DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 523-4564 • Fax: (808) 523-4567
Web site: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

RAE M. LOUI, P.E.
ACTING DIRECTOR

GEORGE T. TAMASHIRO, P.E.
DEPUTY DIRECTOR

ERIC G. CRISPIN, AIA
ASSISTANT DIRECTOR

WWDE.P 01-078

February 22, 2001

Ms. Genevieve Salmonson, Director
Office of Environmental Quality Control
235 S. Beretania Street
State Office Tower, Suite 702
Honolulu, Hawaii 96813

'01 MAR -9 P2:44

Dear Ms. Salmonson:

Subject: Finding of No Significant Impact (FONSI)
La'ie Wastewater Collection System Expansion, Phase I

The City and County of Honolulu, and Hawaii Reserves, Incorporated (HRI) propose to expand the existing wastewater collection system of the La'ie community. Proposed improvements include a new La'ie Wastewater Pump Station and force main, and new connection points for existing gravity systems (Phase 1). These improvements are being developed jointly between the City and County of Honolulu and HRI under a cooperative agreement signed December 29, 2000. The City and HRI have determined that the implementation of this project will not have significant environmental effects, therefore, the agencies are issuing a FONSI.

The City and County of Honolulu and Hawaii Reserves, Incorporated have reviewed the comments received during the Draft Environmental Assessment 30-day public comment period which began July 23, 2000. The chief issues raised during the comment period are discussed below.

Cumulative Impacts
Cumulative impacts result from a series of projects that individually do not generate significant adverse effects, but collectively add up to a significant negative impact on the environment. The La'ie Sewer Project, though broken down into two distinct phases, does not add up to a large, negative impact on the environment. In fact, both Phase 1 and Phase 2 of the La'ie Sewer Project, whether considered individually or jointly, will provide a benefit to the environment by upgrading and integrating the aged sewer system with a new wastewater collection and reclamation system that treats effluent to reusable (R1) quality.

Although it is described within the overall framework of the La'ie Sewer Project, Phase 1 remains a stand-alone project independent of the future of Phase 2. After nearly 30 years of use, the existing sewer lines are displaying signs of deterioration and are in need of upgrading. Phase 1 will not expand sewer service and will not increase effluent disposal from the LWRF. Phase 1 does not require a commitment to Phase 2 activities.

If Phase 2 is undertaken in the future, it will provide the benefit of replacing over 700 cesspool and septic systems, most of which are aged and deteriorating, with a modern sewer collection and reclamation system. Instead of untreated, raw sewage being released into the ground, sewage and wastewater would be collected and treated to high enough levels for reuse for irrigation. Phase 2 is intended to be funded through the establishment of a sewer improvement district, a public process that is administered by the City Council and subject to its approval. If it proceeds, Phase 2 will also be undertaken in compliance with Chapter 343 HRS environmental impact assessment and public review requirements.

With regard to possible future growth, the La'ie Sewer Project is proposed to meet existing wastewater service needs and to support the withdrawal of aging and leaking cesspools from service. The system is designed to carry capacity above existing levels in order to accommodate the possibility of future projected needs in La'ie, as planned in the *Ko'olauloa Sustainable Communities Plan* (KSCP).

Current State of the La'ie Water Reclamation Facility

Since the La'ie Water Reclamation Facility (LWRF) expansion was completed in 1997 there have been no spill or overflow incidents at the facility. The LWRF continues to function effectively. There have been spills along various points of the existing collection system due to pipe failures. Existing pump stations have not experienced any operational problems, but the main gravity and force main is over thirty years old and has failed from time to time, thus supporting the need for a new collection system. Phase I improvements include planned gravity flow line in Naniloa Loop from Iosepa Street to the La'ie Wastewater Pump Station (LWPS), the LWPS, and the force main from LWPS to the LWRF headworks, and the hookup of the Polynesian Cultural Center (PCC), certain HRI commercial properties and BYU-H, to the gravity flow line installed in Naniloa Loop. These upgrades will greatly improve system reliability and will benefit environmental conditions by eliminating or substantially reducing the potential for leaks or spills from aging sewer lines.

With regards to the existing sewage treatment facility and drainfield, we have confirmed that the current wastewater system in La'ie, including the full capacity of the LWRF and disposal system, are approved and permitted by all required city and state agencies. The proposed Phase 1 improvements are in compliance with existing LWRF permits.

Concern was expressed about recent drinking water contamination allegedly caused by the failure of the wastewater pump stations. It has been confirmed that there were no pump station failures and that the recent contamination reading was from a sample taken from a large, isolated private property owner's distribution system. The contamination was likely due to the system not being in use for a period of time. The private distribution system was flushed, is back in use, and there have been no positive readings from the follow up re-testing. Additionally, the Department of Health recently tested La'ie's drinking water at the well source and found no contamination reading.

Hook-up Cost for Residents
Improvements proposed under Phase 1 includes replacement of the existing sewage collection system servicing the BYU-H campus and the PCC and do not include residential sewer connections. Residential hook-up costs to the collection system is a subject of the sewer improvement district (SID) process, which is the funding mechanism for Phase 2 of the La'ie Sewer Project.

Improvement District Boundary
Concern was expressed that kuleana parcels are being excluded from the SID boundary. As mentioned above, the SID boundary is intended to fund Phase 2 work. Phase 1 improvements do not include residential sewer system connections. Thus, this issue is outside of the scope of the Phase 1 project and of this EA. As general information, improvement district boundaries are determined based on densities, public access points for sewer lines, cost-benefit analysis, and zoning, among other criterion.

Archaeology
The State Historic Preservation Division (SHPD) has reviewed and commented on this EA. Project plans include employment of a qualified archaeologist who will monitor work activities according to a state-approved archaeological monitoring plan. SHPD has determined that, with implementation of the monitoring plan, proposed Phase 1 improvements to the La'ie Wastewater Collection System will have "no adverse effect" on significant historic sites.

***Kuleana* Parcels and Agricultural Lands**
The Phase 1 project work will be done entirely on Brigham Young University-Hawaii (BYU-H) land and along a portion of Naniloa Loop. There are a few small land-locked *kuleana* parcels in the vicinity of the proposed pump station. Although small-scale, garden cultivation occurs on some of these parcels, none of the lots are farmed intensively and none are used for *lo'i kalo*. None of these parcels will be directly impacted by the project.

Brigham Young University grows papaya trees, and bananas on lands up-slope of the project site. Lands west of the pump station are unimproved and not cultivated. Other private agricultural parcels, including *kuleana* plots, would not be affected by the project due to their distance away and intervening topography.

Air quality
Odor emission rates must be kept below the exempt amounts established in Hawaii Administrative Rules, Chapter 11-60, "Air Pollution Control". The Department of Health will verify emission rates when an application is made to obtain an air pollution permit for the project.

Odor will be controlled through the use of a carbon filtration system installed at the pump station. Wastewater entering the pump station will be collected in a sealed, lined, wet-well into which two pumps and two air filtration units will be constructed. One of the air filtration units will remain in continuous operation; the other will serve as a back-up system.

The air filtration units use an exhaust fan to draw air out of the air space in the wet-well and through an activated carbon filter that traps and absorbs odorous compounds before venting to the outside air through a dispersion stack. Activated carbon absorbs a variety of organic and inorganic compounds including hydrogen sulfide (H_2S), the most common odorous gas found in wastewater collection and treatment systems.

Spill Response
By law, HRI must report all facility spills and overflows to the State Department of Health (DOH), Clean Water Branch. DOH maintains a log of all wastewater spills and enforcement measures taken. The log is public record. To date, no significant spills have occurred at the La'ie Water Reclamation Facility (LWRF).

The LWRF maintains a spill response plan that includes measures for facility shut down, spill containment, emergency services contact (ambulance, fire, police), public notification, and reporting to the Department of Health.

Public Notification
All residents of La'ie have had the opportunity to participate in plan review through the environmental assessment public comment process. In accordance with Chapter 343 HRS, the Draft EA for the project was published in the July 23, 2000, OEQC Environmental Notice for the 30-day public comment period commencing July 23, 2000. Notice of the comment period was published in the July 24, 2000 Honolulu Advertiser (page B-3).

The project has also been publicized in the La'ie community over the past year and a half. The local paper *Kaleo o Ko'olauloa* published articles about the project on July 8, 1999 and on August 17, 2000. Additionally, Mr. Daniel T. Ditto, President and CEO of Hawaii Reserves Inc. (HRI), and other HRI representatives, have made presentations on the sewer project at Board and general membership meetings of the La'ie Community Association.

Individual comments and responses are referenced in the Final EA, Appendix C, Comments Received during Preparation of the Draft EA and 30-Day Public Comment Period.

Best Management Practices and mitigation measures described in the Final EA will ensure that no significant negative impacts to water and air quality, flora and fauna, cultural and scenic resources, social and economic conditions, land use, and community well-being will result from the proposed project.

The City and County of Honolulu and Hawaii Reserves Incorporated have therefore determined that this project will not have significant environmental effects and hereby issue a finding of no significant impact. Please publish this FONSI in the next Environmental Notice.

We have enclosed a completed OEQC Environmental Notice Publication Form and four copies of the final EA. Please contact Mr. Derek Mukai of R. M. Towill Corporation, agent to the co-applicant, at 842-1133 if you have any questions.

Very truly yours,

RAE M. LOUI, P.E.
Acting Director

Enclosure

2001-03-23-OA-FEA-

FINAL ENVIRONMENTAL ASSESSMENT
Prepared in Accordance with Requirements of Chapter 343, Hawaii Revised Statutes

LA'IE WASTEWATER COLLECTION SYSTEM EXPANSION, PHASE I

La'ie, Oahu, Hawaii

MARCH 2001

Prepared For:

Department of Design and Construction
Wastewater Design and Engineering Division
City and County of Honolulu

and

Hawaii Reserves Incorporated
55-510 Kamehameha Highway
La'ie, Hawaii 96762-1193

R. M. TOWILL CORPORATION
SINCE 1930

420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937
(RMTC Ref: 1-18401-1E)

DEPARTMENT OF DESIGN AND CONSTRUCTION

CITY AND COUNTY OF HONOLULU

FINAL

ENVIRONMENTAL ASSESSMENT

FOR

LA'IE WASTEWATER COLLECTION SYSTEM EXPANSION, PHASE I

AT
LA'IE, OAHU, HAWAII
TMK: 5-5-06: Por. 5

MARCH 2001

PROPOSING AGENCY: Department of Design and Construction
Wastewater Design and Engineering Division
City and County of Honolulu

and

Hawaii Reserves Incorporated
55-510 Kamehameha Highway
Laie, Hawaii 96762-1193

PREPARED BY: R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

THIS ENVIRONMENTAL DOCUMENT IS SUBMITTED PURSUANT TO CHAPTER 343, HRS.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1
Introduction

1.1 BACKGROUND

The City and County of Honolulu and theHawaii Reserves Incorporated (HRI) intend to develop the La'ie Wastewater Collection System under a cooperative agreement signed December 29, 2000. HRI is the owner of the existing wastewater collection system.

Under the agreement, HRI and the City, subject to the City Council's approval, plan to jointly fund the replacement and expansion of the Collection System in two phases so that the La'ie Water Reclamation Facility (LWRF) will treat all wastewater from the La'ie Community. Additionally, HRI intends to convey and transfer the LWRF, and the Facility Site to the City, and the City intends to own and operate the Collection System, the LWRF and the Facility Site, so as to service the La'ie Community.

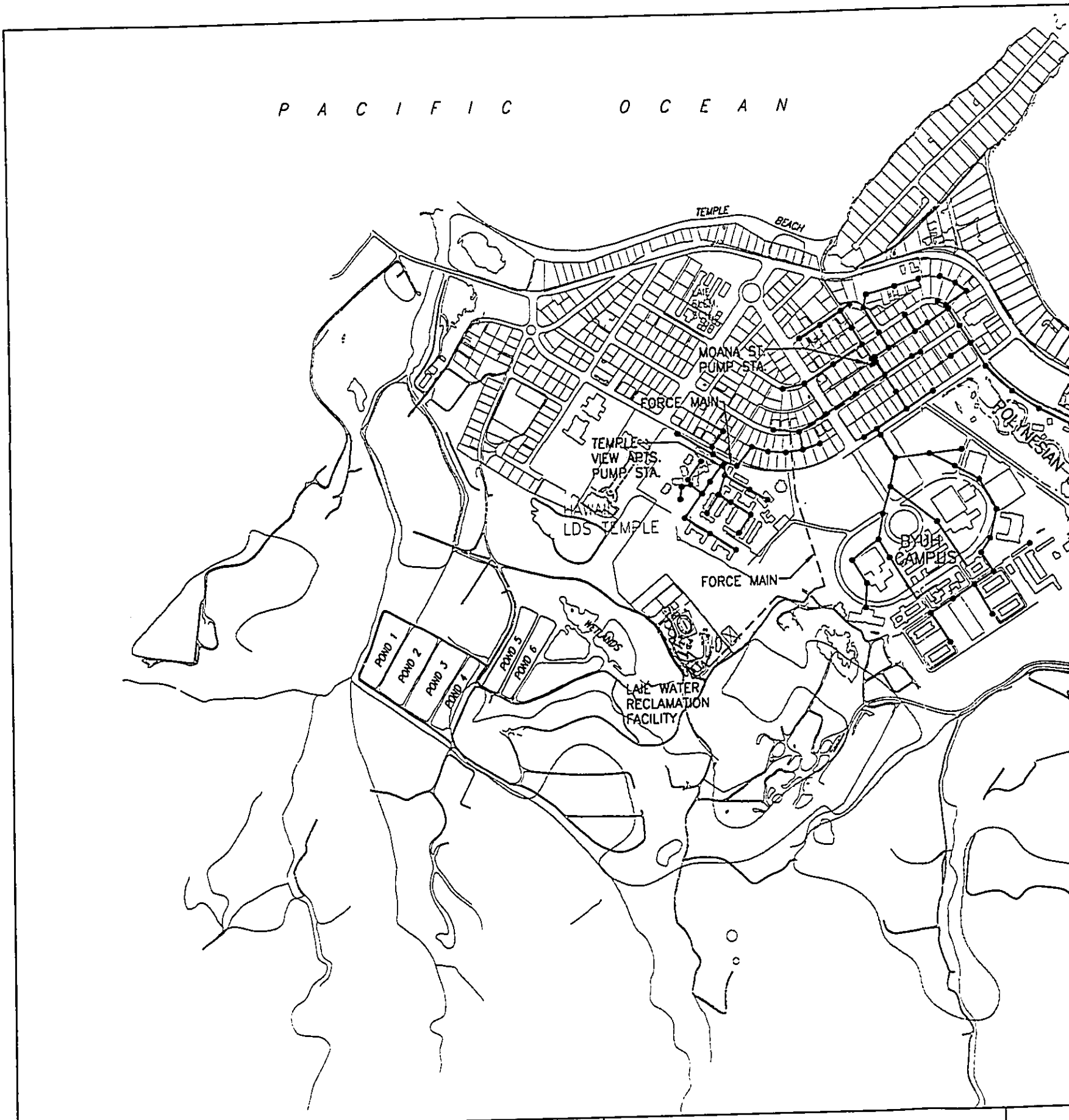
The proposed expansion will include nearly all existing developed areas of La'ie and where necessary and appropriate, modifications to existing non-compliant systems. The expansion will involve two phases. Phase I, which is covered by this Environmental Assessment (EA), will include a new pump station (La'ie Wastewater Pump Station) and force main, and new connection points for existing gravity systems. A second EA will be developed for Phase II, which will include the further expansion of the wastewater collection system to residential areas through the use of a low pressure system.

Although it fits within the overall framework of the La'ie Sewer Project, Phase I is a stand-alone project independent of the future of Phase II. Phase I is being developed to replace the existing sewer main servicing the BYU-H campus and the Polynesian Cultural Center (PCC). After nearly 30 years of use, the existing sewer lines are displaying signs of deterioration and are in need of upgrading. Phase I will not expand sewer service and will not increase effluent disposal from the La'ie Wastewater Reclamation Facility. Phase I does not involve a commitment to additional development.

The town of La'ie is located on the northeast coast of the island of Oahu, approximately 40 miles from downtown Honolulu. A map of La'ie town, its wastewater facilities and existing wastewater collection system are shown in **Figure 1.1-1**. The existing collection system encompasses the Brigham Young University Hawaii (BYU-H) campus, the Latter-day Saints (LDS) Temple, the Polynesian Cultural Center (PCC), Temple View Apartments (TVA) and Faculty Housing, and approximately 25% of the residential area or about 175 homes.

The existing wastewater collection system consists of the following:

- Two lift stations serving La'ie Town (PCC and TVA)
- One pump station (Moana) and gravity collection lines serving the BYU-H campus



Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management

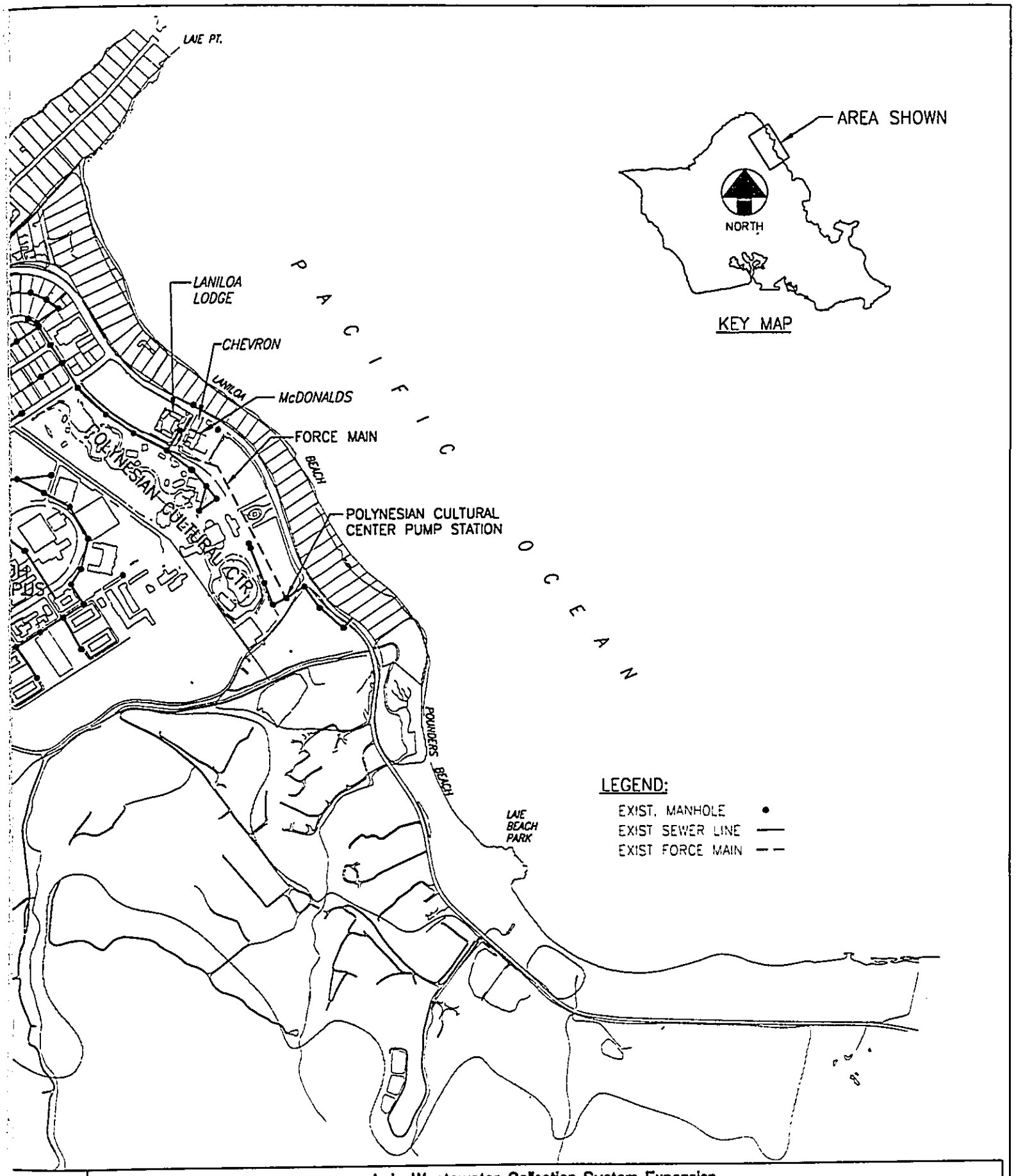
R. M. TOWILL CORPORATION
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

Existi



Laie Wastewater Collection System Expansion

Existing Laie Wastewater System

Figure 1.1-1

The collected wastewater is treated at the La'ie Water Reclamation Facility (LWRF). This facility was recently expanded in 1997, to accommodate a design average flow of 900,000 gallons per day. Current flows from the existing collection system are approximately 300,000 to 350,000 gallons per day. The facility is designed to treat wastewater to "R-1" levels. R-1 water, which is the highest level of treatment for reclaimed water, is oxidized, filtered, and disinfected at the facility, and used for irrigation at various locations in the La'ie area. Reclaimed water use in Hawaii is regulated by the State Department of Health (DOH).

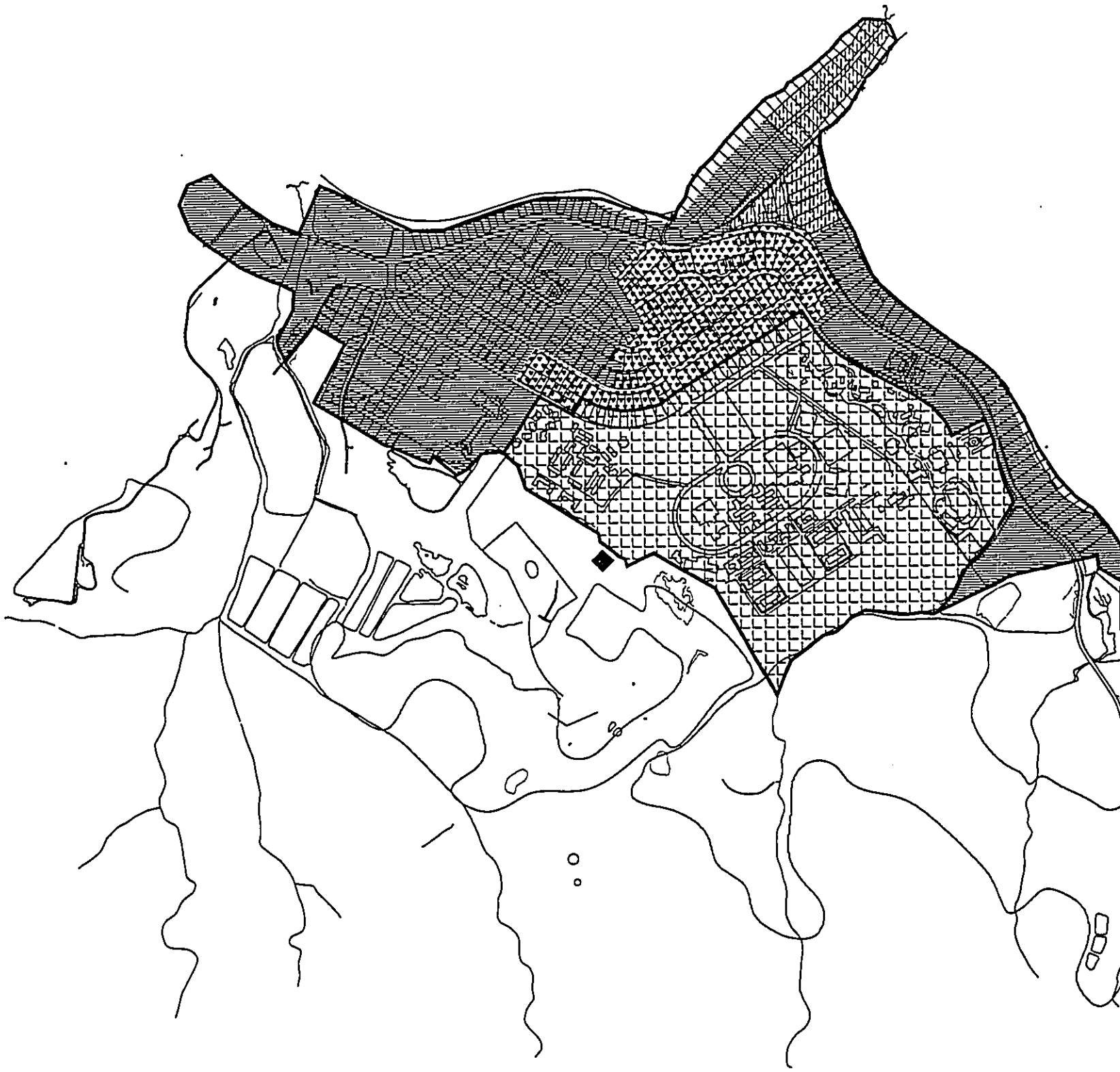
Since the LWRF expansion was completed in 1997 there have been no spill or overflow incidents at the facility. The LWRF continues to function effectively. There have been spills along various points of the existing collection system due to pipe failures. Existing pump stations have not experienced any operational problems, but the main gravity and force mains are over thirty years old. Hence the need for a new collection system. The Phase I project will replace the existing collection system with a new gravity collector, pump station and force main. These upgrades will greatly improve system reliability and will benefit environmental conditions by substantially reducing the potential for leaks or spills from aging sewer lines.

