disposal were evaluated in the NELH FSEIS. The FSEIS recommended that one trench be constructed to dispose of up to 16,100 gpm of seawater from OTEC operations and a second trench be built to dispose of return seawater volumes of up to 25,900 gpm from mariculture research operations at NELH. Trenches to dispose of return seawater volumes of up to 100,000 gpm from fully-developed ocean high technology operations at the former HOST Park were assessed in the HTDC FEIS. Disposal by injection well and by canal were also assessed in the NELH FSEIS.

Table 1.0 lists seawater return flow systems presently in operation at NELHA and the estimated volumes disposed of in each. Seawater return flows evaluated in the two statements were based on return ocean water only. The volumes in the table also include the fresh and brackish water used in operations.

Table 1.0 **SEAWATER RETURN FLOWS AT NELH**
(April, 1991)

Disposal Method	Volume (gpm)
Shallow Gravity Wells (UIC)	8,000
Disposal Trench	700
Seepage Pit	100
Ground Percolation	1,480
Surface Disposal (NPDES)	520
TOTAL	10,800

B. PROPOSED MODIFICATIONS OF APPROVED METHODS OF DISPOSAL

The approved method for disposal of 25,900 gpm of return seawater from mariculture research operations at NELH was into a common trench located adjacent to the NELH access road, parallel to the shoreline and about 900 feet inland at its closest point (Figure 10). "The exact dimensions of the mariculture disposal trench will be determined during the design of the facility" (NELH FSEIS, p. II-9). In order to allow for flexibility in meeting tenant needs, NELHA proposes to allow some tenants to construct individual covered trenches on their property, rather than connecting to a centralized disposal system. The NELH FSEIS (1987) evaluated one trench for NELH mariculture seawater return flow (NELH FSEIS, p. II-8 & 9). The HTDC FEIS, however, discussed separate trenches for NELH and HOST Park mariculture seawater return flow and suggested the possibility of constructing the HOST Park trench in increments as development occurs (HTDC FEIS, p. IV-36).

Disposal of OTEC seawater return would continue to be into a trench, as previously disclosed (NELH FSEIS, p. II-3,6).

C. ENVIRONMENTAL REVIEW

The aquaculture and alternative energy operations at NELHA are dependent on the high quality of the source water offshore of Keahole Point. Thus, the effects of disposal of large volumes of seawater return flow generated by OTEC and mariculture operations are one of the most important environmental concerns associated with development (HTDC FEIS, p. IV-33).

Both the HTDC FEIS and the NELH FSEIS based their evaluation of potential environmental impacts on the same seawater return flow volumes. The two statements differed in their proposed locations for the trenches because more detailed analysis was conducted in the NELH FSEIS. Experience has now shown that the location and sizes of disposal trenches should be modified further. These adjustments were foreseen in the accepted statements. For example, the NELH FSEIS (p. II-2) states: "The specific location of the trench (for OTEC discharges) will be determined after a more detailed site analysis is undertaken".

Trenches of various dimensions were discussed in the NELH FSEIS. To allow for the non-homogeneity of the hydrogeologic characteristics of the Keahole area, it was suggested to test a smaller trench with initial lower flows and modify the trench size as necessary based on this experience (NELH FSEIS, p. II-5,6).

As disclosed in previously-accepted EISs, the most serious potential impact from seawater return flow arises from the temperature and density of the discharge. The lower temperatures and higher salinities of the seawater return flow have the potential to affect anchialine pond and nearshore marine ecosystems.

Seawater return flow percolates into the groundwater system, mixing and diffusing to a certain extent before seeping into coastal waters near sea level. The disposal of discharges was modelled for alternative locations within the project site. For disposal through a single trench, the distance inland was the primary factor affecting the concentration of discharge along the shoreline. Inland locations were recommended because longer residence times and more dilution in the groundwater system would reduce the concentration of trench discharges (NELH FSEIS, p. IV-3-47).

The total length of trenches constructed at NELHA under the de-centralized disposal system will not exceed the maximum length which has been evaluated in previously-accepted EISs (193 feet for OTEC and 607 feet for mariculture operations; see HTDC FEIS, p. IV-36 and NELH FSEIS, p. II-2,9). The total volume of seawater return flow will not exceed that which has been previously disclosed (142,000 gpm total seawater return flow volume for all uses at maximum development; see HTDC FEIS, p. IV-36 and NELH FSEIS, p. II-2,8,9).

De-centralization of disposal (through subsurface dispersion via a series of covered trenches constructed by individual tenants) should reduce the ratio of seawater return volume to groundwater volume so that the concentrations reaching coastal waters are more diluted than a centralized discharge. This ratio, which indicates the concentration of discharge flows and their properties that could actually affect anchialine pond and nearshore marine ecosystems, is a good indicator of potential impact. Lower ratios will have less impact than higher ratios. The reason for siting centralized disposal trenches farther inland (see NELH FSEIS, p. IV-12,13) was to reduce the ratio.