The existing collection system was installed in increments between 1958 and 1974. The stages and their scope are as follows:

1 - (1958) - Sewered the middle part of the residential area, and a portion of BYU-H. Installation of the Moana Street pump station.
2 - (1960) - Sewered the upper area of BYU-H dormitories.
3 - (1961) - L.D.S. Temple and additional residential lots were sewered. Installation of the TVA pump station.
4 - (1962) - Sewered additional residential lots and part of the PCC.
5 - (1970's) - Sewered the TVA and Faculty Housing.
6 - (1974) - Sewered the remaining portions of the PCC. Installation of the PCC pump station.

Collection systems developed under Stages 2, 5, and 6 (mostly private property) will not be modified by this project. The proposed project will add new connection points for BYU-H, PCC, and TVA. The remaining areas will be modified and discussed in the second EA.

A master plan for phased expansion of the collection system originally developed by Hawaii Reserves Incorporated (HRI) is summarized in **Table 1.1-1** and illustrated in **Figure 1.1-2.**



Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management

R. M. TOWILL CORPORATION

808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

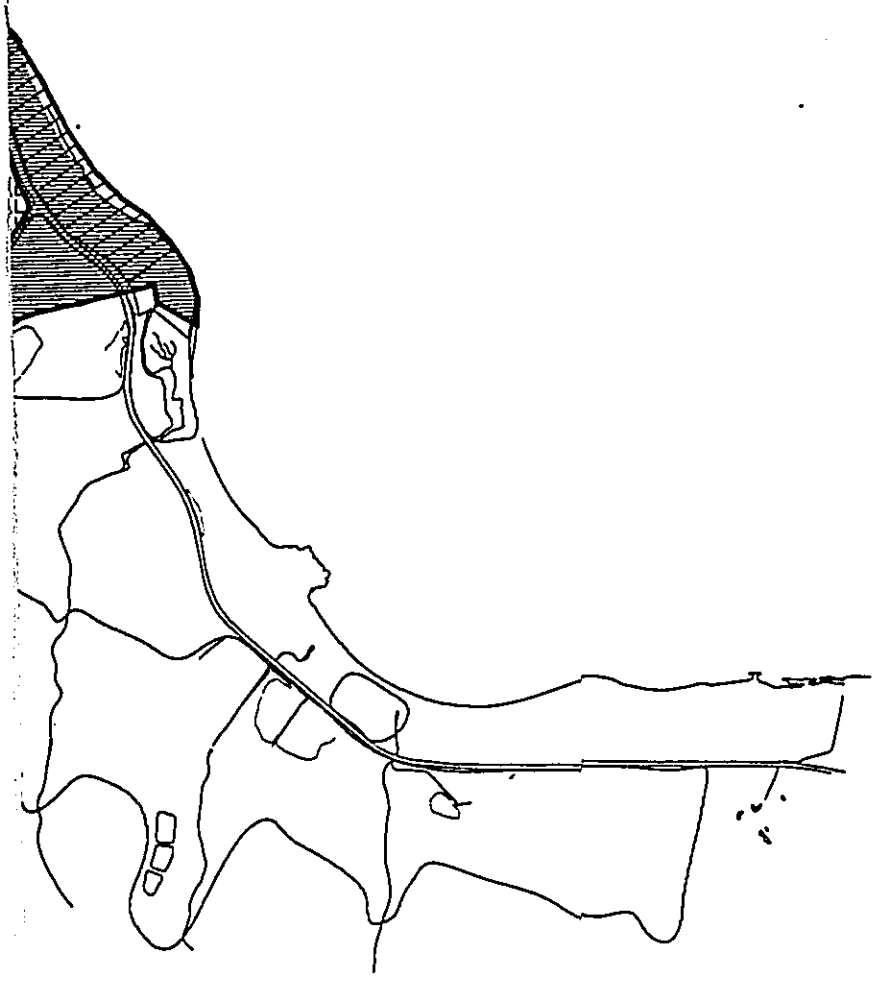
1200' 600' 0 1200' 2400'

SCALE: 1" = 600'

W

LEGEND

PHASE	AREA	
I	1	Existing service area (BYUH, TVA, and Polynesian Center) to be connected to new collection system and new BYUH pump station.
II	2	Existing developed area to be served by new low pressure collection system and new BYUH pump station
II	3	Existing service area to be served by new low pressure collection system and connected to lines feeding BYUH pump station. Abandon Moana pump station. (Old Laie Area). Phase I to include gravity connection of homes fronting Naniloa Loop.
II	4	Area to be served with individual grinder pumps discharge to new low pressure collection system.
	◆	New Laie Pump Station.



2400'

Laie Wastewater Collection System Expansion

Wastewater Collection System Master Plan

Figure 1.1-2

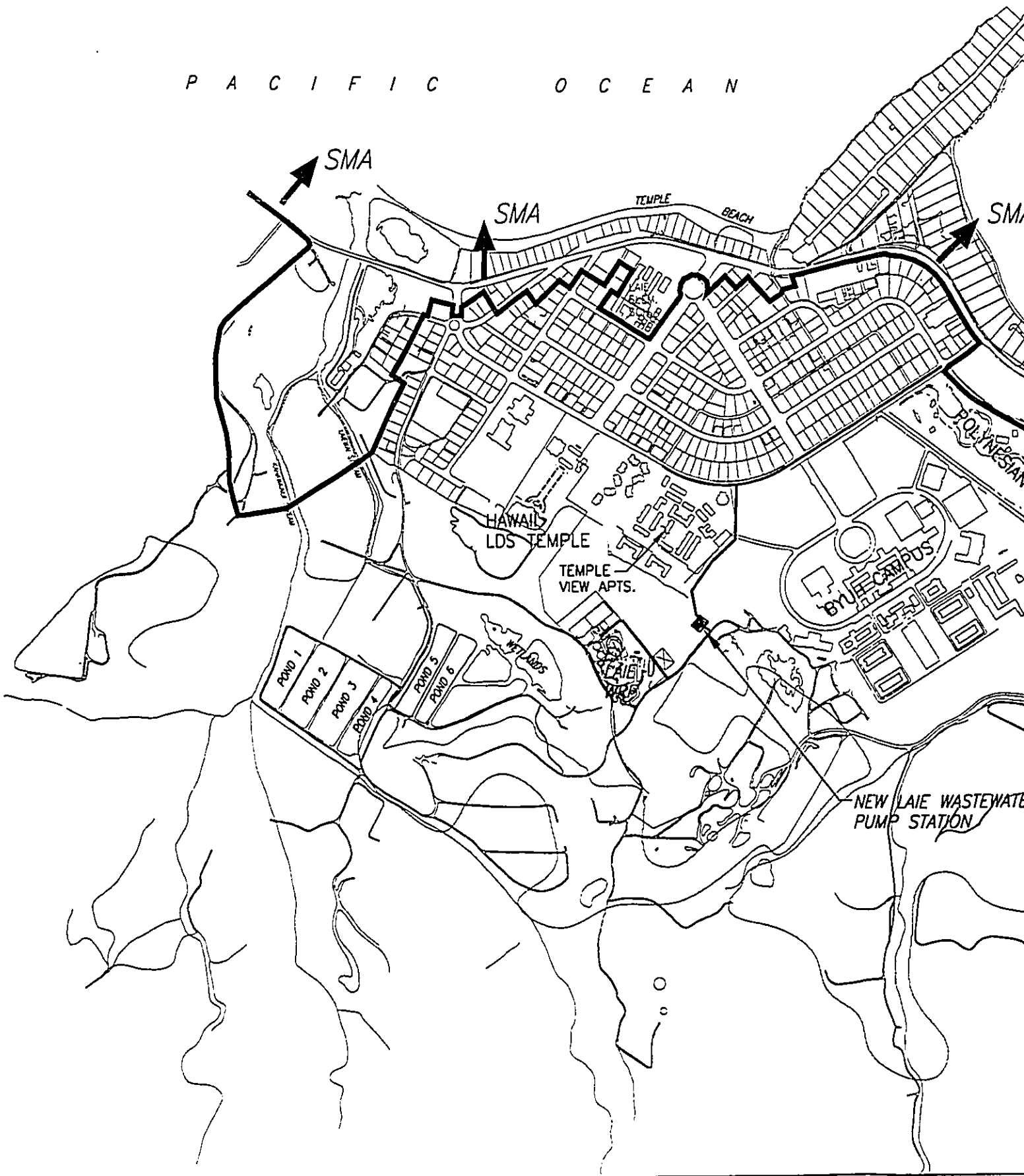
Table 1.1-1
La'ie Wastewater Collection System Expansion Master Plan

Phase	Area	Area Description	Collection System Status	Serving Pump Station
I	2	BYU-H, PCC and TVA	Existing gravity - New connection points only	New La'ie WWPS
II	1	New La'ie and other developed areas along coast and La'ie Pt.	Existing IWS - Install gravity / low pressure system.	New La'ie WWPS
II	3	Old La'ie Area	Existing gravity - Install new collection system	New La'ie WWPS
II	4	La'ie Pt. Area	Existing IWS - Install low pressure system.	New La'ie WWPS
II	9	Existing development area Kailua of La'ie and makai of Kamehameha Highway	Existing IWS - Future gravity connection to PCC lift station	New La'ie WWPS
Future	5	Future development area mauka of BYU-H campus.	Future connection to La'ie WWPS	New La'ie WWPS
Future	6	Future development area Kahuku of Kahawainui Stream	Future connection to New La'ie collection system	New La'ie WWPS
Future	7	Future development area Kailua of PCC and BYU-H	Future low pressure system.	New La'ie WWPS
Future	8	Future development area Kailua of La'ie along Kamehameha Highway	Future low pressure system connection to La'ie collection system.	New La'ie WWPS

The project site (Phase I) is not within the Special Management Area (SMA) boundary which extends along Kamehameha Highway, as shown in **Figure 1.1-3**.

1.2 PROJECT LOCATION AND OWNERSHIP

The proposed site for the wastewater pump station is approximately 600 feet east of the existing wastewater treatment plant. The tax map key number (TMK) for the proposed site is 5-5-06: Portion 9. The property is managed by Hawaii Reserves, Inc. (HRI), a Hawaii corporation, that was established in August 1993. HRI is carrying out responsibilities for the Hawaii properties of Property Reserves, Inc.



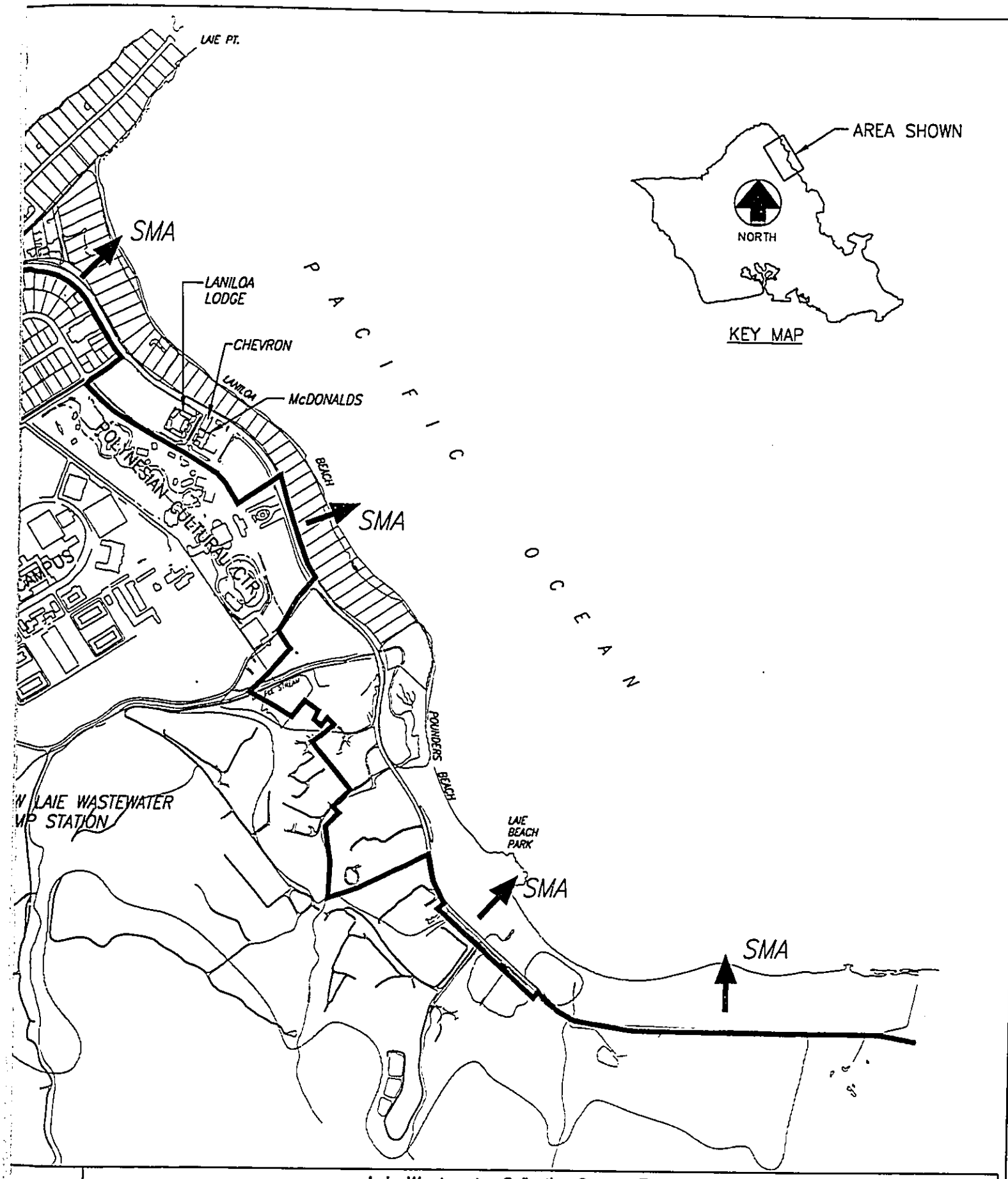
Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management
R. M. TOWILL CORPORATION
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

Speci



Laie Wastewater Collection System Expansion

Special Management Area

Figure 1.1-3

SECTION 2
Description of Project

2.1 PROJECT PURPOSE AND NEED

After nearly 30 years of use, the existing sewer collection system that serves Brigham Young University, Hawaii (BYU-H) and the Polynesian Cultural Center (PCC) is displaying signs of deterioration and is in need of upgrading. Additionally, only about 175 homes of the approximately 720 homes in the La'ie area are sewered. The vast majority of the remainder use aging cesspools or septic systems that are performing poorly.

The La'ie Sewer Project is proposed to upgrade the existing sewer collection system and, ultimately, to replace over 500 cesspool and septic systems with a modern sewer collection and reclamation system. Proposed Phase I improvements comprise the first step towards this objective. Phase I improvements include planned gravity flow line in Naniloa Loop from Iosepa Street to the La'ie Wastewater Pump Station (LWPS), the LWPS, and the force main from LWPS to the LWRF headworks, and the hookup of Polynesian Cultural Center (PCC), certain HRI commercial properties and BYUH, to the gravity flow line installed in Naniloa Loop. These upgrades will greatly improve system reliability and will eliminate the potential for leaks or spills from aging sewer lines. The project also benefits the environment by collecting and treating sewage effluent to reusable (R1) quality.

Although it is described within the overall framework of the La'ie Sewer Project, Phase I remains a stand-alone project independent of future project phases. Phase I improvements are being developed to replace the existing sewage collection system servicing the BYU-H campus and the PCC. Phase I will not expand sewer service and will not increase effluent disposal from the La'ie Wastewater Reclamation Facility. Phase I improvements do not involve a commitment to additional development.

If Phase II is undertaken in the future, it will provide the benefit of replacing over 500 cesspool and septic systems, most of which are aging and deteriorating, with a modern sewer collection and reclamation system. Instead of raw sewage being released into the ground, sewage and wastewater would be collected and treated to high enough quality irrigation reuse. Phase II is intended to be funded through the establishment of a sewer improvement district which is subject to City Council approval. Phase II activities would be undertaken in compliance with Chapter 343 HRS environmental impact assessment and public review requirements.

With regard to possible future development, the overall La'ie Sewer Project is planned to meet existing wastewater service needs and to support the removal of aging and leaking cesspools from service. The system is designed to increase capacity above existing levels in order to accommodate the possibility of future development in La'ie, as planned in the *Ko'olauloa Sustainable Communities Plan* (KSCP).

2.2 SERVICE AREA AND DESIGN FLOWS

The La'ie Wastewater Collection System Expansion Master Plan was previously described in Table 1.1-1. The master plan envisions expansion of the collection system to include residential areas, commercial areas, institutional areas, and resorts. Each of these areas were grouped into service area categories that are identified in **Table 2.2-1.** Phase I areas, listed in the table, consist of privately owned entities that are serviced by an existing sewage collection system. Phase I improvements will be constructed under the terms of a cooperative agreement between the City and HRI (HRI, December 29, 2000). Phase II areas include both sewered and unsewered properties that would be upgraded or serviced by a new sewer system. Wastewater flows from all categories will flow into the new pump station.

Table 2.2-1

Service Area Categories

Category	Area Description
(Phase I)	These are primarily private entities that will remain private and sewered with upgraded system.
	Residential Areas Temple View Apartments Faculty Townhouses
	Commercial Areas Polynesian Cultural Center
	Institutional BYU-H Campus BYU-H Dormitories
(Phase II)	These are the currently sewered and unsewered areas of La'ie that are to be upgraded or sewered through establishment of a Sewer Improvement District
	Residential Areas Currently Sewered (New La'ie) Old La'ie Mauka of Kamehameha Highway Kamehameha Highway, Kahawainui to La'ie Point La'ie Point Kamehameha Highway, La'ie Point to Wailele
	Commercial Areas La'ie Shopping Center Hawaiian Telephone Co. Chevron Service Station McDonalds
	Institutional Elementary School Temple Church - Makai Temple Church - Mauka LDS Chapel LDS Temple
	Resort Laniloa Lodge

Design flows developed for the new pump station were based on various sources including:

- La'ie Water Reclamation Facility (LWRF) Plan, August, 1993
- Water demand data
- City and County of Honolulu wastewater flow generation criteria
- Hawaii Reserves Incorporated information

The proposed sewer lines and pump station have been designed within the limits of the peak design capacity of the LWRF. The LWRF is sized for a design average flow of 0.90 million gallons per day (mgd). Currently, the treatment facility handles a design average flow of approximately 0.30 mgd.

Design flows are presented for the new pump station (La'ie WWPS) and force main in **Table 2.2-2.**

TABLE 2.2-2
LA'IE WASTEWATER PUMP STATION
SUMMARY OF PROJECTED FLOWS AND PUMPING CAPACITIES

	Flow Rate (mgd)
Design Average Flow, mgd	0.69
Design Maximum Flow, mgd	1.94
Design Peak Flow, mgd	
Grinder System	3.16

2.3 TECHNICAL CONSIDERATIONS

2.3.1 NEW COLLECTION SYSTEM

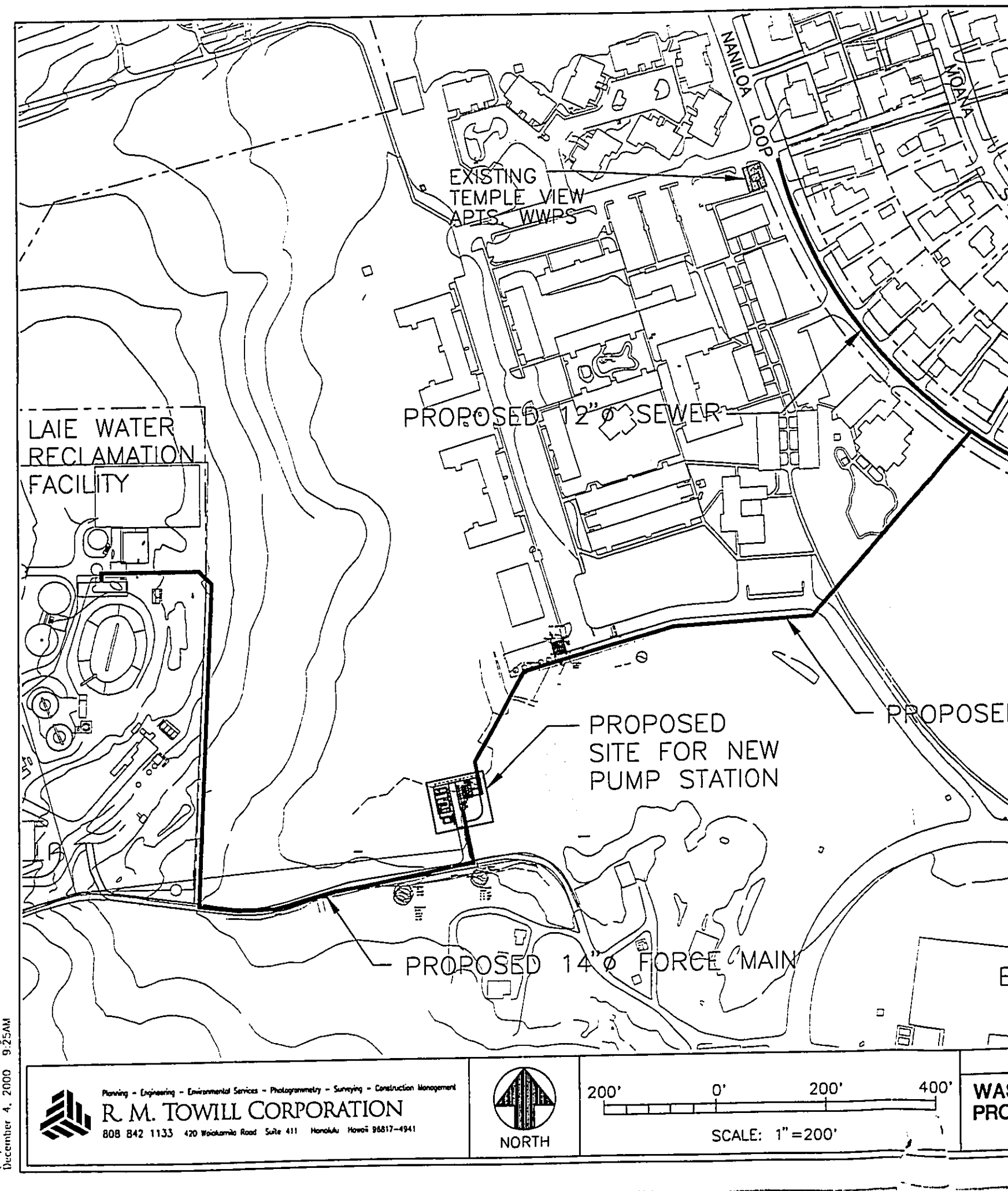
The new gravity collection system for Phase I will establish new connection points for the existing wastewater systems of BYU-H campus, PCC, and TVA. Polyvinyl chloride (PVC) pipe will be used for all gravity sewer applications.

2.3.2 NEW LA'IE WASTEWATER PUMP STATION

The proposed La'ie Wastewater Pump Station (WWPS) is sited on a land parcel owned by Brigham Young University - Hawaii and managed by Hawaii Reserves Inc. (HRI) (as agent for Property Reserves, Inc.). The parcel is identified as Tax Map Key (TMK) 5-5-06: Portion 9. A proposed vicinity plan of the proposed WWPS is presented in **Figure 2.3-1.**

The WWPS will be accessed from a new pump station access road through the existing road (Poohaili Street) that services the LWRF. Poohaili Street, a private road, intersects Kamehameha Highway near the north end of La'ie.

A proposed site plan is presented in **Figure 2.3-2.** The following are the major features of the pump station.

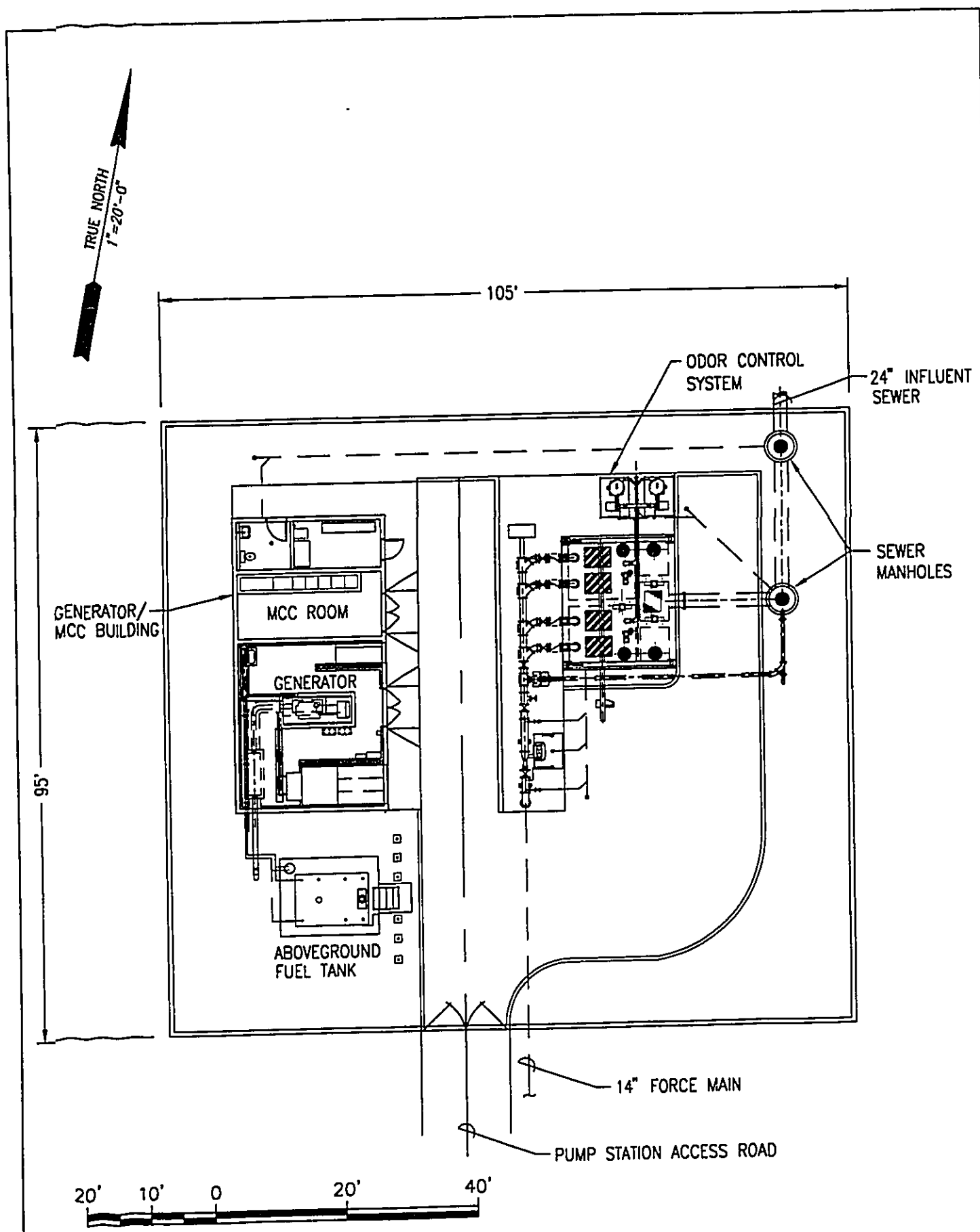


(EL) 2.3-1Site Plan.dwg,DWG
December 4, 2000 9:25AM

Laie Wastewater Collection System Expansion

WASTEWATER PUMP STATION - PROPOSED VICINITY PLAN

Figure 2.3-1



Lale Wastewater Collection System Expansion

R. M. TOWILL CORPORATION
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

PROPOSED SITE PLAN
SUBMERSIBLE PUMP STATION

Figure
2.3-2

- Junction box with two slide gates to distribute flows to the wet wells
- Two wet wells with each having a low capacity and a high capacity submersible pump.
- Discharge piping, valves, and venturi will be supported aboveground.
- Emergency generator and MCC building. The emergency generator room will be designed to meet property line noise requirements during operations.
- Odor control system. An activated carbon filter system will be used, comprised of two air filtration units - one primary and one back-up.
- A 2,000-gallon above ground, concrete encased double-wall steel diesel fuel tank is proposed.
- Flood protection to 11 feet above mean sea level. Existing ground elevation is approximately 7 feet.

The existing utilities are adequate for the needs of the proposed WWPS. Water, electric, and telephone lines are currently available for connection.

2.3.3 NEW FORCE MAIN

The proposed 14-inch diameter force main will convey wastewater from the proposed WWPS to the LWRF. The force main will be approximately 1,400 linear feet.

Based on cursory observations of the topography, two combination air / vacuum relief valves are required on the force main. One combination valve is required on the steep grade near the LWRF and another valve near the Headworks of the facility.

2.4 BEST MANAGEMENT PRACTICES (BMPs)

The BMPs will include guidelines and mitigation measures to prevent construction related runoff, discharge pollution, and other detrimental impacts to waters of the State. Mitigation measures shall include, but not be limited to the following:

- Clearing and excavation shall be held to a minimum necessary to meet project design and construction plan requirements.
- Construction shall be phased to minimize the exposure time of cleared or excavated areas. Existing ground cover shall not be destroyed, removed or disturbed more than 20 calendar days prior to the start of construction.
- Storm water flowing toward active project areas shall be diverted as much as practicable using appropriate controls, such as berms and silt fences, as determined by the contractor according to site conditions.
- Areas that remain unfinished for more than 30 calendar days shall be hydro-mulched or seeded to provide temporary soil stabilization.
- The project contractor will select locations for stockpiling construction material. As appropriate to the site, a sediment retention berm or silt fence will be installed around the down-slope side of stockpile sites to retain sediment discharge during heavy rainfall.

- Fueling of construction equipment will be performed off-site or within an area designated by the contractor. Any site designated for refueling shall be located away from surface water and constructed to contain spills and seepage and prevent storm water runoff from carrying pollutants into state coastal waters.
- The contractor, based on professional experience and expertise, may modify the proposed BMP mitigation measures as necessary to account for unanticipated or changed site conditions.

2.5 PROJECT SCHEDULE AND COST

2.5.1 PROJECT SCHEDULE

The project is expected to proceed in accordance with the following schedule:

Completion of design phase	February 2001
Start of construction	June 2001
Completion of construction	November 2002

2.5.2 ESTIMATED COST

The estimated Phase I construction cost for the proposed project is $5.8 million dollars. (For a detailed cost breakdown, refer to Engineering Report for the La'ie Wastewater Collection System Expansion, R. M. Towill Corporation, August, 2000.) Under the terms of the cooperative agreement, the City and HRI intend to share equally in the Phase I project cost.

SECTION 3
Description of Affected Environment

3.1 PHYSICAL ENVIRONMENT

3.1.1 CLIMATE

Climate data presented here is summarized from the La'ie Wastewater Reclamation Facility (LWRF) Plan.

La'ie is located on the windward coast on the northeastern portion of Oahu. The area has constant exposure to the northeast tradewinds that are the predominant winds to Oahu. Average wind velocity in the area varies from 10 to 15 mph.

Mean temperatures are typical of the island chain. Mean maximum temperatures range from the mid 70's F in winter to the low 80's F in fall and summer. Mean minimum temperatures range from the low 60's in the winter to the low 70's in summer.

Average annual rainfall recorded at BYU-H farms Station 903.1 was 54.37 inches (4.5 inches/month) for the period from 1968 to 1991. The dryer months of May through September average 3-4 inches per month. The wetter months of October through April average 4-8 inches per month.

3.1.2 TOPOGRAPHY

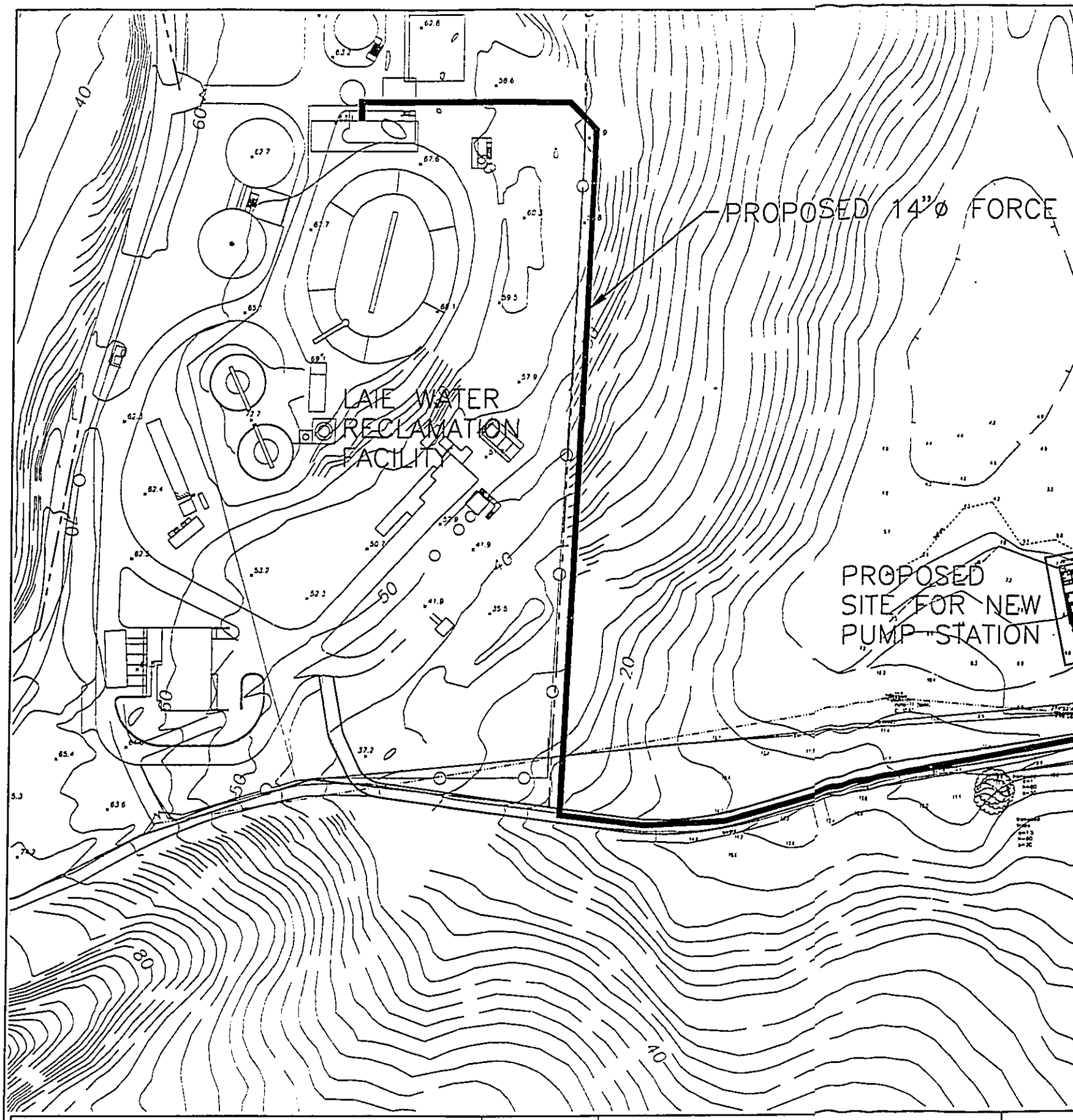
The major developed areas of La'ie are generally located in low lying areas. Elevations are typically in the 6 ft. to 10 ft. msl range. The land rises sharply as one moves more inland. The existing LWRF is located on a rise at an elevation in the 70 ft.+ msl. The proposed pump station site and homes along Naniloa Loop are located in areas with elevations under 10 ft. The proposed pump station topography site plan is presented in **Figure 3.1-1.**

Impacts and Mitigative Measures

There will be some alteration of the existing land as a result of construction of the proposed project. All excavated material will be used as fill and retained on BYU-H/HRI property within La'ie. All grading and related construction activities will be conducted in full compliance with the dust and erosion control requirements of the City and County, State, and Federal regulations. An erosion control plan will be submitted for approval to the City and County of Honolulu, Department of Public Works. Some dust and erosion control methods include temporary ground covers, barrier fences, and detention ponds.

3.1.3 SOILS AND GEOLOGY

Design level geotechnical explorations were completed in March 1999 and presented in the draft report "Preliminary Geotechnical Engineering Exploration - Expansion of the La'ie Treatment Works Sanitary Sewer Collection System" May 1999, Geolabs. The following is a summary of the report:



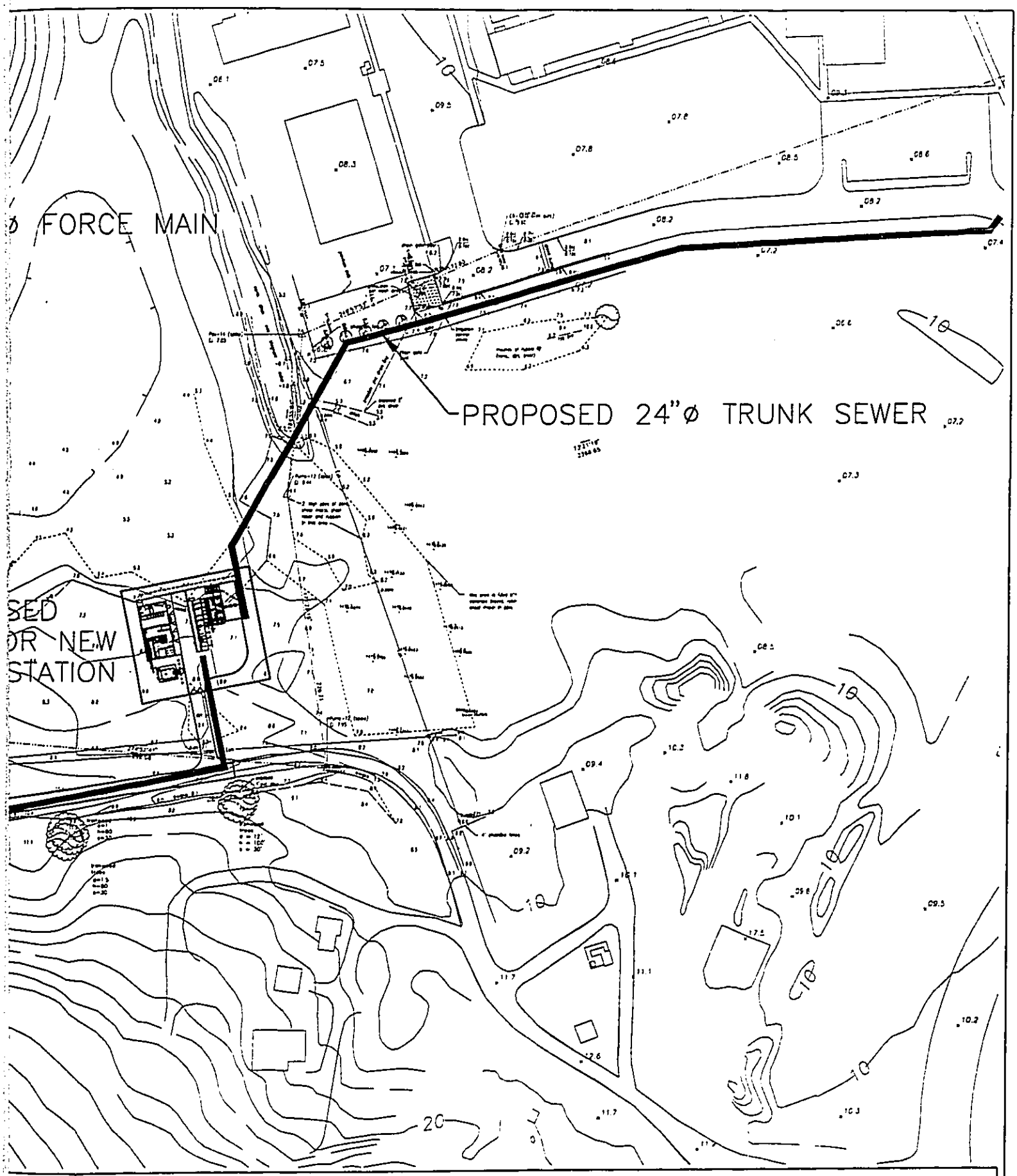
Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management

R. M. TOWILL CORPORATION

808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

PUMP

(LL) 3.1-11topo-plan.dwg.DWG
December 4, 2000 9:22AM



Lake Wastewater Collection System Expansion

200'

PUMP STATION SITE TOPOGRAPHY MAP

Figure
3.1-1

- Groundwater is generally at elevations in the +2 ft. msl range implying that groundwater is present at elevations from less than 2 ft. to 9 ft. below the ground surface.
- The soil characteristics in the area can be generally described as being underlain by dense coral sands and gravel extending to a depth of about 40 feet below the existing ground surface.

Impacts and Mitigative Measures

- Conventional open trench method may be used for the installation of gravity sewers.
- Due to sandy subsoils and the high groundwater levels throughout the project site, special attention should be given to the excavation shoring and dewatering operations during construction.
- Portions of the gravity sewers could be underlain by loose coral sands and gravel. Therefore special bedding requirements and soft ground stabilization measures should be considered in the design.
- For the pump station site, a mat foundation bearing on the medium dense coral sands and gravel underlying the site appear adequate for the deeper wetwell structure.

3.1.4 HYDROLOGY

Hydrology information presented here is summarized from the La'ie WRF Plan.

The La'ie plain is underlain by two aquifers: a shallow "caprock" aquifer and a deeper basalt aquifer. The caprock aquifer is composed of coral, sand, silt, lithified dunes, and clay. Sedimentary materials such as clay strata and limestone within the caprock retard the movement of groundwater. Groundwater within the cap rock moves toward the ocean, however, local variations may affect the flow direction. This underlying groundwater is not considered a drinking water source. Recharge of the cap rock aquifer is predominantly from infiltration of precipitation, but smaller amounts also enter the aquifer as return flow either from irrigation, seepage from the PCC lagoon, or seepage from the existing leach field.

The deeper basalt aquifer underlies the cap rock aquifer and extends thousands of feet into the subsurface. The basalt aquifer consists of thin bedded lava flows of very high permeability. The upper portion of the basalt aquifer is comprised of weathered volcanics that normally have a lower permeability than the underlying unweathered basalts. The basalt aquifer, like the cap rock aquifer is also recharged predominantly by rainfall, primarily from the mountains mauka of La'ie.

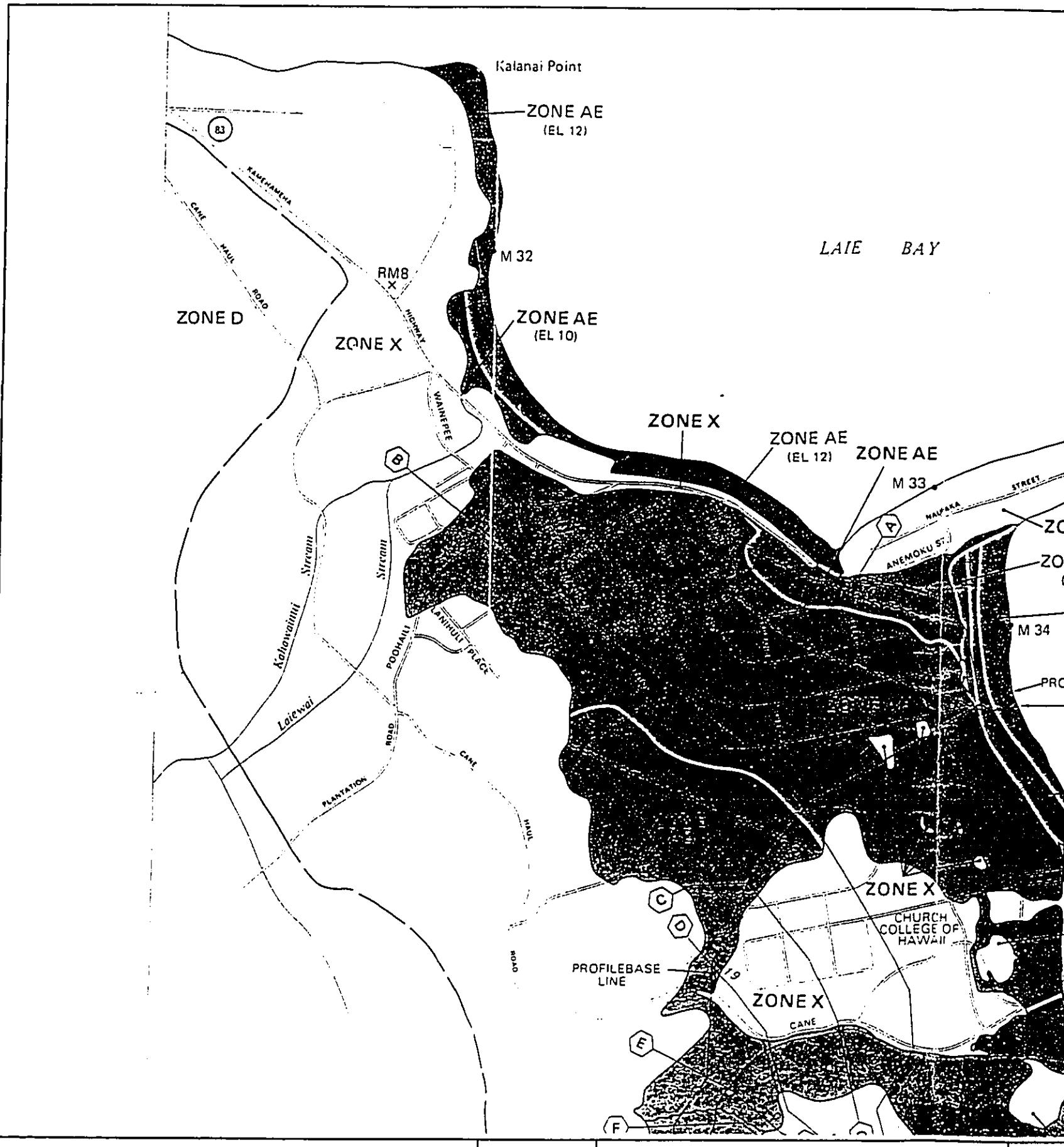
Impacts and Mitigative Measures

The proposed project is not expected to have a significant impact on hydrology. Implementation of appropriate Best Management Practices (BMP) by the contractor will minimize the impacts from construction dewatering and the disposal of hydrotesting water.

3.1.5 FLOODS AND TSUNAMI

The Flood Insurance Map (see **Figure 3.1-2**) shows that the project site is prone to flooding. The collection system along Naniloa Loop and the pump station site and force main are subject to flooding.

DOCUMENT CAPTURED AS RECEIVED



Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management

R. M. TOWILL CORPORATION

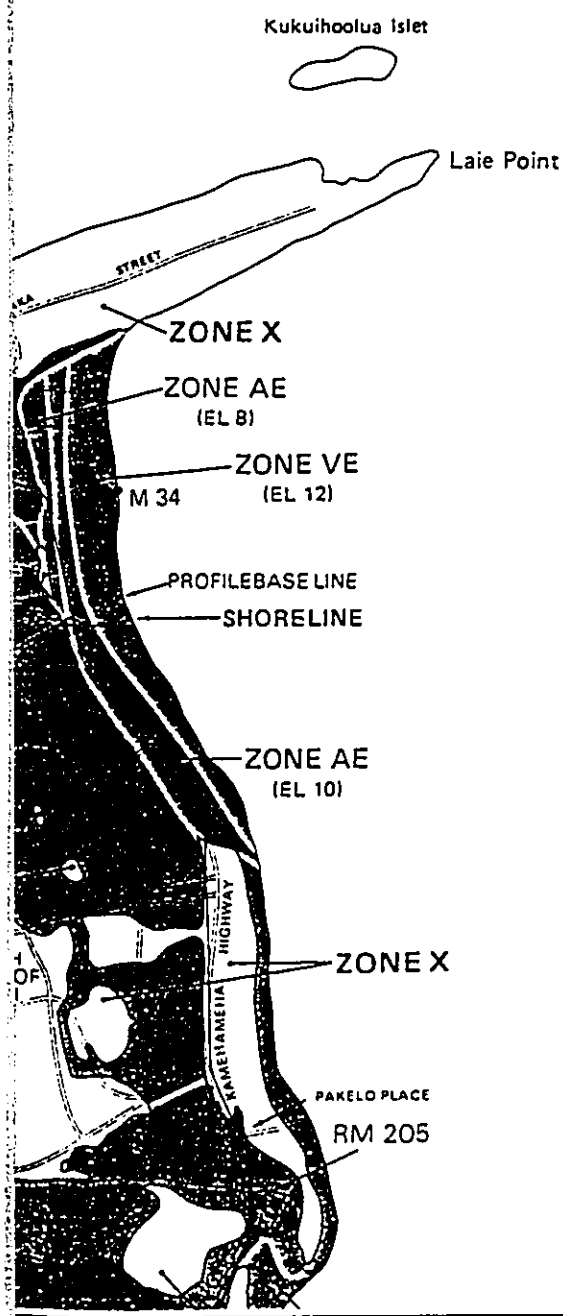
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

Floo
for



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*
- D — D — Cross Section Line
- (EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone*
- RM7 X — Elevation Reference Mark

2000'

Laie Wastewater Collection System Expansion

Flood Insurance Rate Map for Laie Collection System Area

Figure 3.1-2

The seismic rating for the La'ie area according to the Uniform Building Code is Zone 2A, an area of moderate seismic activity. The proposed pump station and force main, and the majority of the gravity sewer lines are not located within the tsunami evacuation zone. Some sections of the gravity main along Naniloa Loop, between Kulanui Street and Kamehameha Highway are located within the tsunami evacuation zone.