The construction of a series of individual subsurface disposal systems will be more localized and will generate impacts that are less than or in the same range as those associated with the construction of a centralized disposal trench system. The mitigating measures recommended in previously-accepted EISs will function more effectively for a de-centralized disposal than for a more centralized system:

- A series of appropriately located monitoring wells allow easier identification of contamination sources than a centralized trench system (see Appendix A).

- The monitoring wells could detect the presence of toxic materials and thus allow an early response to localized problems and stop the violation before the environment is damaged.

- NELH is investigating possible water treating requirements that would be mandated before tenants discharge used ocean water. These might include warming or reoxygenating return flows. Enforcement of testing and treatments will be facilitated if tenant discharges are not combined into one central trench, but rather separated and monitored by means of the wells.

The Cooperative Environmental Monitoring Program will continue to provide an "early warning" of any unacceptable ecological changes detected at two anchialine pond stations and two nearshore marine stations. The monitoring program will allow alternative disposal methods to be instituted before any irreversible or long-term environmental damage occurs (NELH FSEIS, p. IV-13-47).

Based on the preceding analysis, it is concluded that the impacts generated by de-centralization of the trench disposal system for seawater return flow will be less than or in the same range as those previously disclosed in accepted EISs.

APPENDIX A

DESCRIPTION AND PRELIMINARY RESULTS OF THE COMPREHENSIVE ENVIRONMENTAL MONITORING PROGRAM

Background

Because of the linkages in mission and administration and their physical proximity, a cooperative program to monitor the environmental effects of operations at the Hawaii Ocean Science and Technology (HOST) Park and the Natural Energy Laboratory of Hawaii (NELH) was developed (GK & Associates, 1989) and implemented. The objectives of the Comprehensive Environmental Monitoring Program (CEMP) were protection of the environmental resources at Keahole Point and satisfaction of data requirements associated with a number of existing permits and future permit applications.

The process through which the CEMP was designed to protect Keahole's environmental resources is as follows:

- establish a baseline for groundwater and offshore water quality and coastal biota;
- compare monitoring results with baseline information to detect unacceptable changes;
- trace the cause of an unacceptable change to its source; and
- provide facilities management with options for corrective measures.

Implementation of the CEMP began in late 1989, and was phased to allow new measurements to be added as the facilities of the laboratory were expanded. The CEMP incorporated and continued the monitoring of source waters begun in 1982. For many of the parameters this provides an excellent data base.

The Monitoring Network

The CEMP has six distinct components which require monitoring: intake water quality; marine water quality; groundwater quality; anchialine pond biota; marine biota; and facilities discharges. Figure A-1 shows the locations of existing monitoring stations. The CEMP provided a matrix which identified by resource type the parameters to be monitored and the sampling frequency.

Results

Table A-1 summarizes selected (relevant) data collected during the first full year of the CEMP. The following briefly reviews these data, and then describes how the CEMP has functioned to protect environmental quality in three specific instances. Looking at the table from the top down, source waters are presented in the first three rows. The deep sea water (DSW) is cold and nutrient-rich; the surface sea water (SSW) is warm and nutrient-poor. The next eight rows contain data from the oceanic stations, with the number shown after the dash being the sampling depth in feet. In general, the results from these stations are very similar to those of the surface water intake. Depth stratification is not apparent indicating a well-mixed water column at this distance offshore. There appear to be isolated high values of silicate, ammonium and total organic carbon. These may represent influences of the NELH outfall, nonpoint source influences or anomalies resulting from the small size of this data base as compared with the baseline. No significant impacts are apparent, and continued monitoring is expected to clarify the causes of these anomalies.

In establishing the nearshore (coastal) stations a preliminary survey of 27 stations was done. Based on those results, the CEMP specified monitoring at four key locations. Data from these locations are presented in the next four rows of the table. (NELHA personnel have continued to monitor all 27 of the coastal stations and have even added two additional sites to ensure complete geographical coverage along the shoreline.) The coastal stations, especially C24 taken near a small spring, show the influences of brackish groundwater seepage. As the proportion of groundwater increases (salinity decreases), nutrients, especially silicate and nitrogen, increase.

The two complexes of anchialine ponds on the site are represented in the CEMP by monitoring stations A1 and A2. These ponds intersect the water table, and data from these stations display the characteristics of the underlying water table, i.e., low salinity and high nutrient concentrations.

The remainder of Table A-1 compiles data collected from the on-shore monitoring wells. (The numbers following the slash in the station designators refer to the depths in feet below mean sea level from which the wells draw.) Generally there is an inverse relationship between the salinity and the nutrient concentrations, as is apparent in the anchialine pond and to some extent the coastal samples. The effect of distance from the shoreline can be seen in the thickening of the layer of less saline water at greater distances inland.