Impacts and Mitigative Measures
Flood elevations in the collection system area range from +10 to +11 ft. msl. The proposed new La'ie WWPS is subject to a +11 ft. msl flood and hence floor elevations and containment areas must have a minimum elevation of +13 ft. msl. The sewer collection system will also be below the water table, so polyvinyl chloride (PVC) will be used for the pipe material to minimize infiltration and inflow (I/I) from flooding or tsunami inundation.

3.1.6 FLORA AND FAUNA

Vegetation communities are categorized according to the relative abundance of the vegetation cover type. The proposed areas for development are primarily "California Grass Dominated Areas" which generally occur along ponds, streams, and low-lying areas and include cattail, honohono, primrose willow, moonflower, false daisy, barnyard grass, and water hyacinth. None of the plant species identified on or near the proposed site represent endemic species, or plants native to the Hawaiian Islands. None of the plants are listed as "threatened" or "endangered" species. None of the plants observed is proposed or is a candidate for such status. (Char and Associates, April 1991, November 1993).

Faunal surveys (Bruner, April 1991, November 1993) noted the presence of four endangered and endemic waterfowl in the Poohaili Wetlands, mauka of the existing wastewater treatment facility. They are the Koloa (Hawaiian Duck) (*Anas wyvilliana*), black-necked stilt (*Himantopus mexicanus knudseni*), American coot (*Fulica americana alai*), and common moorhen (*Gallinula chloropus sandvicensis*). Other wildlife known from the area include introduced bird species such as the common mynah, cattle egret, zebra dove, red-crested cardinal, spotted dove and the Japanese white-eye. Mammals in the area include rats and mongooses.

Several surveys of aquatic wildlife in the Kahawainui floodplain and stream have been conducted (AECOS, Inc., May 1991; Environmental Technologies, Inc., February 1992). Aquatic fauna observed during these surveys includes the common guppy, tilapia, Chinese catfish, bull frogs, and freshwater snails. The surface water also harbors an abundance of spiders and insects, particularly earwigs. Additionally, three common species of endemic o'opu (goby) (*Eleotris sandvicensis, Stenogobius genivittatus, Auraous staminueus*), were observed in Kahawainui Stream. None of the aquatic fauna noted are threatened species.

Impacts and Mitigative Measures
Clearing and grubbing activities will affect vegetation for less than half an acre for the new site. No significant adverse impacts to vegetation are expected as a result of this project. No threatened or endangered plant species will be affected by this project.

The project site is dominated with common, introduced plant species not identified with traditional gathering practices. Clearing of the project site will not, at any rate, diminish the availability of these plant species as a resource. The project does not occur near the shoreline and does not interfere with access to shoreline resources.

The proposed improvements are not located near the Poohaili Wetlands and will not involve the use or destruction of wetland habitat frequented by the birds noted above. The replacement of existing aged cesspools with an improved wastewater collection and treatment system will eliminate a potential source of ground and surface water contamination that could affect wetland habitat and surface water resources. Activities required to construct and operate the new wastewater collection system are not expected to have a significant effect on terrestrial and aquatic wildlife.

3.1.7 WATER QUALITY

The various streams in the La'ie community collect runoff from urban, agricultural, and vacant natural areas. Runoff constituents are carried downstream, and are discharged into the ocean during peak precipitation periods, thereby periodically degrading ocean water quality. Runoff constituents include silt, organic material, debris, trash, terrigenous bacteria, and dissolved runoff constituents.

The La'ie Bay area is designated as "Class A" by the Department of Health, State of Hawaii (DOH). Waters designated as "Class A" are to be protected for recreational uses, aesthetic enjoyment, and protection and propagation of marine life.

Impacts and Mitigative Measures

No adverse impacts on water quality are anticipated from construction of this project. The proposed upgrades will benefit environmental conditions by eliminating or substantially reducing the potential for leaks or spills from aging sewer lines. Grading permit requirements will be implemented during construction to prevent runoff discharges into nearby shores. The impact of small amounts of suspended sediment entering ocean waters as a result of construction activities is anticipated to be negligible. Runoff from construction sites will be regulated under NPDES permit conditions which limit the soil loss from work sites. (See Section 2.4, Best Management Practices).

3.1.8 AIR QUALITY

The present ambient air quality in the project area is considered good due to the prevailing northeasterly tradewinds and the absence of "heavy" industries. The air quality is mostly affected by air pollutants from natural and / or vehicular sources. Natural sources include ocean spray, wind-blown dust, or possible distant volcanic emissions from the Island of Hawaii. Vehicular emissions from motorists traveling on Kamehameha Highway, the Quarry Access Road, or local farm roads.

The pump room, which is exposed to wastewater, will be sealed to prevent the escape of odors. Foul air within these spaces will be removed and treated before being released to the atmosphere. The proposed project will be equipped with one diesel-powered generator capable of automatically providing back-up power during a commercial power outage.

Impacts and Mitigative Measures

The proposed project is not expected to have a significant impact on air quality. Construction activities may result in short-term air quality impacts. To mitigate these impacts, the Contractor will be required to comply with provisions of Hawaii Administrative Rules, Chapter 11-60.1-33, Fugitive Dust. The site clearing, grubbing, and grading

activities will temporarily generate fugitive dust during the site preparation period. Temporary dust emissions will generally be downwind of the construction activities and are not expected to affect existing residential, institutional, and commercial facility areas in the La'ie community.

Long-term impacts to air quality can result from the wastewaters potential for generating odors. Odors at the pump station should be minimal since the wastewater detention times within the tributary collection system and at the pump station are relatively short. The short detention time should prevent septic conditions from developing. However, as a precautionary measure, a new odor control system will be provided.

Odor will be controlled through the use of a carbon absorption system installed at the pump station. Wastewater entering the pump station will be collected in a sealed, lined, wet-well into which two pumps and two air filtration units will be constructed. One of the air filtration units will remain in continuous operation, the other will serve as a back-up system.

The air filtration units use an exhaust fan to draw air out of the air space in the wet-well and through an activated carbon filter which traps and absorbs odorous compounds before venting to the outside air through a dispersion stack. Activated carbon absorbs a variety or organic and inorganic compounds including hydrogen sulfide (H_2S), the most common odorous gas found in wastewater collection and treatment systems. When the capacity of this type of carbon is reached, it can be regenerated in place by means of a water wash.

The new odor control systems will minimize long-term impacts on air quality. Emission rates from the odor control system will be kept below the exempt amounts established in HAR, Chapter 11-60, "Air Pollution Control". The Department of Health will verify emission rates when an application is made to obtain an air pollution permit for the project.

Emergency generators will be used only during power outages or equipment maintenance and testing. If operated only during power outages or equipment maintenance and testing, the generators will be exempt from the requirements of Hawaii Administrative Rules (HAR), Chapter 11-60, "Air Pollution Control".

3.1.9 NOISE

Ambient noise conditions in the proposed project area are generally low due to its rural location. The dominant noise is from vehicular traffic along Kamehameha Highway and the local roadways. Local residences are generally exposed to sound levels ranging from 70 dB to 60 dB or lower (Day-Night average sound levels). Other normal daytime sources of noise include lawn mowers, barking dogs, and power tools.

Impacts and Mitigative Measures

Short-term noise impacts are related primarily to construction activities. A majority of the noise generated will be during operation and mobilization of the heavy construction equipment, particularly during site preparation and access improvements at the pump station site. Noise levels of the construction equipment are expected to be in the range of 55 and 90 dBA in close proximity to the site. To mitigate short-term construction related impacts, compliance with the provisions of HAR, Chapter 11-46, "Community Noise Control," will be required.

Long-term noise impacts would generally be attributed to operation of the wastewater pumps, the odor control systems, and the emergency generators. Potential adverse noise impacts will be minimized by housing noise generating machinery in acoustically treated enclosures. Acoustical treatments will include the following: silenced inlet and discharge air openings, interior wall and ceiling finish insulation, sound rated door assemblies, and exhaust mufflers.

3.2 SOCIO-ECONOMIC ENVIRONMENT

3.2.1 LAND USE

La'ie is situated in a traditionally rural area which is characterized as maintaining a "country" lifestyle. However, the notion of "country" living varies considerably. La'ie's population resides primarily in well-defined neighborhoods, while social and economic activity is largely anchored to the town's business center, the Polynesian Cultural Center and Brigham Young University.

The present general mix of land uses in the area consists of: schools, parks, water reservoirs, wastewater facilities, commercial office, retail, and residential and agricultural uses. Land immediately adjacent to the pump station are unused, former agricultural lands. The Brigham Young University, Hawaii Campus is located less than one-quarter mile to the east of the proposed pump station site, and the Temple View apartments are located less than one-quarter mile to the north.

The pump station and force main are within the State Land Use Agricultural District. Portions of the State Land Use Urban District are also included in the project for the gravity collection system along Naniloa Loop and to the pump station. Those portions of the project located in the State Urban District are subject to zoning regulations under the City and County of Honolulu Land Use Ordinances.

The proposed site for the pump station and the force main is zoned for agriculture (AG-1) as classified by the City and County of Honolulu. The AG-1 Restricted Agricultural District zoning designation generally includes lands classified as "Prime" or "Unique" under the Agricultural Lands of Importance to the State of Hawaii (ALISH) system. The remaining gravity collection system along Naniloa Loop is zoned R-5, Residential.

Impacts and Mitigative Measures

Construction activities will have short-term impacts on surrounding land uses. To mitigate short-term construction related impacts, the Contractor will be required to follow applicable State and City erosion, dust, and noise control regulations and implement appropriate BMPs.

The proposed project is not expected to have significant long-term adverse impacts on current or future land uses in the area. Mitigative measures will be taken to minimize potential odor, noise, and visual impacts. An odor control system will be installed at the pump station to reduce the risk of odor nuisance. Extensive acoustical treatments will minimize noise levels at the property lines. Landscaping at the pump station will be utilized to minimize adverse visual impacts on surrounding areas.

3.2.2 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Many observations of the archaeological and historical resources in the La'ie area have been conducted. Observations include reports by Cultural Survey Hawaii (1991), which identified sites that were determined by review of existing archaeological surveys, literature, historic maps, photographs, and Land Court documents. None of these sites have been included in the National or State Register of Historic Places. Taro terraces, for example, were known to exist however, most were destroyed through sugarcane cultivation and other modern land modifications. An additional historic site, the Nioi Heiau Complex (SIHP No. 50-80-02-281) is adjacent to the project area, however, according to the State Historic Preservation Division (SHPD), proposed project activities will have "no effect" on historic sites in that area (see Appendix C, Correspondence, SHPD letter dated August 16, 2000).

More recent studies have been conducted in identifying areas where cultural resources would be least impacted by construction of the LWRF. In 1992, a walk-through survey by Paul H. Rosendahl was conducted to locate proposed sites for the LWRF. A cluster of features resembling temporary habitation sites were identified on a limestone outcrop. These areas as presented in **Table 3.2-1** are not within the proposed project boundaries. Additionally, the project site contains Jaucas sand deposits, which are known to contain significant subsurface cultural deposits and human burials.

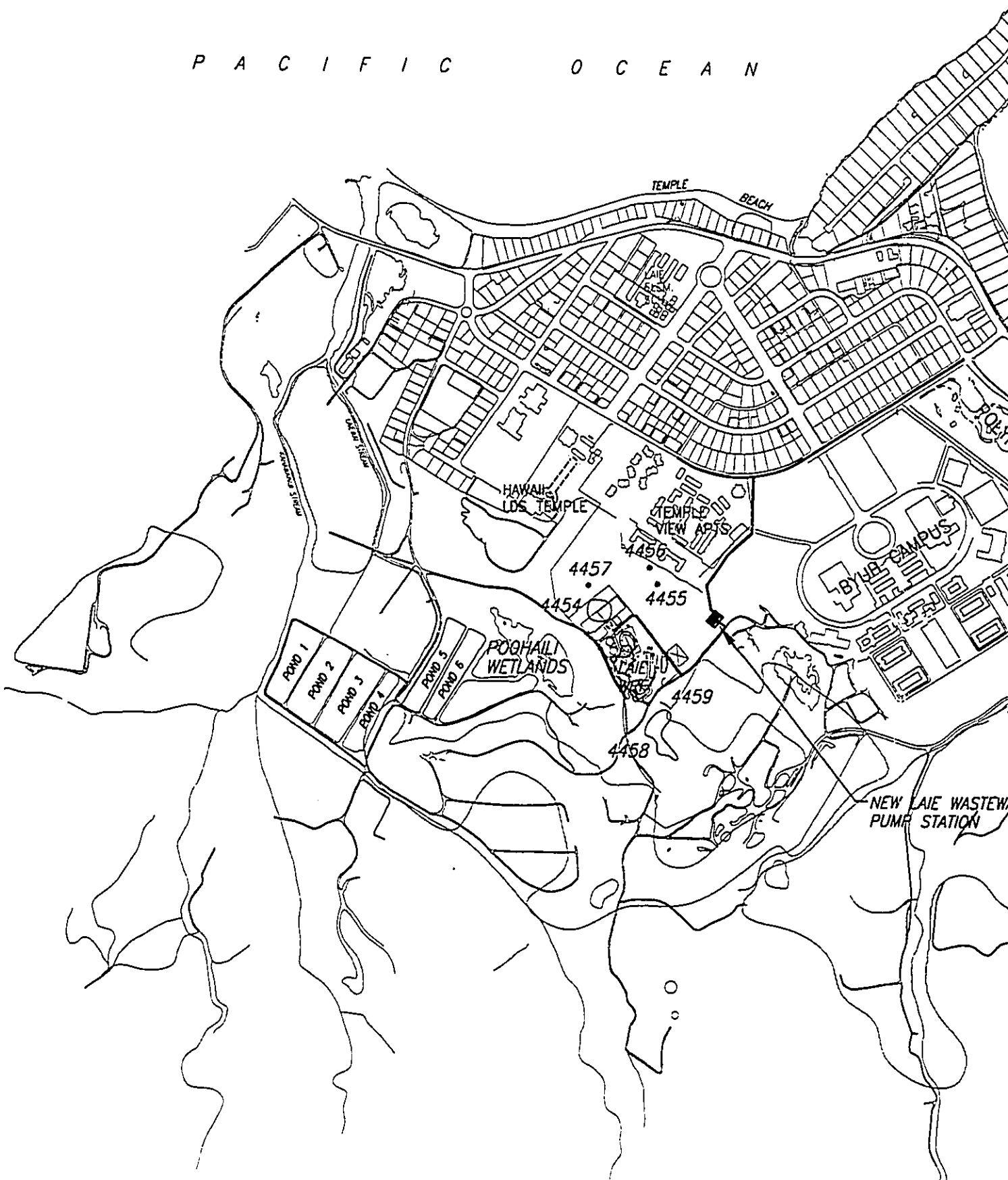
TABLE 3.2-1
Archaeological Sites

Site No.	Site Feature Types	Significance Assessment / Recommended Treatment
4454	Agricultural Complex (Historic)	Important for information content, no further data collection necessary
4455	Foundation (Historic)	Important for information content, further data collection necessary
4456	Modified Outcrop (Recent)	Important for information content, no further data collection necessary
4457	Irrigation Ditch (Historic)	Important for information content, no further data collection necessary
4458	Agriculture / Habitation (Prehistoric)	Important for information content, no further data collection necessary Culturally significant, preservation "as is" recommended
4459	Irrigation Ditch (Historic)	Important for information content, no further data collection necessary

Source: Paul H. Rosendahl, Ph.D., Inc. (April 1992)

Impacts and Mitigative Measures

All archaeological sites as presented in **Figure 3.2-1** are located outside the project site. The limits of the construction area will be clearly identified prior to construction. Care will be taken during site work and construction so all identified archaeological sites would not be disturbed. Efforts will be made to maintain a five meter buffer (per DLNR recommendation) to avoid disturbance during use of heavy equipment.



Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management

R. M. TOWILL CORPORATION

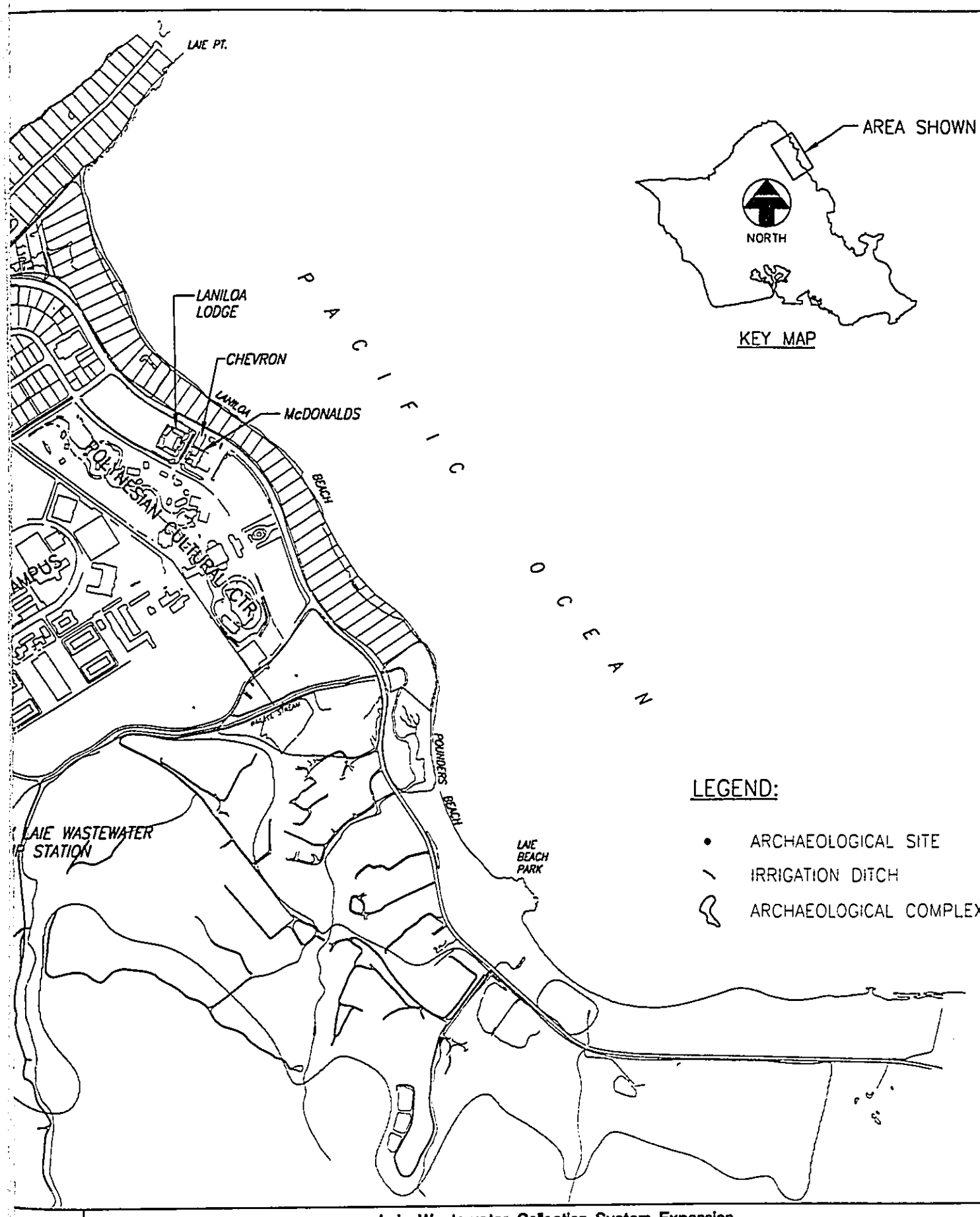
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

Ar



Laie Wastewater Collection System Expansion

Archaeology Exhibit

Figure 3.2-1

Further, a qualified archaeologist will be employed to monitor excavations in the Jaucas sand deposits along Naniloa Loop. Prior to beginning work in this area, an archaeological monitoring plan will be prepared by the archaeologist and submitted to SHPD for review, along with available information on soils testing and geology in the area.

A portion of the construction will involve extensive modification of the land surface and there is a possibility of encountering unknown or unexpected cultural features, deposits, or burials. If this situation occurs, work in the area will be suspended immediately until the monitoring archaeologist has the opportunity to evaluate the significance of the findings. The Historic Preservation Division of the State DLNR would be immediately notified to determine the appropriate course of action.

3.2.3 SCENIC AND VISUAL RESOURCES

The existing visual character of the project area and adjoining lands to the north and south of the La'ie community and south of the Hawaii LDS Temple can be generally classified as "rural" in nature. This is exemplified by the predominance of agricultural fields including banana, papaya, coconut, and wetland ponds. The existing structures at the LWRF are generally hidden from direct view by existing landscaping or natural land forms. Only the solids drying facility roof structure of the LWRF site is visible from the entrance and driveway to BYU-H off Naniloa Loop.

Impacts and Mitigative Measures

There will be no significant visual impacts associated with the proposed WWPS as it will be a single story structure. The site will also be substantially lower in elevation than the existing ground on the east side of the pump station, thereby blocking views from Kamehameha Highway. The proposed pump station is also inland from Kamehameha Highway so the pump station will not block any coastal views from the highway. The architectural and landscaping features of the proposed facilities will be designed to minimize visual impacts on the area by effective architectural and landscaping schemes.

There will be no adverse visual impacts caused by the proposed underground force main and sewer collection system along Naniloa Loop.

3.2.4 RECREATIONAL FACILITIES

There are several City and County parks and a State recreational area within the general area of the proposed project. These recreational areas provide sunbathing, surfing, bodysurfing, fishing, picnicking and volleyball. The Polynesian Cultural Center is a popular commercial recreational attraction while BYU-H provides softball games and tennis.

Impacts and Mitigative Measures

There will be no significant impacts on the use of public recreational facilities.

3.2.5 ACCESS FOR PERSONS WITH DISABILITIES

The Americans with Disabilities Act (ADA) is a wide-ranging civil rights statute that prohibits discrimination against people with disabilities.

Impacts and Mitigative Measures

General areas will be designed for accessibility in accordance with Americans with Disabilities Act Accessibility Guidelines (ADAAG). However, mechanical areas will not be made accessible for the handicapped as the project will be staffed by only able bodied

personnel. The construction documents will be submitted to the Commission on Persons with Disabilities for review and comments.

3.2.6 ECONOMY

Employment opportunities within the La'ie community come from BYU-H, PCC, and other commercial and retail establishments. PCC, a tourist attraction, employs a majority of the area residents while BYU-H also employs a considerable amount of La'ie people. Additional employment is provided by a shopping center, grocery stores, restaurants, and other retail-sales stores. Due to projected population growth increases as anticipated by the City and County's resident and visitor population, the La'ie area will continue to experience an economic surge. Along with new economic opportunities, both resident population and visitor population will continue to grow.

Impacts and Mitigative Measures

The proposed project is not expected to have significant adverse economic impacts. The proposed infrastructure improvements provide one of the basic services needed to support development efforts in the area. Economic impacts from the proposed project will result from construction jobs, services, and procurements in the form of construction supplies and equipment.

3.2.7 POPULATION

La'ie is the largest settlement within the Koolauloa Census Division, comprising an area stretching from Kaaawa to Waimea Bay. The Census Division includes the entire Koolauloa Development Plan Area and a portion of the North Shore Development Plan area. Between 1980 and 1990, La'ie's population, increased from 4,643 to 5,577, an average of 20 percent, or two-thirds the annual growth rate for the Koolauloa Census Division (29.9 percent) (State of Hawaii Data Book 1987, 1997). A current population projection is not available for La'ie, but projected population growth in the Koolauloa census division between 1990 and 1995 showed an increase of 3.8 percent This suggests a relative stabilization of the population compared to the significant growth during the 1980's. More accurate population data will be known after the national 2000 census data becomes available.

Impacts and Mitigative Measures

The proposed project is not expected to have significant adverse impacts on population. The proposed infrastructure improvements provide one of the basic services needed by the existing residents and businesses in the La'ie community.

3.3 INFRASTRUCTURE SYSTEMS AND SERVICES

3.3.1 TRAFFIC AND TRANSPORTATION SYSTEMS

The project site will be accessed through the existing LWRF via a new pump station access road. Poohaili Street, a private road, which provides access to the LWRF, intersects Kamehameha Highway near the north end of La'ie.

Impacts and Mitigative Measures

The proposed project is not expected to have significant adverse impacts on traffic. This project will add an insignificant number of vehicular trips and will not change the existing traffic system. However, construction related activities may have short-term traffic impacts. To mitigate these impacts, the Contractor will be required to follow State and City traffic control regulations.

3.3.2 POTABLE WATER SYSTEM

Potable water will be provided to the project site by a private system owned and operated by La'ie Water Company. The system is not connected to the Board of Water Supply (BWS) however, the system has been evaluated by BWS for possible operation in the future.

The La'ie community receives drinking water from five wells as shown in **Figure 3.3-1.** The "BYU Wells" are numbered 3855-06, 07, and 08 and the "Temple Well" is 3956-03. Potable water is currently used for residential, institutional, and commercial services.

The potable water is pumped from a contained artesian aquifer and stored in a 2.0 million gallon reservoir, located mauka of the BYU-H campus. The reservoir is a welded steel tank that was reconstructed in 1987. The reservoir provides water through a single system that serves the La'ie community. The size and type of transmission pipes vary considerably and presently extends service to the existing LWRF.

Daily usage at the pump station is anticipated to be for sanitary fixtures, landscape irrigation, washdown, and other maintenance purposes. Additional water is needed on an intermittent basis for wet well cleaning and maintenance of the odor control system.

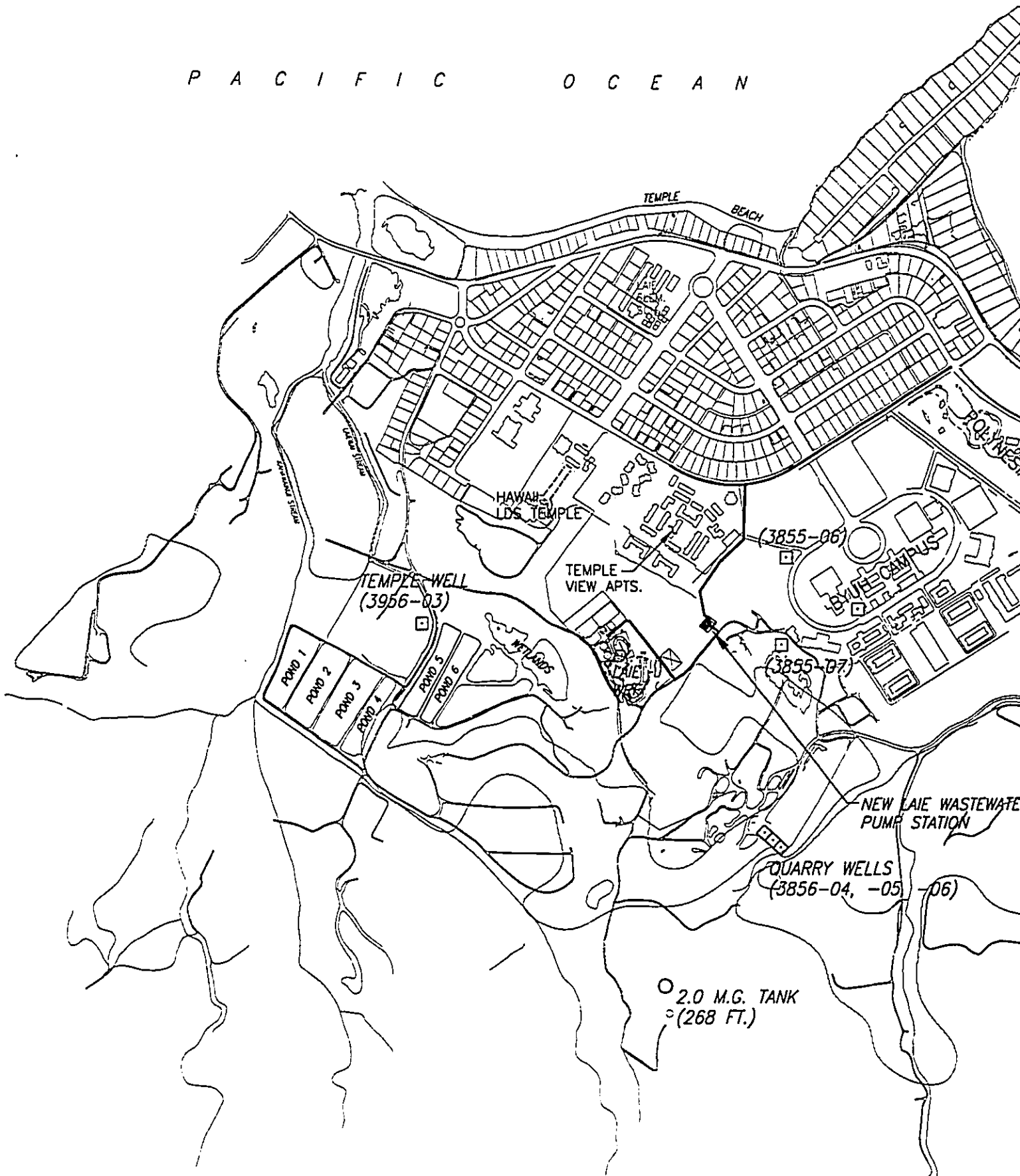
Impacts and Mitigative Measures

The proposed project is not expected to have a significant impact on the potable water system. Daily water demands are not expected to increase significantly. Continued availability of potable water is anticipated.

3.3.3 DRAINAGE SYSTEM

Drainage in the La'ie area has been a significant concern due to the low elevations, high groundwater table, and the higher elevation of Kamehameha Highway which acts like a dam. La'ie is bordered by two streams, Kahawainui to the north and Wailele to the South. Wailele has been a source of flooding. The existing drainage system is illustrated in **Figure 3.3-2.**

In 1990, the Kahawainui Flood Control Project was completed to accommodate the Standard Project Flood (SPF) and is therefore no longer a flood threat. Wailele Stream has overtopped its banks a number of times since 1879. The Army Corps of Engineers are currently developing flood control alternatives for this area.



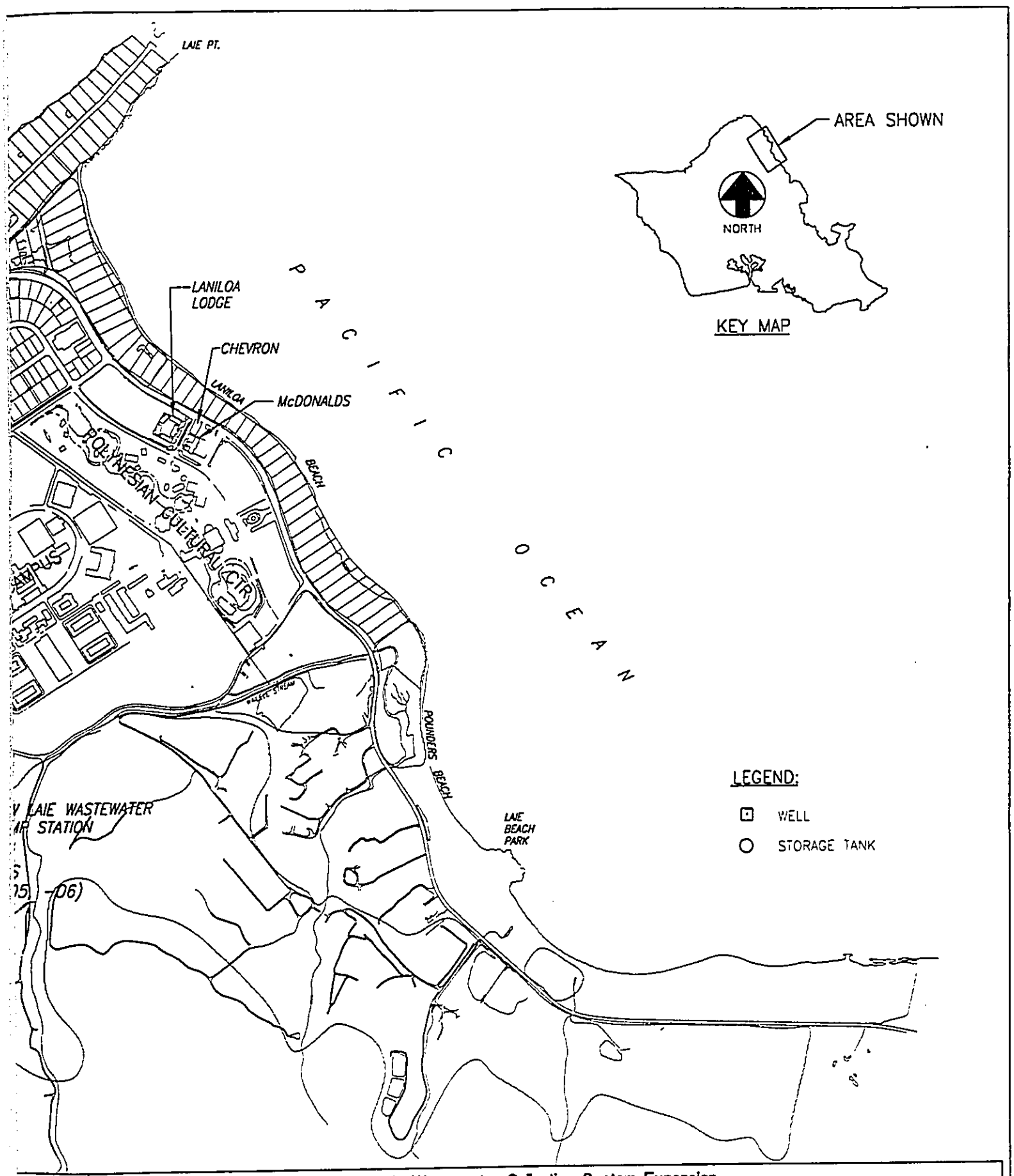
Planning - Engineering - Environmental Services - Photogrammetry - Surveying - Construction Management
R. M. TOWILL CORPORATION
808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'

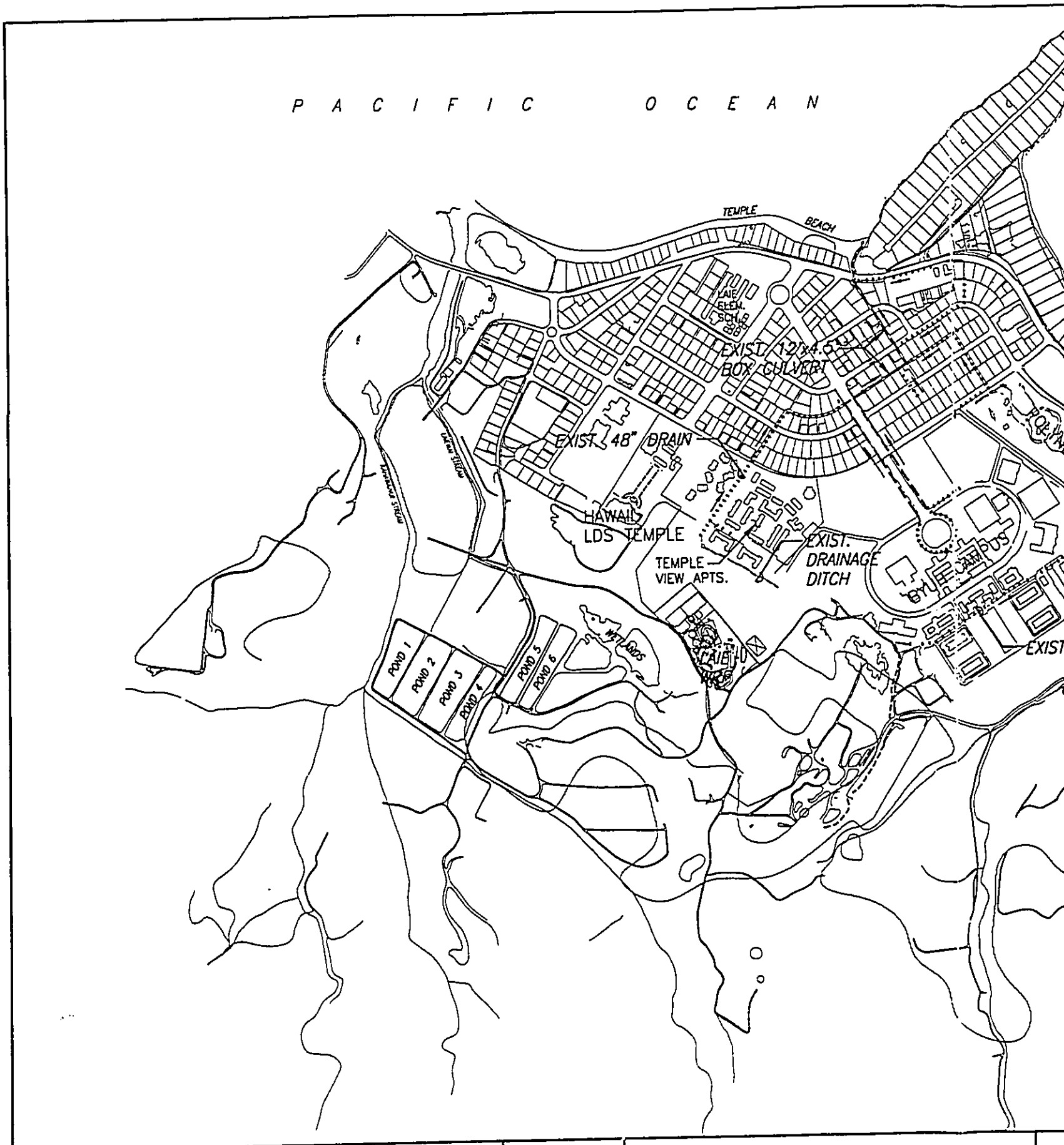
Exis



Laie Wastewater Collection System Expansion

Existing Potable Water System

Figure 3.3-1



Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management

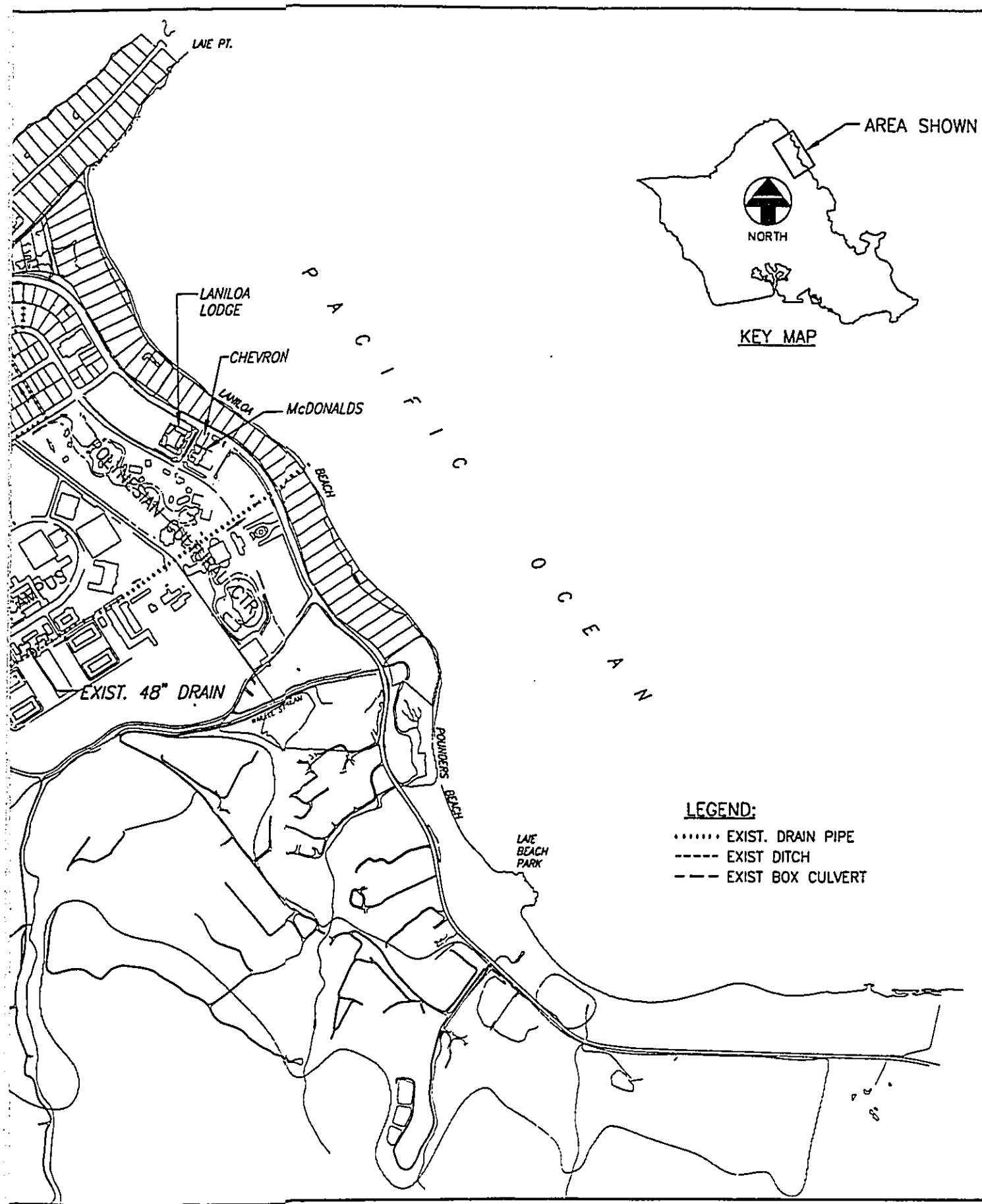
R. M. TOWILL CORPORATION

808 842 1133 420 Waiakamilo Road Suite 411 Honolulu Hawaii 96817-4941

NORTH

1000' 500' 0 1000' 2000'

SCALE: 1" = 1000'



Laie Wastewater Collection System Expansion

Existing Drainage System

Figure 3.3-2

Impacts and Mitigative Measures

The proposed site will have proper drainage controls both on-site and off-site to accommodate additional runoff. Control of the runoff will be through storm drainage facilities, swales, detention basins, and pits as needed. Development of the proposed site will not place an additional burden on the existing drainage facilities or create a potential flood hazard for the existing properties of La'ie especially the low-lying sections of the community. No adverse impacts to the existing drainage systems are anticipated.

3.3.4 WASTEWATER SYSTEM

Wastewater from the service area is conveyed to the pump station and pumped to a force main to the LWRF for treatment and disposal. Should incoming wastewater flows exceed the pumping capacity of the WWPS, the excess flow would be diverted to an existing drainage ditch, then to an existing 48" drain, and to an existing 12'x4.5' box culvert, and finally discharged into the ocean. Any unintentional or intentional discharge of wastewater from the wastewater system at any point other than the predetermined discharge point is considered a wastewater spill. All wastewater spills have to be reported to the Department of Health, Clean Water Branch. DOH maintains a public log of all reported spills and enforcement measures taken. The current wastewater system in La'ie, including the full capacity of the LWRF and disposal system, are approved and permitted by required city and state agencies. The proposed Phase 1 improvements will comply with existing LWRF permits. Copies of the permits can be obtained by contacting HRI or DOH Clean Water Branch.

Impacts and Mitigative Measures

The proposed project will keep wastewater spills to a minimum by maintaining adequate pumping capacity backed up by an emergency generator. Wastewater collected in the proposed system will be conveyed to the existing La'ie Wastewater Treatment Facility where it will be treated and discharged in compliance with the facility's current NPDES individual permit. The LWRF maintains a spill response plan that includes measures for facility shut down, spill containment, emergency services contact (ambulance, fire, police), public notification, and reporting to the Department of Health, Clean Water Branch.

3.3.5 ELECTRICAL AND COMMUNICATIONS SYSTEMS

The electrical power and communications utilities which serve La'ie are privately owned by Hawaiian Electric Company and Hawaiian Telephone Company. Existing overhead transmission lines deliver 46 kV power to the Hauula and Kahuku substations, which then steps power down to 11.5 kV for overhead distribution in La'ie. Overhead distribution lines currently extend to the existing WWTP.

Impacts and Mitigative Measures

The pump station is expected to generate an electrical load requirement of approximately 310,000 Kilowatt-hours per year. The HECO system has adequate service capacity to meet the projected power requirements of the proposed project. Input line reactors and filters will be installed if required to limit harmonic distortion imposed on the HECO system and the pump station's electrical system. The proposed electrical system and generator upgrades will improve station reliability and reduce the risk of wastewater spills.

3.3.6 SOLID WASTE DISPOSAL SYSTEM

Presently the solid waste generated by La'ie residents is collected by both private vendors and from the City and County of Honolulu and disposed of at the Waimanalo Gulch landfill near Ewa or the

H-Power facility in Campbell Industrial Park. At the northern end of La'ie adjacent to the City and County's Corporation Yard there is a City operated "convenience center" where residents can drop off their waste. Depending on the type, waste from the convenience center is recycled, combusted, or disposed of in a landfill.

Impacts and Mitigative Measures

The proposed project is not expected to have a significant impact on the solid waste disposal system. The proposed design should not have a significant effect on the amount of solid waste generated at the facility. Debris generated during construction will either be utilized on-site or trucked to an appropriate area off-site. This will place some additional short term demand on the City and County solid waste disposal facilities. However, daily trash volume generated from plant operations is not expected to be significant and will not adversely impact public waste disposal facilities.

3.3.7 FIRE, POLICE AND MEDICAL SERVICES

Fire protection service is provided through the Honolulu Fire Department's Kahuku and Hauula Fire Stations. Each fire station has one fire truck and is able to provide engine and medical services. Police protection services are provided by the Honolulu Police Department's Kahuku Substation. The Kahuku Hospital is located approximately five to ten minutes drive by car from La'ie and provides health care services.

Impacts and Mitigative Measures

The new pump station site will be completely enclosed with a boundary fence for health and safety requirements as well as for security of plant operations. Buildings and facilities will be designed in accordance to City and County fire protection standards. In consultation with the Honolulu Fire Department, the project contractor will notify the Fire Communication Center of any interruption to the existing fire hydrant system during the project. The proposed project is not expected to have a significant impact on fire, police and medical services.

SECTION 4
Relationship to State and County Land Use Plans and Policies

4.1 THE HAWAII STATE PLAN

The Hawaii State Plan, Chapter 226, Hawaii Revised Statutes, serves as a written guide for the future long range development of the State. The Plan identifies statewide goals, objectives, policies, and priorities.

The proposed project would be in conformance with the State Plan, Section 226-15, Objectives and Policies for Facility Systems - Solid and Liquid Wastes.

> *(a) Planning for the State's facility systems with regard to solid and liquid wastes shall be directed towards the achievement of the following objectives:*
>
> *(1) Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.*
>
> *(2) Provision of adequate sewerage facilities for physical and economic activities that alleviate problems in housing, employment, mobility, and other areas.*

The La'ie wastewater collection system will provide sewerage to homes and businesses in the La'ie community that currently rely on aging cesspools for wastewater disposal. The proposed collection system will provide a significant environmental and public health benefit by minimizing the likelihood of ground and surface water contamination from malfunctioning cesspools.

4.2 STATE LAND USE LAW

The La'ie area includes lands which are designated by the State of Hawaii in three categories, including Urban, Agricultural, and Conservation as presented in **Figure 4.2-1.** The pump station and force main are within the State Land Use Agricultural District. Portions of the State Land Use Urban District are also included in the project for the gravity collection system along Naniloa Loop and to the pump station. Those portions of the project located in the State Urban District are subject to zoning regulations under the City and County of Honolulu Land Use Ordinances.

4.3 CITY AND COUNTY GENERAL PLAN

The City and County of Honolulu General Plan serves as a written guide for the future long-range development and welfare of Oahu. The Plan identifies island-wide goals, objectives, policies, and priorities for achieving the aspirations of Oahu's residents.