Mitigating Actions

Thus far the CEMP has been successful in identfying three instances of objectionable levels of discharges and correcting them. In the first instance, high concentrations of coliform bacteria were encountered at station A1, in the northern anchialine pond complex. The problem may have been due to unsanitary campers. Reduced bacteria levels were observed following their subsequent removal.

In two cases, documented in the data from well complexes 4 and 5, nutrient and organic carbon concentrations indicated supplemental enrichment of groundwaters. Elevated nutrient levels in Wells 4 and 4A were traced to disposal of excess algal growth media by one of the tenants. Once this practice was discontinued, the nutrient values in these wells dropped back to normal levels. The elevated concentrations in Well 5 were traced to discharges by another tenant. Procedures for seawater disposal from this facility were modified to include routing of seawater return flows through settling tanks, and the values in the wells returned to normal.

Comparing the above actions to the environmental protection strategy outlined above, the following conclusions may be drawn.

- A voluminous baseline data base is being amassed against which to monitor impacts of seawater return flows disposed of into the ground behind the Keahole Point shoreline.

- Three instances of anomalous values were detected through the monitoring program.

- In each case, it was possible to determine the origin of the high values.

- In each case, corrective action by NELHA management appears to have mitigated the problem.

The CEMP has proven to be a powerful and flexible management tool for protecting the quality of the waters beneath and offshore of Keahole Point. Prior to expansion of NELHA activities into the land exchange parcel, the potential usefulness of additional wells, coastal and offshore stations will be evaluated, and new monitoring sites established, if needed.

TABLE A-1

CEMP RESULTS

Site	Temp. °C	Sal. o/oo	SI µM	PO_4 µM	TDP µM	NO_3 µM	NH_4 µM	TDN µM	TOC mg/l
DSW 40"	7.5	34.4	82.6	2.95	3.06	40.6	0.04	43.1	0.35
DSW 12"	8.7	34.3	74.0	2.93	3.04	39.0	0.06	41.6	0.33
SSW	26.0	34.7	2.36	0.18	0.36	0.30	0.13	5.50	0.44
O1-3	26.6	34.5	7.84	0.17	0.56	0.67	0.01	4.13	1.74
O2-3	26.8	34.6	3.52	0.15	0.50	0.40	0.13	3.93	3.81
O3-3	26.8	34.7	2.12	0.13	0.54	0.26	0.01	3.84	1.51
O4-3	26.8	34.7	3.83	0.13	0.56	0.29	0.00	4.16	1.64
O1-60	26.7	34.7	2.64	0.14	0.56	0.28	0.07	4.31	1.48
O2-60	26.8	34.7	2.46	0.13	0.54	0.24	0.03	4.10	6.51
O3-60	26.9	34.7	2.19	0.13	0.53	0.26	0.29	3.99	2.06
O4-60	26.9	34.7	2.19	0.13	0.50	0.26	0.04	4.20	1.62
C1	25.7	32.5	62.0	0.56	0.94	7.40	0.20	12.4	1.44
C5	25.9	34.5	16.6	0.30	0.76	2.31	0.14	5.62	1.72
C24	23.1	15.3	480	2.50	2.95	63.2	0.20	68.8	1.22
C27	26.0	34.3	11.5	0.31	0.94	1.80	0.28	5.72	1.38
A1	23.5	11.4	600	2.64	3.31	52.9	2.05	60.2	2.21
A2	21.4	6.9	672	3.52	3.74	83.0	0.43	91.2	1.03
W1/135	20.2	7.0	718	3.59	3.64	79.3	0.08	88.4	0.70
W2/53.5	18.6	27.7	291	1.16	1.48	24.3	0.18	25.5	0.53
W2A/24.5	19.4	16.7	529	2.44	2.74	51.8	0.34	53.7	0.70
W2B/14.5	20.4	7.6	689	3.31	3.48	74.6	0.10	80.4	0.94
W3/65	20.7	25.3	379	1.50	1.73	27.5	0.26	30.5	0.42
W3A/35	22.0	11.5	642	2.98	3.15	65.6	0.21	67.4	0.40
W3B/25	21.6	7.7	698	3.27	3.43	75.6	0.17	78.2	1.23
W4/69	21.4	18.9	498	2.61	3.08	57.3	0.39	48.3	9.95
W4A/39.5	21.7	15.3	323	8.89	10.7	135	25.3	172	17.0
W5/18	19.3	24.6	329	5.23	6.11	85.1	0.33	107	1.26
W5A/28	17.2	29.0	226	5.32	5.65	84.7	0.25	87.5	2.44
W5B/55	17.1	30.5	189	3.01	3.51	58.9	0.28	66.1	0.94
W6/49.6	17.2	29.6	207	3.42	3.74	74.1	0.20	78.2	0.95
W6A/18	21.1	20.9	407	3.20	3.59	68.3	0.20	71.8	0.82
W6B/29	17.3	26.8	270	3.95	4.50	76.2	0.20	78.3	0.91