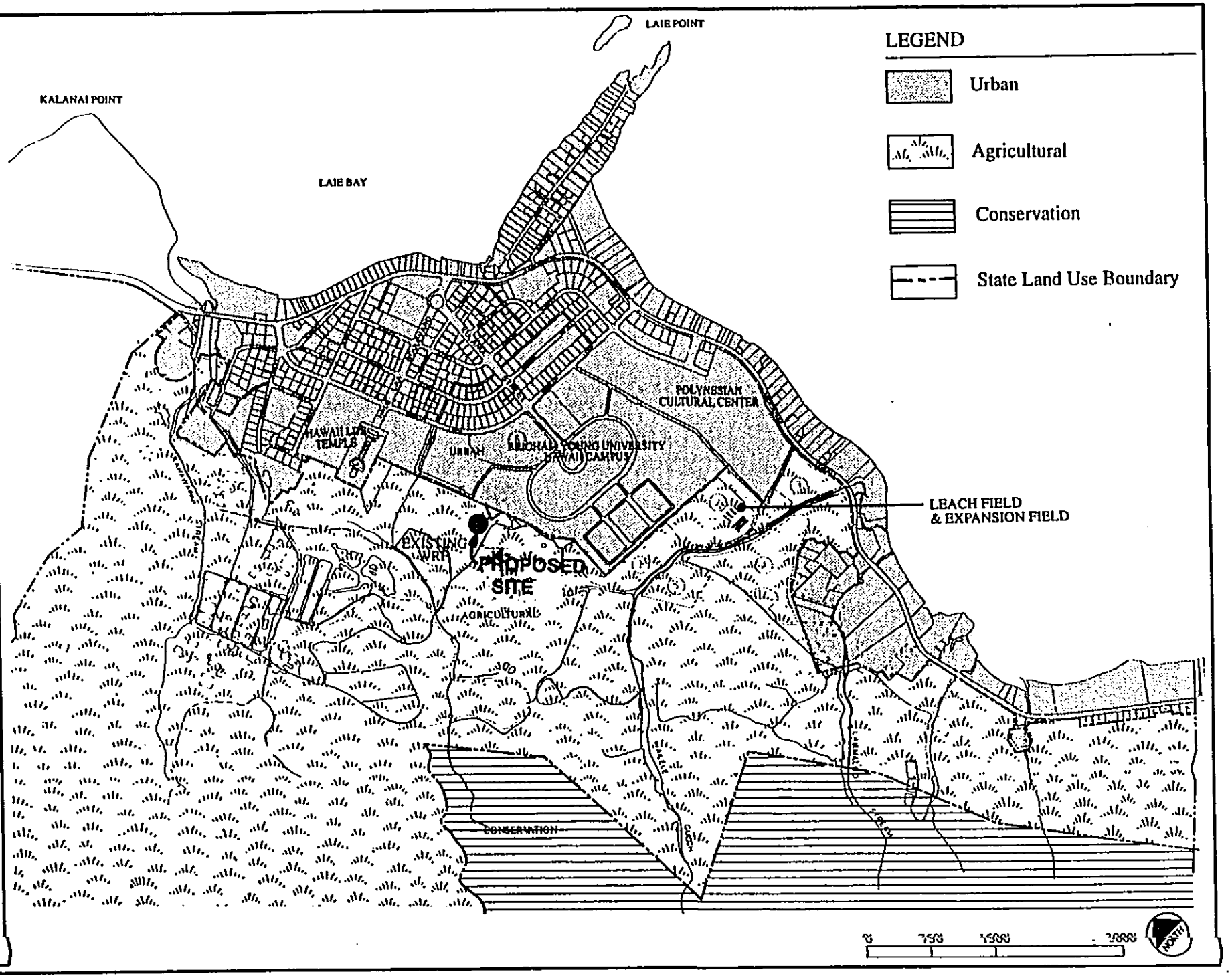
The proposed project is in accordance with the following objectives:

R. M. TOWILL CORPORATION

Laie Wastewater Collection System Expansion

STATE LAND USE DISTRICTS

Figure 4.2-1



Section V. Transportation and Utilities:

Objective B - To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sound systems of waste disposal.

- *Policy 3 - encourage the development of new technology which will reduce the cost of providing water and the cost of waste disposal.*
- *Policy 5 - provide safe, efficient, and environmentally sensitive waste-collection and waste-disposal services.*
- *Policy 6 - Support programs to recover resources from solid waste and recycle wastewater.*

Objective C - To maintain a high level of service for all utilities

- *Policy 2 - Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.*
- *Policy 3 - Plan for the timely and orderly expansion of utility systems.*

The proposed improvements will replace aging and poorly performing cesspool systems with a safer and more reliable wastewater collection and treatment system. The proposed project will provide a significant environmental and public health benefit by minimizing the potential for contamination from failing cesspools. Wastewater collected in the proposed system will be treated to a high level of purity before being recycled for irrigation and other non-potable uses. This additional source of non-potable water will reduce demands on potable water resources in the La'ie community.

4.4 CITY AND COUNTY ZONING

The proposed site for the pump station and the force main (as shown in **Figure 4.4-1**) are zoned for agriculture (AG-1) as classified by the City and County of Honolulu. The AG-1 Restricted Agricultural District zoning designation generally includes lands classified as "Prime" or "Unique" under the Agricultural Lands of Importance to the State of Hawaii (ALISH) system. The remaining gravity collection system along Naniloa Loop is zoned for R-5 Residential.

4.5 CITY AND COUNTY DEVELOPMENT PLAN

The City and County of Honolulu classifies lands within the La'ie community on the Koolauloa Development Plan (DP) Land Use Map. These DP designations (presented in **Figure 4.5-1**) reflect the residential, commercial, institutional, and agricultural uses of the community, as well as the mauka preservation areas. The proposed site for the pump station and force main are designated as Public Facility on the Koolauloa Development Plan Land Use Map (DPLUM). A portion of the gravity collection system along Naniloa Loop is designated as Residential on the (DPLUM).

There is no requirement to amend the Koolauloa DP Land Use Map designations to develop and operate the proposed pump station and force main and collection system. However, once the facility is in operation, the Department of Planning and Permitting will administratively amend the Land Use Map so that it reflects the existence of this use.

4.6 KO'OLAU LOA SUSTAINABLE COMMUNITIES PLAN

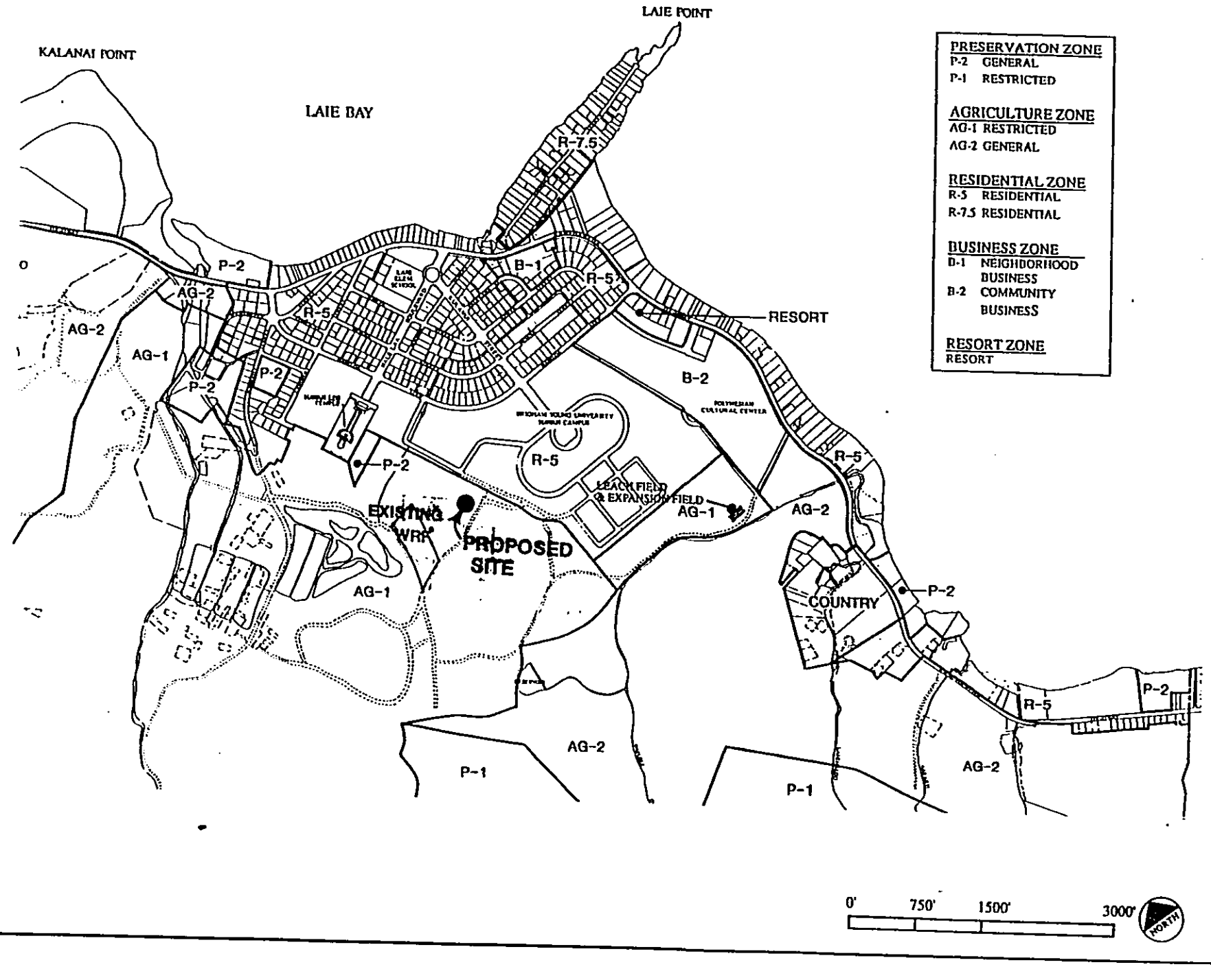
The Ko'olau Loa Sustainable Communities Plan (City and County of Honolulu Ordinance 99-72) provides policies, guidelines, and conceptual schemes to serve as a guide for more detailed

R. M. TOWILL CORPORATION

Lake Wastewater Collection System Expansion

CITY AND COUNTY ZONING DISTRICTS

Figure 4.4-1



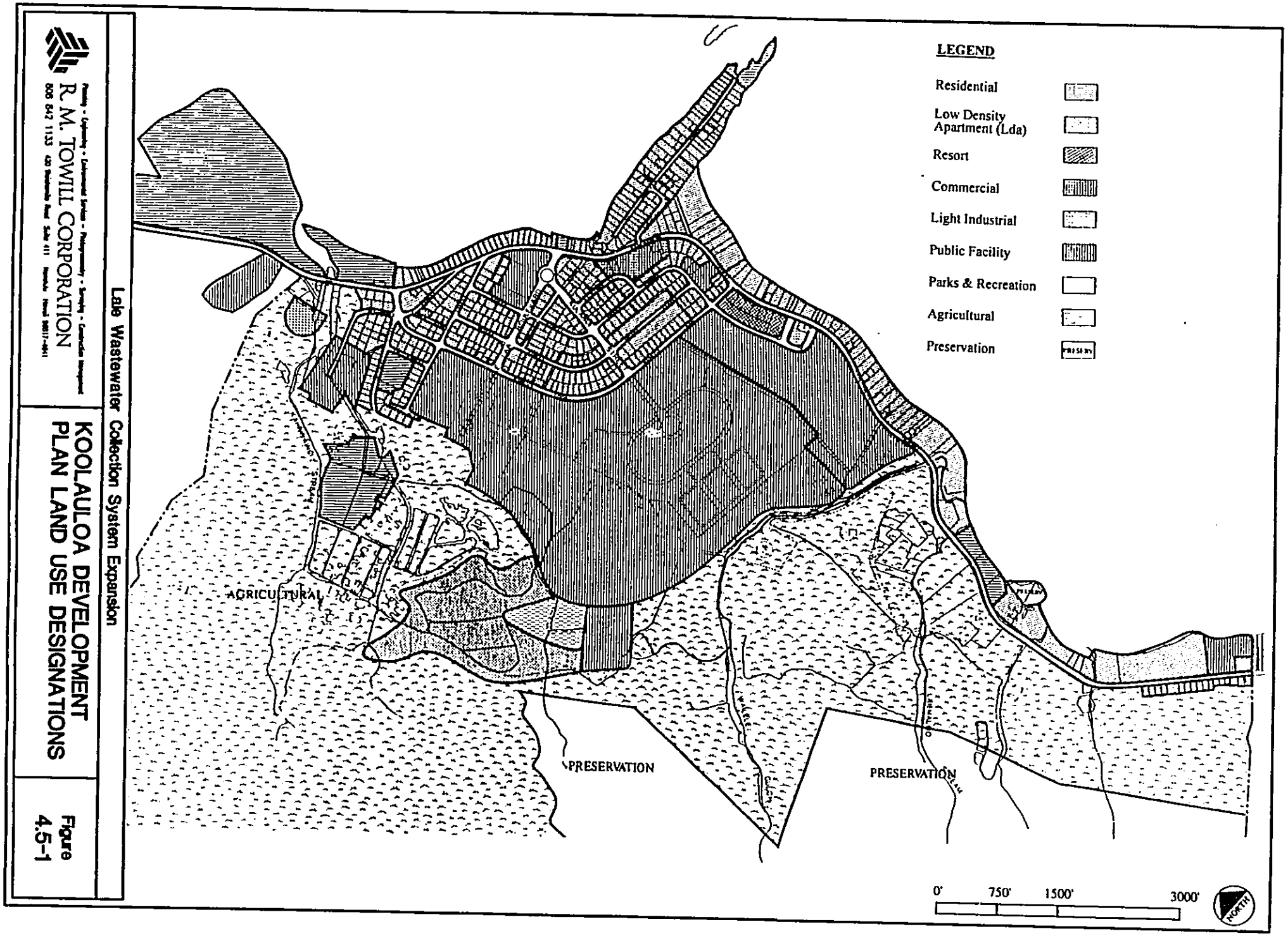
PRESERVATION ZONE
P-2 GENERAL
P-1 RESTRICTED

AGRICULTURE ZONE
AG-1 RESTRICTED
AG-2 GENERAL

RESIDENTIAL ZONE
R-5 RESIDENTIAL
R-7.5 RESIDENTIAL

BUSINESS ZONE
B-1 NEIGHBORHOOD BUSINESS
B-2 COMMUNITY BUSINESS

RESORT ZONE
RESORT



Lale Wastewater Collection System Expansion

R. M. TOWILL CORPORATION

KOOLAULOA DEVELOPMENT PLAN LAND USE DESIGNATIONS

Figure 4.5-1

zoning maps and regulations and for public and private sector investment decisions. The proposed project is being developed in accordance with Section 4.3, Wastewater Treatment, of the Ko'olau Loa Sustainable Communities Plan. The following general policies apply to wastewater in Ko'olau Loa:

- Encourage coordination between public agencies and private landowners in addressing adequacy of wastewater treatment within the region. The planned expansion of the La'ie Water Reclamation Facility proposed for existing and future homes in La'ie should proceed in accordance with applicable State and Federal regulations and conditions of existing land use approvals.

- Provide collection systems, where practical, to eliminate individual cesspools, and to protect aquifers, streams, estuaries and near-shore waters from contamination.

- Replace outdated individual cesspools with septic tanks and leaching fields.

- Encourage water recycling at Kahuku Wastewater Treatment Plant.

- Treat and beneficially use, where feasible, reclaimed water for irrigation as a water conservation measure.

4.7 SPECIAL MANAGEMENT AREA (SMA) RULES AND REGULATIONS

SMA areas are defined as sensitive environments that should be protected in accordance with the State's coastal zone management policies. None of the proposed activities for development of the pump station and force main, and collection system (Phase I) will involve lands within the SMA. The SMA boundary is depicted in **Figure 1.1-3,** presented previously in Section 1.

SECTION 5
Alternatives to Proposed Action

5.1 NO ACTION

If "no action" is taken, then the existing wastewater collection system will continue to operate under aging and deteriorating conditions and the potential for leaks and spills from system failures will continue to increase. Further, The no action alternative does not give consideration to possible future development and does not ensure sufficient capacity to service development goals envisioned in the *Koolau Loa Sustainable Communities Plan.* For these reasons, this alternative was rejected.

5.2 CONVENTIONAL WWPS

The principal components of this alternative are as follows:

- Junction box with two slide gates to distribute flows to the wet wells
- Two wet wells with vertical, flexible shaft, non-clog pumps
- Venturi meter vault
- The structure over the dry well consists of the emergency generator room, MCC room, storage room, restroom, and shower.
- Odor control system
- A 1,000-gallon above, concrete and steel diesel fuel tank

The conventional pump station requires a larger structure both below ground and above ground than the submersible pump station, thus increasing costs. The relatively shallow groundwater table, sandy soil conditions, and station depth also result in higher costs to excavate and build underground. In addition, the operation and maintenance of the automatic level controlled, variable speed driven pumps require a highly trained staff.

5.3 CANNED WWPS

The principal components of this alternative are as follows:

- Junction box with two slide gates to distribute flows to the wet wells
- Two wet wells with vertical, close coupled, dry pit type.
- Dry well consisting of a pre-assembled steel cylinder housing all suction and discharge piping, pumps, valves, controls, and elevator access.
- Emergency generator and MCC building.
- Odor control system
- A 1,000-gallon above, concrete and steel diesel fuel tank

The canned WWPS was considered, but was rejected because it provides limited space within the dry well for maintenance of the pumps and valves. The corrosion of the steel housing of the canned pump station is also a concern over the life of the station. As an additional consideration, the City and County of Honolulu allows canned type pump stations for temporary use only.

SECTION 6
Necessary Permits and Approvals

6.1 CITY AND COUNTY OF HONOLULU

The following permits are required by the City and County of Honolulu:

- Building Permit - Department of Planning and Permitting
- Combustible and Flammable Liquids Tank Installation Permit - Honolulu Fire Department
- Grading, Grubbing, Excavation and Stockpiling Permits - Department of Design and Construction
- Street Usage Permit - Department of Planning and Permitting

The following approvals are required by the City and County of Honolulu:

- Department of Design and Construction
- Department of Environmental Services
- Flood Determination in General Flood Plain District - Department of Planning and Permitting
- Landscaping Plan - Department of Planning and Permitting

6.2 STATE OF HAWAII

The following permits are required by the State of Hawaii:

- State Land Use District - Land Use Commission
- NPDES Permit for Construction Related Discharges - Department of Health

The following approvals/review are required by the State of Hawaii:

- Air Pollution Control - Department of Health
- Archaeological Review - Department of Land and Natural Resources
- Community Noise Control - Department of Health
- Wastewater Systems - Department of Health
- Commission on Persons with Disabilities

6.3 FEDERAL AGENCIES

The proposed action does not require Federal permits or approvals.

6.4 UTILITY COMPANIES

Construction documents will be reviewed by the following private utility companies:

- Hawaiian Electric Company
- GTE Hawaiian Telephone Company Incorporated

SECTION 7
Organizations and Agencies Consulted During the 30-Day DEA Review Period

7.1 CITY AND COUNTY OF HONOLULU

Board of Water Supply
Department of Design and Construction
Department of Environmental Services
Department of Planning and Permitting
Department of Transportation Services
Fire Department
Police Department

7.2 STATE OF HAWAII

Department of Accounting and General Services
Department of Business, Economic Development and Tourism
    Office of Planning
Department of Hawaiian Home Lands
Department of Health,
    Clean Water Branch
    Environmental Management Division
    Office of Environmental Quality Control
Department of Land and Natural Resources
    Commission on Water Resources Management
    Historic Preservation Division
    Land Division
Department of Transportation, Highways Division
University of Hawaii
    Environmental Center
    Water Resources Research Center

7.3 FEDERAL AGENCIES

Department of the Army, Corps of Engineers
US Fish and Wildlife Service

7.4 GOVERNMENT OFFICIALS

Representative Colleen Meyer, 46th Congressional District
Senator Bob Nakata, 23rd Senatorial District
Councilman Steve Holmes, Council District II
Mr. Creighton U. Matton, Koolauloa Neighborhood Board, No. 28

7.5 UTILITY COMPANIES

Verizon Wireless
Hawaiian Electric Company, Inc.

7.6 PRIVATE ORGANIZATIONS / INDIVIDUALS

Life of the Land
Sierra Club

SECTION 8
Determination

The potential effects of the proposed project are evaluated based on the significance criteria in section 11-200-12 (Hawaii Administrative Rules, revised in 1996). The following is a summary of the potential effects of the action.

(1) Involves an irrevocable commitment to loss or destruction of any natural or cultural resource:

Development of the project will involve the irrevocable loss of certain resources, including the land area required for construction of the proposed pump station. Surveys of botanical resources conducted in the project area found no threatened or endangered plant species. Faunal surveys noted the presence of four endangered and endemic waterfowl in the Poohaili Wetlands, mauka of the existing wastewater treatment facility. The proposed improvements are not located near the wetlands and will not involve the use or destruction of wetland habitat frequented by these birds. The replacement of existing aged cesspools with an improved wastewater collection and treatment system will eliminate a potential source of ground and surface water contamination that could affect wetland habitat and surface water resources.

A survey of historic and archaeological resources was also conducted in the project area during preparation of the Final Supplemental Environmental Impact Statement for the La'ie Water Reclamation Facility (Hawaii Reserves Inc. 1995). Archaeological sites known from the area have been mapped and recorded with the State Historic Preservation Division. An additional historic site, the Nioi Heiau Complex (SIHP No. 50-80-02-281) is adjacent to the project area, however, according to the State Historic Preservation Division (SHPD), proposed project activities will have "no effect" on historic sites in that area (see Appendix C, Correspondence, SHPD letter dated August 16, 2000).

Additionally, the project site contains Jaucas sand deposits, which are known to contain significant subsurface cultural deposits and human burials. A qualified archaeologist will be employed to monitor excavations in the Jaucas sand deposits along Naniloa Loop. Prior to beginning work in this area, an archaeological monitoring plan will be prepared by the archaeologist and submitted to SHPD for review.

A portion of the construction will involve extensive modification of the land surface and there is a possibility of encountering unknown or unexpected cultural features, deposits, or burials. If this situation occurs, work in the area will be suspended immediately until the monitoring archaeologist has the opportunity to evaluate the significance of the findings. The Historic Preservation Division of the State DLNR would be immediately notified to determine the appropriate course of action.

(2) Curtails the range of beneficial uses of the environment:

The project will not curtail the range of beneficial uses of the environment. Wastewater collection pipes and force mains will be installed underground. Installation and operation of the pump station will not detract from the function or use of peripheral parcels.

(3) Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in chapter 344, HRS:

The project will be undertaken in a manner that conforms with Chapter 344, HRS, State Environmental Policy. The proposed collection system will provide a significant environmental and public health benefit by minimizing the likelihood of ground and surface water contamination from the aged cesspools currently being used by the majority of homes and businesses in La'ie.

(4) Substantially affects the economic or social welfare of the community or State:

The proposed improvements to La'ie's wastewater collection and treatment system are not anticipated to have negative effects on the area's economic activities or the social welfare of the community or state. The proposed project will improve service reliability and sanitation conditions for wastewater disposal in the La'ie community.

(5) Substantially affects public health:

Only about 175 homes of the approximately 720 homes in the La'ie area are currently sewered. The vast majority of the remainder use aged cesspools that are performing poorly. The expansion of the existing wastewater collection system will allow previously discharged raw wastewater from unsewered homes to be collected and treated. Replacing existing cesspools with the proposed wastewater collection and treatment system will reduce the potential for ground and surface water contamination and thereby provide a significant improvement to public health.

(6) Involves substantial secondary impacts, such as population changes or effects on public facilities:

The proposed improvements are being undertaken to service existing residential and commercial development. The upgraded sewer system will not result in substantial secondary impacts, such as population changes or effects on other public facilities. The proposed improvements will not provide an impetus to additional growth.

(7) Involves a substantial degradation of environmental quality:

The proposed project is not anticipated to involve a substantial degradation of environmental quality. The project requires minimal clearing and grubbing during installation of wastewater collection lines and construction of the La'ie WWPS. The proposed improvements will occur in an area that has already experienced extensive development and modification to the natural environment. The improved waster water treatment system will result in improvements to environmental quality by eliminating the use of aged and potentially leaking cesspool systems.

(8) Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions:

Cumulative impacts result from a series of projects that individually do not generate significant adverse effects, but collectively add up to a significant negative impact on the environment. The La'ie Sewer Project, though broken down into two distinct phases, does not add up to a large, negative impact on the environment. In fact, both Phase I and Phase II of the La'ie Sewer Project, whether considered individually or jointly, will provide a benefit to the environment by upgrading and integrating the aged sewer system with a new wastewater collection and reclamation system that treats effluent to reusable (R1) quality reuse water.

Although it is described within the overall framework of the La'ie Sewer Project, Phase I remains a stand-alone project independent of the future of Phase II. Phase I is being developed to replace the existing sewer main with a new trunk sewer line, pump station, and force main. After nearly 30 years of use, the existing sewer lines are displaying signs of deterioration and are in need of upgrading. Phase I will not expand sewer service and will not increase effluent disposal from the La'ie Wastewater Reclamation Facility. Phase I improvements do not require a commitment to Phase II activities.

With regard to possible future growth, the La'ie Sewer Project is proposed to meet existing wastewater service needs and to support the withdrawal of aging and leaking cesspools from service. The system is designed to carry capacity above existing levels in order to accommodate the possibility of future projected needs in La'ie, as planned in the *Ko'olauloa Sustainable Communities Plan* (KSCP).

(9) Substantially affects a rare, threatened, or endangered species, or its habitat:

While endangered and endemic waterfowl are known to frequent the wetland area mauka of the existing La'ie Water Reclamation Facility (LWRF), the proposed wastewater collection system improvements do not encroach on that habitat. An intervening mountain ridge separates the project site from the wetland area. The alignment of proposed wastewater collection mains and proposed pump station site occupy areas that have been subject to substantial modification and use over time. No rare, threatened, or endangered species are known from the project site. The proposed project is not anticipated to have substantial effects on rare, threatened, or endangered species, or their habitats.

(10) Detrimentally affects air or water quality or ambient noise levels:

The project is not anticipated to result in significant adverse effects on the area's long-term air or water quality or ambient noise levels. The improvements are being developed in order to improve overall water quality and minimize potential contamination of surface and ground water sources through containment and treatment of waste water. Temporary noise impacts related to construction activities will occur, but will cease when the project is completed. Following construction, the emergency generator for the new pump station will be tested periodically. While operating, the emergency generator will emit noise and exhaust smoke. The emergency generators will be housed in acoustically treated enclosures to minimize noise impacts. Operation of the generators will comply with the provisions of HAR, Chapter 11-46, "Community Noise Control".

Emergency generators will be used only during power outages or equipment maintenance and testing. If operated only during power outages or equipment maintenance and testing, the generators will be exempt from the requirements of HAR, Chapter 11-60, "Air Pollution Control".

(11) Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters:

The project site is located in a special flood hazard area subject to inundation during 100-year flood conditions. Flood elevations in the collection system area and at the proposed pump station are estimated at +11 feet msl, hence floor elevations and containment areas will be built to a minimum elevation of +13 feet msl. The sewer collection system will also be below the water table, so polyvinyl chloride (PVC) will be used for the pipe material to minimize infiltration and inflow. The proposed improvements will not alter existing drainage patterns or shoreline configurations. The seismic rating for the project area according to the Uniform Building Code is Zone 2A, an area of moderate seismic activity.

(12) Substantially affects scenic vistas and viewplanes identified in county or states plans or studies:

There will be no significant visual impacts associated with the proposed wastewater pump station. The site will be substantially lower in elevation than the existing grade on the east side of the pump station, thereby blocking views from Kamehameha Highway. The proposed pump station is also inland from Kamehameha Highway so the pump station will not block any coastal views from the highway. The architectural and landscaping features of the proposed facilities will be designed to minimize visual impacts on the area. The underground sewer collection system along Naniloa Loop will not be visible except for manhole covers.

(13) Requires substantial energy consumption:

Construction activities associated with the project will require high, short-term energy use. Energy will also be required for operation of the pump facility, however the project is not anticipated to result in a substantial increase in energy consumption. Further, energy requirements for the project should be viewed in consideration of the public health and environmental benefits the proposed project will provide.

In accordance with the provisions set forth in Chapter 343, Hawaii Revised Statutes, this Environmental Assessment has determined that the project will not have significant adverse impacts to water quality, air quality, existing utilities, noise, archaeological sites, or wildlife habitat. Therefore, it is recommended that an Environmental Impact Statement (EIS) not be required and a Finding of No Significant Impact (FONSI) be issued for this project.

SECTION 9
References

AECOS, Inc., (1991) Water Quality and Biology of Aquatic Environments in Kahawainui Stream and its Tributaries, La'ie, Oahu, Kailua, HI

AECOS, Inc., (1993) Water Quality and Biology of Aquatic Environments in Kahawainui Stream and its Tributaries, La'ie, Oahu, Kailua, HI

Bruner, Phillip, (1991) Report on a Faunal Survey of Wetland Habitat Associated with the La'ie Wastewater Treatment Plant Project, La'ie, HI.

Char & Associates, (April 1991) *Botanical Survey La'ie Wastewater Treatment Plant* Project, La'ie, Koolau Loa District, Oahu, Honolulu, HI.

City and County of Honolulu, Department of Planning and Permitting, (October 1999) *Ko'olau Loa Sustainable Communities Plan (KSCP)*. Honolulu, HI.

Cultural Surveys Hawaii, (1991) Archaeological Survey of the La'ie Sewer Plant with Historical Background on La'ie Ahupua'a, Kailua, HI.

Environmental Technologies, Inc., (February 1992) Bio-reconnaissance of Kahawainui Stream at La'ie, Oahu, Honolulu, HI.

Hawaii Reserves, Inc., (December 29, 2000) Cooperative Agreement to Jointly Construct a Collection System and Transfer the La'ie Water reclamation Facility, La'ie, Koolauloa District, Oahu, HI.

Hawaii Reserves, Inc., (1988, 1994) La'ie Water Reclamation Facility, Final Environmental Impact Statement, Oahu, HI.

Hawaii Reserves, Inc., (1988, 1995) La'ie Water Reclamation Facility, Final Supplemental Environmental Impact Statement, Oahu, HI.

Hawaii State Department of Business, Economic Development & Tourism, (1987, 1997) State of Hawaii Data Book, Honolulu, HI.

Paul H. Rosendahl, Ph.D., Inc., (April 1992) Final Report: Background, Summary of Findings, and General Significance Assessments and Recommended General Treatments, Archaeological Inventory Survey, La'ie Master Plan Project, Lands of Malaekahana and La'ie, Koolauloa, Oahu.

R. M. Towill Corporation, (August 2000) Engineering Report for the La'ie Wastewater Collection System Expansion, La'ie, Oahu, Hawaii.

Zions Securities Corporation, (1993) La'ie Water Reclamation Facility, Facility Plan, Oahu, HI.

APPENDIX A

BIOLOGICAL STUDIES

Water Quality and Biology of Aquatic Environments in Kahawainui Stream and its Tributaries, Laie, Oahu

AECOS No. 639

WATER QUALITY AND BIOLOGY OF AQUATIC ENVIRONMENTS IN KAHAWAINUI STREAM AND ITS TRIBUTARIES, LA'IE, O'AHU

Prepared For:

James H. Pedersen Planning Consultant
P.O. Box 22
Volcano, Hawaii 96785

Prepared By:

AECOS, Inc.
970 N. Kalaheo Ave., Suite C311
Kailua, Hawaii 96734

August 1991
Revised and updated: January 1992

Table of Contents

INTRODUCTION

In March 1991, a series of water quality measurements were made weekly at stations established at various locations along Kahawainui Stream and it's tributary, Laiewai Stream, as well as in Laie Bay near the mouth of Kahawainui Stream. Water quality monitoring continued thereafter on a monthly basis to assess seasonal aspects and to document impacts of proposed improvements in drainage and waste water treatment (i.e., the Laie Wastewater Reclamation Facility) proposed for the watershed. In addition to these regular visits for monitoring purposes, special visits were made and/or special stations added to answer specific water quality questions raised by the analytical results. Biological observations were conducted on most visits to inventory wetlands biota in relation to the WWTP effluent and other influences on the aquatic environments of the floodplain.

This report details the results of the water quality and biological observations made in March and April and compares those results with previous surveys conducted in this watershed. Also reported are the results of monthly monitoring through the end of 1991.

Site Description

The water quality surveys conducted in March and April 1991 encompassed the lowland portion or floodplain of Kahawainui and Laiewai streams at Laie on the Island of Oahu. Figures 1A and 1B show the relationships of the various streams, ponds, marshlands, and drainage ditches in this area. Figure 1A depicts the area between the marsh and the ocean. Stations 1 and 2 were along the sand beach shoreline of Laie Bay, on either side of the present mouth of Kahawainui Stream. The mouth is frequently blocked by a sand berm which builds during periods of low stream flow. Just north of the present-day mouth (located between Stations 1 and 2) the stream forms a now blind channel leading to an area (just north of Station 1) where the stream formerly breached the shore during periods of high

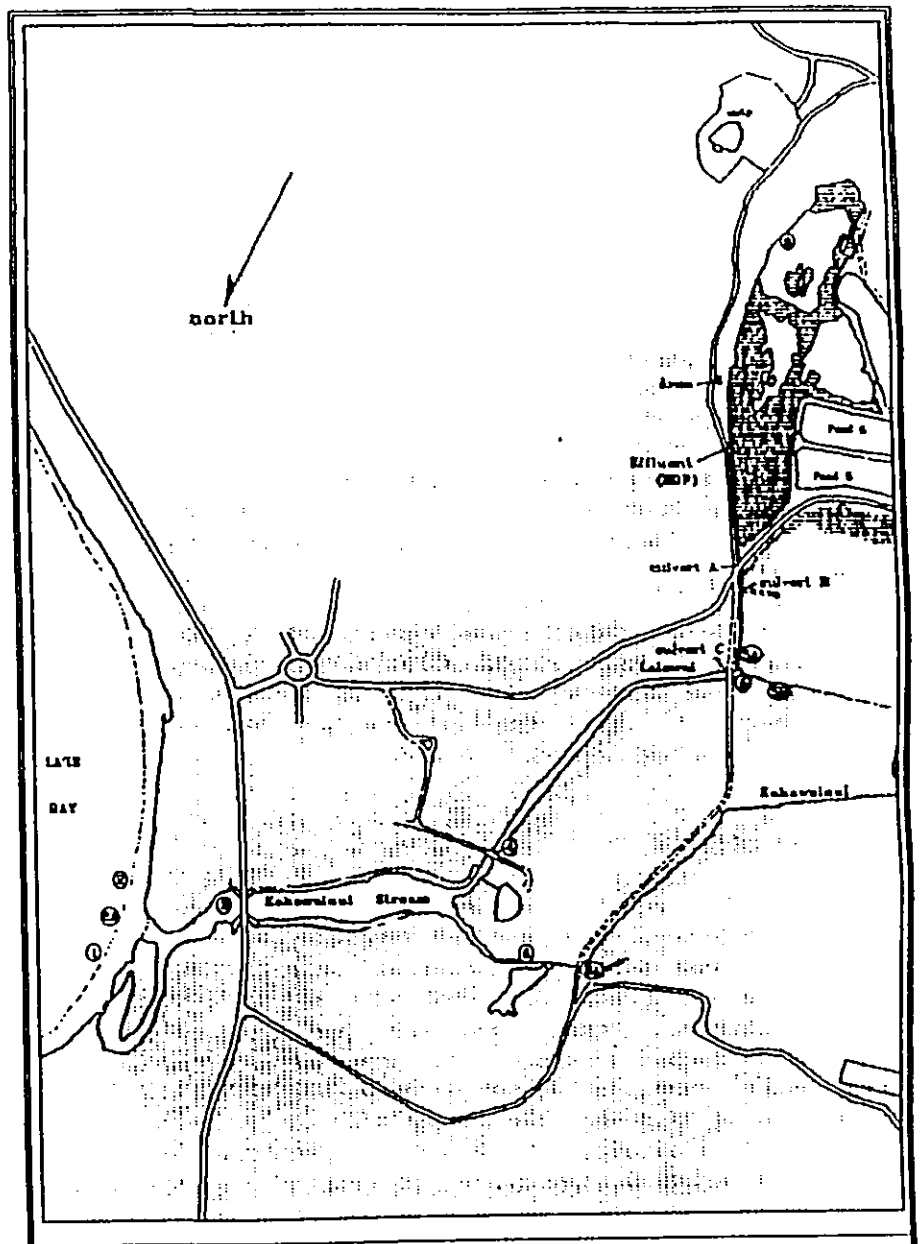


Figure 1A. Location map for Lower Kahawainui Stream watershed stations and features.

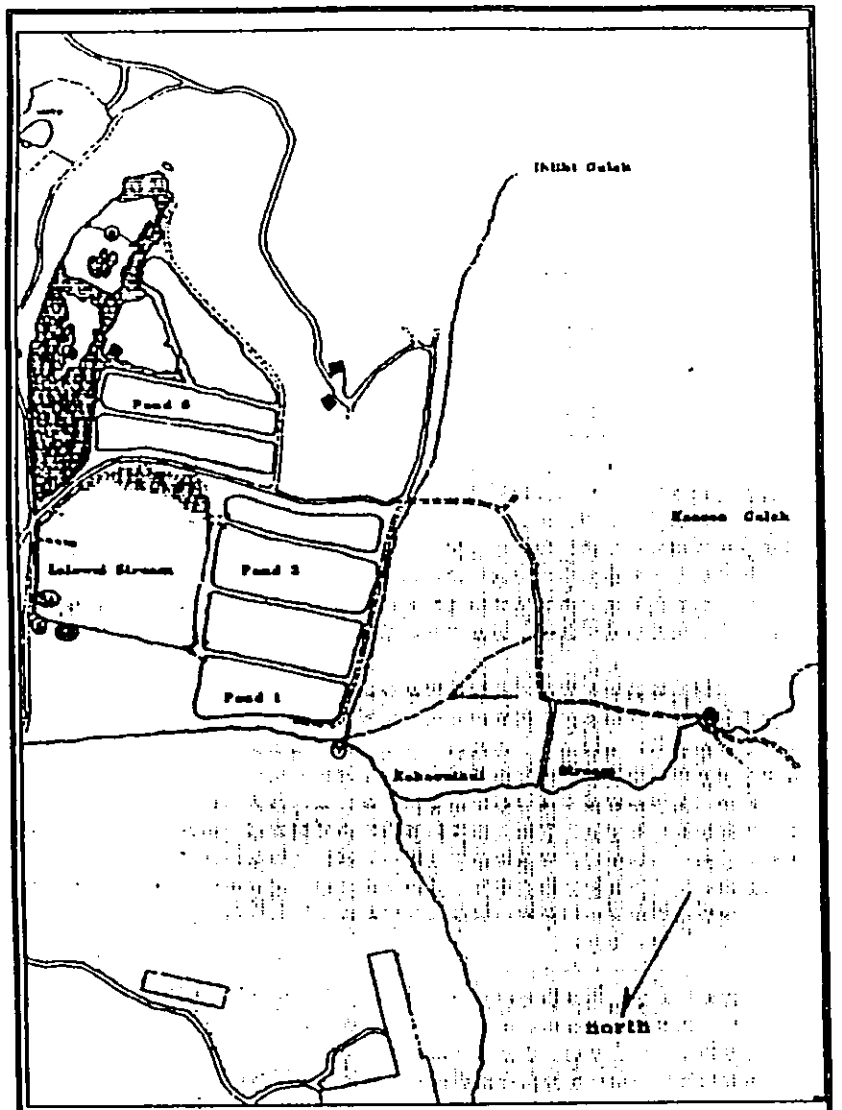


Figure 1B. Location map for middle Kahawainui Stream watershed stations and features.

water flow. Station 3 sampled the ponded water (a feature known in Hawaiian as a muliwai) at a point a short distance downstream of the Kamehameha Highway bridge.

From the Kamehameha Highway bridge to the first major fork, Kahawainui Stream is confined within a bermed flood basin constructed by the U. S. Army Corps of Engineers in the 1980s. Kahawainui Stream branches towards the north; the south fork is Laiewai Stream. Both forks are confined within levees and/or man-made channels across the floodplain. No part of Laiewai Stream below the marshland to the flood control basin has the appearance of a natural stream environment.

Three stations sampled Kahawainui Stream above the flood control basin: Station 6 located opposite a cemetery, Station 7 (see Figure 1B) located at a point where two drainage ditches (draining Ka'aoao and 'Ihi'ihi gulches) join Kahawainui Stream; and Station 8, located just above a road crossing at the upper end of the flood plain and upstream of most of the croplands on this watershed. After April, sampling for Station 6 was moved upstream some 230 feet (70 meters) to a concrete ford designated Station 6A.

Initially, three stations sampled the Laiewai drainage: Station 4 located along the drainage canal adjacent to a cemetery; Station 5, located at the upper end of this same canal where two ditches feed into the canal; and Station 9, located in a pond at the upper end of the marshland located behind Laie town. The La'ie WWTP effluent enters this marsh near its lower (downstream) end and about midway between Stations 5 and 9. The distance between the effluent discharge point (EDP) and Station 5 is approximately 950 feet (290 meters).

The marsh drainage is confined to a ditch and passes through three concrete pipe culverts. These are here designated culvert "A" (under the main access road to agriculture and aquaculture areas in the valley, located about 475 feet downstream from EDP), culvert "B" (under a private driveway, 580 feet downstream from EDP), and culvert "C" (directly downstream of Station 5 and 925 feet downstream from EDP). After March, this part of the drainage

system was sampled at Station 5A located some 30 feet (10 meters) upstream of Station 5 (915 feet from EDP).

Several aquaculture ponds (designated Ponds 5, 6, and 7) drain directly into the marsh at various points along the western margin of the wetland. These ponds, the marsh, and several open water bodies within the marsh, occupy a depression surrounded on three sides (south, east, and west) by lithified dune formations. At least one small spring feeds this depression at the south end and the entire wetlands drains to the north through the ditch which is described above as Laiewai Stream.

Another four aquaculture ponds (designated Ponds 1 through 4) drain to a common collecting ditch along their eastern side. This common ditch joins Laiewai Stream at Station 5. After March, the water in this ditch representing outflow from the aquaculture ponds was measured at a point (designated Station 5B) located approximately 150 feet (50 meters) above Station 5. Although the outflow from Ponds 3 and 4 enters the common collecting canal, most of the water at the south end of this ditch appears to move south then east through a small wetland which drains into Laiewai Stream at the downstream end of Culvert "A". Later, some of this flow was routed more directly into a ditch which followed the road to the downstream end of Culvert "A".

The aquaculture ponds are fed by water pumped from a well on site and are isolated from higher elevation drainages ('Ihi'ihi Gulch and the smaller Ka'aoao Gulch) by an interceptor ditch joining Kahawainui Stream at Station 7. This ditch is separated from the southern flood plain area by a high berm (levee) between the ditch and an access road to ponds 1 through 4. During periods of exceptionally high rainfall, drainage from 'Ihi'ihi Gulch overtops the levee at a low point where the road crosses it and water flows towards Laiewai Stream between the aquaculture Ponds 4 and 5. This situation occurred on March 19-20.

Beginning with the April 15 visit, a sample station (Station 10) was added on Wailele Stream located at the south end of Laie town. However, after April Wailele Stream dried up and no additional samples could be collected here.

This stream and its muliwai were incorporated into a watert quality monitoring network established in November 1991 for the La'ie WWTP drain field located south of La'ie (see AECOS, 1992).

Rainfall

Rainfall records covering March 1991 for the Laie area were provided by BYU Farms (Table 1). During this period, several days of above normal rainfall and flooding in the La'ie area occurred.

Table 1. Daily rainfall in inches for March 1990 at Laie, Oahu (from BYU Farms).

Day	Rainfall	Day	Rainfall
1	0.05	16	NR
2	NR	17	NR
3	NR	18	0.55
4	0.02	19	**NR**
5	0	20	18.30
6	0	21	1.32
7	NR	22	NR
8	0	23	NR
9	0.19	24	NR
10	NR	25	1.48
11	**NR**	26	NR
12	NR	27	0.24
13	0.20	28	0
14	0	29	0
15	0.10	30	NR

NR - gauge not read.
Dates of stream sampling shown in bold type.

Previous Studies

The U.S. Fish and Wildlife Service (1984) conducted observations and collected water samples for analyses in Kahawainui, Laiewai, and Wailele streams in March and April

of 1981, presumably as background for the U.S. Army Corps flood control project. The results are given here in Table 2. USFWS Stations 1 and 2 were in the muliwai of Kahawainui below Kamehameha Highway. Station 3 was located near our Station 3, but above Kamehameha Highway. Stations 3 through 5 were spread along the area now occupied by the flood control basin, with Station 5 at the fork where Kahawainui and Laiewai Streams join. Station 6 was located along Laiewai Stream just above our Station 4. Stations 7 and 8 were established along Wailele Stream south of La'ie.

Table 2. Results reported by USFWS (1984) for a one time sampling in Kahawainui, Laiewai, and Wailele streams at Laie, Oahu (March/April 1981).

Site No.[1]	1	2	3	4	5	6	7	8
Location[2]	mouth	3	3	basin	basin	4	Wailele	
	----- Kahawainui Stream ---- Laiewai Stream							
Temperature °C	26	26	26	26	23	23	21	23
Conductivity umhos	2500	3300	1350	650	410	410	90	90
pH	6.5	6.5	6.5	6.5	5.2	5.5	5.2	4.9
Ammonia mg/L	1.89	2.07	2.44	1.71	0.73	0.85	0.90	0.98
Nitrate mg/L	0	<1	<1	<1	2.0	2.0	1.0	1.0
Oxygen mg/L	--	--	--	--	1.8	1.6	6.1	9.0

1 - USFWS location number.
2 - Location relative to features and or stations used in the present survey.

Zions Security contracted to have water samples from the La'ie WWTP and the Kahawainui floodplain analyzed nine times between May 18 and October 16, 1990. Samples were analyzed by Food Quality Labs in Honolulu and are referred to herein as the Food Quality Labs samples. Most of samples

were from the Laiewai Stream portion of the drainage system, but included were samples from the WWTP, Kahawainui Stream above the flood basin, and from a variety of drainages feeding into Laiewai Stream from agriculture and aquaculture areas. On some occasions, a sample was collected from Kaliuwa'a Stream (Kaluanui, Sacred Falls). The results of microbiological analyses on these samples are given in Table 3. On four occasions, samples of the WWTP influent and effluent were collected and analyzed for BOD_5, non-filterable residue (NFR), total Kjeldahl nitrogen (TKN), and total phosphate (TP). These results are summarized in our Table 4.

Starting in July 1990, the chloride content was measured on most of the samples collected by Food Quality Labs. Values ranged from 37 to 224 ppm, all indicative of fresh waters. An October 16 sample from "Sacred Falls" gave a chloride concentration of 5,025 ppm, which would be clearly brackish (around 9 ppt salinity). This result would seem to indicate that the station was located in the estuary of Kaliuwa'a Stream. Samples from near the mouth of Kahawainui Stream (near our Station 3) were not collected after June 1990.

Another ongoing study under the direction of Bob Gearheart (Environmental Resources Engineering, Humboldt State University, California) sampled the marsh and drainage ditch on several occasions between October 1990 and January 1991. The focus of this study was on WWTP effluent impacts on the marsh environment. Analyses were performed by AECOS, Inc. Sampled were two marsh stations, one in the immediate vicinity of the WWTP effluent discharge (EDP) and one upstream to the southeast (Avea Farm), one station on Laiewai Stream (at our Station 5), and two stations in aquaculture ponds which drain into the marsh. Results of the microbiological analyses are summarized in Table 5. A series of samples were collected as well from along the shoreline of La'ie Bay for the Humboldt State University study but are not reported herein. On the four sampling dates, nutrients, pH, BOD, NFR, and conductivity were measured in addition to the microbiological analyses at the same stations (see Tables 6 and 7).

Table 3. Microbiological results from the Food Quality Labs samples of the La'ie WWTP, Laiewai Stream, and adjacent areas (from Food Quality Labs).

Station Location[1]	Date	Coliforms total[2]	Coliforms fecal[2]	Entero-cocci[3]
WWTP effluent	5/18/90	< 2	< 2	< 1
WWTP oxidation pond	"	540	49	< 1
marsh above EDP (Avea)	"	> 2400	> 2400	550
small marsh drainage	"	1600	220	360
nr culvert "B"	"	> 2400	> 2400	> 5000
above Sta. 5B	"	> 2400	920	500
Sta. 4	"	> 2400	> 2400	150
Kahawainui below Sta. 7	"	> 2400	> 2400	3800
nr Sta. 6A	"	> 2400	1600	580
nr Sta. 3 muliwai	"	> 2400	1600	580
WWTP effluent	6/13/90	> 2400	110	4
WWTP oxidation pond	"	> 2400	> 2400	110
marsh above EDP (Avea)	"	> 2400	1400	24
small marsh drainage	"	> 2400	1000	500
nr culvert "B"	"	1600	350	380
above Sta. 5B	"	220	23	44
Sta. 4	"	> 2400	1600	3
Kahawainui below Sta. 7	"	540	540	340
nr Sta. 6A	"	> 2400	> 2400	3000
nr Sta. 3 muliwai	"	220	79	35
"Child pump" ?	"	240	23	--
Water Tank	"	< 2	< 2	--
WWTP effluent	6/26/90	920	33	< 1
WWTP oxidation pond	"	920	170	1
marsh above EDP (Avea)	"	> 2400	> 2400	2400
small marsh drainage	"	> 2400	> 2400	> 4000
nr culvert "B"	"	> 2400	1600	2800
above Sta. 5B	"	> 2400	130	> 2600
Sta. 4	"	> 2400	> 2400	470
Kahawainui below Sta. 7	"	> 2400	> 2400	1700
nr Sta. 6A	"	> 2400	> 2400	950
nr. Sta. 3 muliwai	"	> 2400	> 2400	140
WWTP effluent	7/24/90	13	--	--
WWTP oxidation pond	"	79	2	--
Sta. 9 marsh pond	"	540	540	--
above Culvert "A"	"	> 2400	> 2400	--
above Sta. 5B	"	220	140	--
Sta. 4	"	> 2400	> 2400	--
nr Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	> 2400	--
Kaliuwa'a Stream	"	> 2400	1600	--

Table 3. (continues)

Station Location[1]	Date	Coliforms total[2]	Coliforms fecal[2]	Entero-cocci[3]
WWTP effluent	8/08/90	240	540	--
WWTP oxidation pond	"	> 2400	350	--
Sta. 9 marsh pond	"	> 2400	31	--
above culvert "A"	"	> 2400	> 2400	--
above Sta. 5B	"	> 2400	540	--
Sta. 4	"	> 2400	> 2400	--
nr Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	> 2400	--
Kaliuwa'a Stream	"	> 2400	> 2400	--
WWTP effluent	8/28/90	79	--	--
WWTP oxidation pond	"	70	5	--
Sta. 9 marsh pond	"	> 2400	1600	--
above culvert "A"	"	> 2400	> 2400	--
above Sta. 5B	"	> 2400	130	--
Sta. 4	"	> 2400	350	--
nr. Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	> 2400	--
Kaliuwa'a Stream	"	> 2400	180	--
WWTP oxidation pond	9/18/90	> 2400	> 2400	--
Sta. 9 marsh pond	"	1600	350	--
above culvert "A"	"	> 2400	> 2400	--
above Sta. 5B	"	920	130	--
Sta. 4	"	> 2400	> 2400	--
nr Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	> 2400	--
WWTP oxidation pond	10/02/90	920	49	--
Sta. 9 marsh pond	"	> 2400	110	--
above culvert "A"	"	> 2400	1600	--
above Sta. 5B	"	> 2400	33	--
Sta. 4	"	> 2400	> 2400	--
nr Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	> 2400	--
WWTP oxidation pond	10/16/90	> 2400	1600	--
Sta. 9 marsh pond	"	1600	1600	--
above culvert "A"	"	> 2400	> 2400	--
above Sta. 5B	"	> 2400	94	--
Sta. 4	"	> 2400	> 2400	--
nr Sta. 8 Kahawainui	"	> 2400	> 2400	--
nr Sta. 6A	"	> 2400	1600	--
Kaliuwa'a Stream	"	> 2400	> 2400	--

Table 3. (continues)

1 - Station numbers refer to stations designated for the present survey. EDP = effluent discharge point.
2 - MPN/100 ml.
3 - Membrane filter; No. per 100 ml.

Table 4. Analyses for BOD_5, NFR. TKN, and TP on Laie WWTP influent and effluent samples (Food Quality Labs).

Station Location	Date	BOD_5 mg/L	NFR mg/L	TKN mg/L	TP mg/L
WWTP Influent	6/13/90	13000	169	96	0.52
WWTP Effluent	"	670	139	114	0.50
WWTP Influent[1]	8/28/90	320	132	0.46	2.10
WWTP Effluent[1]	"	45	72	0.57	0.74
WWTP Influent	9/18/90	320	209	4.50	0.72
WWTP Effluent	"	78	15	3.63	0.34
WWTP Influent	10/16/90	320	112	38.6	0.85
WWTP Effluent	"	44	61	29.8	0.66

1 - labeled "24-hour composite"

Table 5. Microbiological results from the Humboldt State University samples of the Laie WWTP and Laiewai Stream.

Station Location[1]	Date	Coliforms total[2]	Coliforms fecal[2]	Entero-cocci[3]
Avea farm	10/26/90	--	2000	500
WWTP effluent at EDP	"	--	8000	< 2000
Station 5	"	--	1200	200
Avea farm	11/20/90	--	--	TNTC
WWTP effluent at EDP	"	--	--	216
Station 5	"	--	--	3600
WWTP effluent	12/19/90	3140000	2100000	7300
Avea farm	"	40000	1800	1100
WWTP effluent at EDP	"	2000000	1860000	15700
Station 5	"	560000	340000	3000
Pond 5	"	> 220000	100000	2100
Pond 6	"	2200	600	400
Avea farm	1/07/91	130000	1750	10900
WWTP effluent at EDP	"	30000	**	< 10
Station 5	"	120000	**	500
Pond 5	"	3000	**	600
Pond 6	"	1000	10	180
Avea farm	2/11/91	30000	3000	70
WWTP effluent at EDP	"	< 100	< 100	< 4
Station 5	"	30000	6000	< 10
Pond 5	"	1000	200	10
Pond 6	"	14000	TNTC	240

1 - Station numbers are those of the present study. EDP = WWTP effluent discharge point; Avea farm = edge of marsh 260 feet southeast (upstream) of EDP.

Table 6. Analyses for pH, BOD_5, NFR, and conductivity in the Humboldt State University samples of the Laie WWTP and Laiewai Stream.

Station Location	Date	pH	BOD_5 mg/L	NFR mg/L	Cond. umhos/cm
WWTP influent[2]	10/26/90	7.25	142	130	729
WWTP effluent[2]	"	7.26	22	14	693
Avea farm	"	7.43	19	310	489
WWTP effluent EDP	"	7.24	24	31	745
Station 5	"	7.31	52	24	505
WWTP influent	12/19/90	7.46	129	278	858
WWTP effluent	"	7.32	45	78.5	732
Avea farm	"	7.22	1.9	5.5	325
WWTP effluent EDP	"	7.34	32	36.5	777
Station 5	"	7.65	7.6	48.5	410
Pond 5	"	7.66	11	82.5	298
Pond 6	"	7.54	5	49.5	291
Avea farm	2/11/90	7.06	2	8.8	367
WWTP effluent EDP	"	7.46	120	14.4	821
Station 5	"	7.26	7	23	497
Pond 5	"	7.63	13	104	321
Pond 6	"	7.58	8	87	326

[1] - Station numbers are those of the present study;
EDP = WWTP effluent discharge point;
Avea farm = edge of marsh 260 feet upstream of EDP.
[2] - 24-hour composite; pH from last sample taken.

Table 7. Analyses for nutrient parameters in the Humboldt State University samples of the Laie WWTP and Laiewai Stream.

Station Location	Date	NO_2-NO_3 mg/L	NH_4 mg/L	TN mg/L	TP mg/L
WWTP Influent[2]	10/26/90	0.003	12.5	30.3	6.32
WWTP Effluent[2]	"	0.044	10.4	22.2	5.08
Avea farm	"	1.11	1.43	9.08	1.54
WWTP effluent EDP	"	0.034	16.7	28.0	7.52
Station 5	"	0.022	4.10	9.95	2.12
WWTP influent	12/19/90	0.002	27.2	22.4	5.87
WWTP effluent	"	0.022	14.7	21.9	5.66
Avea farm	"	0.019	0.27	2.43	0.08
WWTP effluent EDP	"	0.018	12.0	36.8	5.89
Station 5	"	0.027	4.37	6.17	1.24
Pond 5	"	0.006	0.67	2.76	0.23
Pond 6	"	0.064	1.02	2.76	0.19
Avea farm	2/11/90	0.012	0.214	1.94	0.128
WWTP effluent EDP	"	0.057	14.5	13.7	9.48
Station 5	"	0.018	5.1	8.77	1.07
Pond 5	"	0.001	0.022	3.04	0.276
Pond 6	"	0.033	0.176	2.78	0.248

[1] - Station numbers are those of the present study;
EDP = WWTP effluent discharge point;
Avea farm = edge of marsh 260 feet upstream of EDP.
[2] - 24-hour composite; pH from last sample taken.

WATER QUALITY RESULTS

Temperature

Temperature measurements are presented in Table 8. Measurements showed a gradual warming at all locations through the month of May, and remained high through October 1991, declining through the wet season which encompasses the cooler months in Hawaii. Not unexpectedly, the temperature in Kahawainui Stream was usually lowest of the locations sampled, with the temperature of the water showing an increase in the downstream direction (Stations 8, 7, and 6). Highest temperatures were recorded in slower moving bodies of water such as the upper pond of the marsh (Station 9) and the muliwai below the flood basin pond (Station 3).

Temperature measurements were taken at several locations (mostly on Laiewai Stream) on April 20 as shown in Table 11. These show the expected patterns of increasing temperature with progressive solar input (from morning to afternoon) and conditions of water flow (higher temperatures occurred in downstream areas characterized by low velocity flow).

The Inland Water Criteria for temperature in freshwater streams (DOH, 1989) relate that the temperature "...shall not vary more than one degree Celsius from ambient conditions". All conditions measured here would be regarded as "ambient". The temperature of the water is an important consideration for other analytes measured in this study, such as oxygen content, but temperature itself is not a parameter of particular concern in this instance.

Turbidity

Turbidity is a measure of the lack of clarity of a water. Turbidity is actually a physical property and is measured using a nephelometric instrument: that is, an instrument which measures the amount of light scattered by (or reflected off) small particles in a water sample. The

nephelometer is calibrated with a standard sample and the units of measurement are nephelometric turbidity units (NTUs). These units do not relate directly to a specific amount of material suspended in the water, although such a relationship could be worked out if the nature of the material did not change.

Table 8. Temperature measurements (^{o}C) at all stream, pond, and marsh stations, March through December 1991.

	Sample Station						
	3 muliwai	4 Laiewai	5	6 -	7 Kahawainui	8 -	9 marsh
Mar. 5	no measurements taken						
Mar. 11	22	23	22.8	21.5	20.5	19.5	21.8
Mar. 19	20	21	21.8	18.5	--*	--*	20.2
Mar. 28	27	25	25.5	24.0	23.2	22.2	26.9
Apr. 15	27	26.5	26[1]	26	25.5	27	27.5
May 8	27	26	26[1]	27[2]	25.5	24	29
June 18	26	26	26.3[1]	25	24	22.5	26
July 22	27	27	26.5[1]	26.0	24.0	24.0	28
Aug. 12	27.5	25.5	27.5[1]	24.6	24.9	23.9	26.2
Sept. 9	27.5	26.0	28.0[1]	28.8	29.5	26.5	28.8
Oct. 7	27.8	28.0	27.8[1]	28.2	28	24.2	27.5
Nov. 22	28	28.5	28	27	25.5	24	28
Dec. 20	22.2	22.5	24	22	21	19	23

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B was 27.2 ^{o}C in April, 27 ^{o}C in May, 26 ^{o}C in June, 27 ^{o}C in July, 25.5 ^{o}C in August, 25.8 ^{o}C in September, 27.0 ^{o}C in October, 25.5 ^{o}C in November, and 22 ^{o}C in December.
2 - For Station 6A after April.

Measurements of the turbidity of the water were made on each of the regular six sample collection dates in March, April and May. Additional measurements were made at selected stream stations on April 1 and April 3 (Table 9). The purpose of the latter two samplings was to assess the rate at which stream waters cleared following a major rainfall event.

Turbidity sampling was continued monthly after May at all stream and pond stations. At many locations, the highest values were measured on March 19 following a period of heavy rainfall during the night of March 18-19. However, considerably more rainfall was received on March 19-20, accounting for the exceptionally high value in the upper pond of the marsh (Station 9) at the next sampling on March 28. A steady improvement (decline in suspended sediment) was noted through April 3 at which time samples were among the clearest recorded for Kahawainui Stream above the flood control pond. Turbidity tended to remain high during this period in Laiewai Stream quite probably because this branch is fed by the ponded water in the marsh which had become extremely turbid as a result of storm induced runoff. Not surprising, turbidity in Kahawainui declined rapidly after the rainfall and run-off ceased because turbid water was flushed out of the stream. Laiewai Stream, however, is fed by a reservoir of turbid water (the marsh) which clears only slowly as suspended material settles to the bottom, outflow accounting for only a fraction of the volume each day after runoff ceases.

After March, rainfall and water flow declined in the Laie area through the dry season. Under these conditions, turbidity values tended to reflect productivity of phytoplankton in the water body rather than sediment carried in from land runoff. However, after March and particularly in June through August, dredging and clearing of various parts of the drainage system was undertaken. These activities sometimes contributed to high turbidity values. For some stations, the geometric mean turbidity for the 1991 dry season was higher than for the wet seasons data obtained through December.

Table 9. Turbidity measurements (NTUs) at all stream, pond, and marsh stations in March through December 1991.

	Sample Station						
	3	4	5	6	7	8	9
	muliwai	Laiewai		- Kahawainui -			marsh
Mar. 5	5.88	12.8	10.8	7.77	7.73	13.7	11.7
Mar. 11	4.95	12.9	21.4	7.40	9.0	14.2	7.18
Mar. 19	37.7	10.8	27.8	34.2	--*	--*	19.5
Mar. 28	16.4	18.0	28.8	14.9	17.1	20.7	189.6
Apr. 1	22.2	23.6	30.1	9.93	8.46	10.1	--
Apr. 3	15.2	21.1	24.0	7.75	6.56	6.08	--
Apr. 15	18.6	27.2	10.1[1]	7.11	6.15	8.02	12.8
May 8	13.3	16.3	6.36[1]	22.1[2]	2.76	3.85	10.9
June 18	9.27	25.9	14.9[1]	71.2	5.20	9.26	19.7
July 22	4.64	27.0	15.5[1]	14.9	6.38	12.1	16.3
Aug. 12	8.68	23.5	8.54[1]	25.2	591	12.2	19.9
Sept. 9	3.04	20.6	10.8[1]	22.9	2.86	6.87	26.4
Oct. 7	13.6	9.27	7.66[1]	14.0	2.90	20.6	13.9
Nov. 22	27.8	9.52	6.34[1]	21.6	15.1	19.4	17.8
Dec. 20	24.4	26.2	16.0[1]	24.6	21.1	23.5	14.4
Geometric Mean							
Dry[3]	7.7	19.3	10.1[1]	23.9	10.5	11.6	16.9
Wet[4]	15.6	15.5	10.1[1]	14.1	11.5	15.7	19.3

* Station could not be reached because of flooded roads
1 - Station 5A. Station 5B values were 84.8 ntu in April, 82.9 ntu in May, 3700 in June, 858 in July, 226 in August, 120 in September, 71.9 in October, 48.9 in November, and 44.6 in December.
2 - Measured at Station 6A after April 1991.
3 - Dry season: May through October measurements excluding special sampling on April 1 and April 3.
4 - Wet season: March, April, November, and December measurements.

The turbidity at stations on Kahawainui Stream (such as Stations 7 and 8) declined after March, whereas ponded waters showed not much change in turbidity or even an increase in turbidity through much of the dry season. Station 5 was abandoned and two new stations added for the April 15 sampling: one station (5A) sampled the water which drained the marsh and the other (5B) sampled water which originated in the aquaculture ponds (primarily Ponds 1 and 2). The geometric means in Table 9 are calculated from the Station 5A data only. The Station 5B samples showed that the aquaculture pond drainage contributed much of the turbidity previously measured at Station 5. Geometric means calculated for Station 5B were 283 NTU for the dry season and 57.0 NTU for the wet season. Consistently high turbidities during the summer months contributed to the high dry season mean; for example, the turbidity on June 18 in the canal at Station 5B was 3700 NTU. The situation at Station 6 (and 6A) is unusual and discussed elsewhere (see page 20).

The specific criteria for turbidity in streams in the State Water Quality Standards (DOH, 1989) provide that the geometric mean of all measurements made from November through April (wet season) shall not exceed 5.0 NTU. The mean turbidity at all of the stations sampled in this study were two to three times the standard limit. The dry season (May through October) geometric mean not to be exceeded is 2.0 NTU. This criterion also was not met at any of the locations sampled regularly.

Dissolved Oxygen

Measurements of dissolved oxygen (DO) were taken at most stations on all but the initial visit to the area. During March through December, DO values measured in freshwater environments in the field ranged from 0.5 to 16 ppm (Table 10). The solubility of oxygen in water varies with water temperature -- warmer water holding less oxygen at saturation. At 20 ^{o}C the solubility of oxygen in fresh water is 9.09 ppm. At 27 ^{o}C, solubility drops to 7.97 ppm.

Table 10. Dissolved oxygen measurements (mg/l) at all Kahawainui and Laiewai stream and pond stations.

	Sample Station						
	3 muliwai	4 Laiewai	5	6 -	7 Kahawainui	8 -	9 marsh
Mar. 5	no measurements taken						
Mar. 11	9.0	1.5	4.8	6.2	5.3	9.5	9.2
Mar. 19	7.8	1.5	5.6	10.0	--*	--*	7.5
Mar. 28	5.3	1.8	2.0	7.6	7.3	8.5	4.1
Apr. 15	6.4	1.7	0.6[1]	5.1	6.3	4.3	9.3
May 8	16	2.3	0.6[1]	10.2[2]	6.4	2.6	5.8
June 18	9.6	0.5	2.5[1]	7.0	3.4	3.9	3.5
July 22	10.0	1.2	1.8[1]	4.1	3.9	2.8	7.8
August 12	4.0	1.2	1.6[1]	3.7	3.5	6.8	6.9
Sept. 9	6.5	0.4	1.2[1]	5.7	7.2	3.5	7.2
Oct. 7	4.0	2.4	1.8[1]	4.2	7.5	0.7	10.0
Nov. 22	4.6	1.4	1.2[1]	6.8	6.9	7.3	11.8
Dec. 20	6.7	3.4	1.3[1]	7.7	7.9	8.4	10.6
Mean Values							
Dry[3]	8.4	1.3	1.6[1]	5.8	5.3	3.4	6.9
Wet[4]	6.6	1.9	1.0[1]	7.2	6.7	7.6	8.8

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B was 3.6 mg/L on April 15, 2.2 on May 8, 0.5 on June 18, 0.8 on July 22, 1.8 on August 12, 1.5 on September 9, 2.6 on October 7, 3.1 on November 22, and 4.5 on December 20.
2 - Measured at Station 6A from May 8 on.
3 - Dry season: May through October measurements excluding special sampling on April 1 and April 3.
4 - Wet season: March, April, November, and December measurements.

The lowest values measured in the field were associated with Stations 4 and 5 on Laiewai Stream and these stations had the lowest mean levels in both the wet and dry seasons. Values at Station 4 were notably lower than those at Station 5, although the latter is located closer to the WWTP effluent discharge point. These results suggest that depressed oxygen values in this part of Laiewai Stream result from a biochemical oxygen demand which persists as the water moves downstream. The probable cause of this oxygen demand is the inorganic and organic loading from the WWTP effluent. Oxygen measurements have not been taken at night when the net biological oxygen demand might be even greater than during the daylight hours.

The highest values were measured at Stations 3, 8, and 9, representing quite different aquatic environments. Oxygen concentration at Station 8 on upper Kahawainui Stream tended to be near saturation in March, a period when flow in the stream was strong. As conditions became stagnant in this part of the stream (e.g, on April 15 and May 8), oxygen concentration dropped to nearly 50% of saturation. Mean values are higher at these stream stations in the wet season as compared with the dry season. Station 9 represents a pond environment within the marsh. Oxygen levels were above saturation on some occasions (e.g., the April 15 dissolved oxygen concentration was 117% of saturation). Super-saturation can occur in relatively still water as a result of the photosynthetic activity of submerged plants and phytoplankton. The May 8 measurement at Station 3 represents an extreme case of supersaturation produced by high productivity in the stagnant water of the muliwai.

Unlike locations on Kahawainui above the muliwai, the dry season mean at Station 3 in the muliwai is higher than the wet season mean. This result is no doubt influenced by the fact that only daytime values have been recorded (see below). Oxygen in the marsh pond and the muliwai was low at the time of high turbidity caused by runoff during the heavy rains in March.

A series of measurements were made at various points along Laiewai Stream on April 20, 1991 to clarify the influence of the marsh drainage (and WWTP effluent) on

stream DO values (see Table 11). The lowest oxygen values were found at Station 5A, located about 35 feet (10 meters) upstream of Station 5 along the ditch draining the wetland. A morning measurement was not taken at Station 4, but the afternoon value was higher than the afternoon measurement at Stations 5a and slightly lower than the afternoon measurement at 5C. Station 5C is in the drainage canal immediately below culvert "C", thus representing the mixing of waters from the aquaculture pond drainage (measured at Station 5B) and the marsh. These results plus the April and May measurements which separately sampled the two ditches which join at Station 5, indicate that the measurements made in March at Station 5 represented mixed water from the marsh (and WWTP) and the aquaculture ponds.

Low daytime oxygen concentration is a characteristic of the drainage from the marsh. The WWTP effluent tumbles and splashes over rocks before entering the marsh and the DO within the marsh directly downstream of the discharge was 5.9 mg/L on April 20. Most of this oxygen was used up during the approximately one hour period that elapsed as the effluent water flowed some 475 feet through the marsh vegetation to culvert "A". Values at Station 5A are consistently low.

Dissolved oxygen can show diel fluctuation, particularly in ponds and slow moving bodies of water. Phytoplankton and submerged vegetation produce oxygen only during the daylight hours, whereas respiration (by plants and animals) uses up oxygen all of the time. Thus, oxygen values at most stations would be lowest in the morning before sunrise (before photosynthesis starts). Stations with very high daytime levels, could have very low nighttime levels. The State of Hawaii, Water Quality Criterion (DOH, 1989) for dissolved oxygen in fresh water streams is "not less than 80% saturation". Depending upon the time of day samples were taken, the water at many or perhaps most of the stations would not meet this standard some of the time. The April and May measurements at Station 8 are below 80% saturation. The values at Station 7 on those dates are at 80% saturation. The dissolved oxygen concentration at Stations 4 and 5 would appear to be regularly less than 80% of the saturation value.

Table 11. Measurements of temperature, dissolved oxygen, and total chlorine residual at selected points along Laiewai and Kahawainui Streams on April 20, 1991.

Station/Location		time	temp. (°C)	DO (mg/L)	total residual chlorine (mg/L)
		morning			
4	Laiewai, canal	0852			0.1
5A	Above Sta 5	0930	25.5	0.45	0.2
5	Above culvert 'C'	0945	24.3	1.25	--
5B	Above Sta 5	0957	24.2	3.2	--
5	Above culvert 'C'	1003	24.0	3.7	--
	Above culvert 'A'	1016	25.3	0.65	0.17
	WWTP Effluent	1037	--	--	>6.0
35'	dwnstrm of effl.	1054	27.1	5.9	0.28
		afternoon			
6A	Above Sta. 6	1356	27.3	4.3	--
5A	Above Sta. 5	1410	27.0	0.36	--
5C	Below culvert 'C'	1415	26.1	1.95	--
4	Laiewai, canal	1428	25.7	1.51	0.18
3	muliwai	1442	30.5	5.9	0.08

Measurements of 5-day Biochemical Oxygen Demand (BOD_5) were made on samples collected from several stations monthly between April and December (Table 12). Included in the table are measurements of the WWTP effluent BOD, which was high relative to the other waters. Previous samples of the effluent have provided values between 22 and 670 mg/L for this effluent (Tables 4 and 6). After August, the WWTP effluent BOD increased substantially.

The BOD downstream of the effluent discharge point (Station 5A), was high relative to Kahawainui Stream (Stations 6 and 7) and increased slightly downstream. The increase may be attributed to the effluent from aquaculture ponds (Station 5B) which always had a higher BOD than the marsh drainage (which includes the WWTP effluent) when samples of the two waters collected just above their confluence are compared.

Table 12. Biological Oxygen Demand (BOD) of Kahawainui and Laiewai stream and pond stations measured monthly between April and December, 1991.

Station	BOD_5 (mg/L) 4/20	5/8	6/18	7/22	8/12	9/9	10/7
	Laiewai						
WWTP Effl.	22	16	25.7	74.6	--	2700	1950
5A	7.2	3.6	16.1	13.2	13.7	14.3	5.7
4	8.3	5.9	17.5	18.0	32.3	14.5	4.1
5B[1]	10	7.7	168	179	35.8	22.6	5.4
	Kahawainui						
7	2.3	--	2.1	29.8	1.5	< 1	1.3
6	1.6	12.8[2]	--	--	--	--	--
3	5.7	17.4[3]	10.4	8.2	2.4	4.1	3.6

Station	BOD_5 (mg/L) 12/20
	Laiewai
WWTP Effl.	3200
5A	2.1
4	4.0
5B[1]	12.3
	Kahawainui
7	< 1
3	--

1 - Aquaculture pond effluent above Station 5.
2 - Station 6A.
3 - Estimated; final DO reading <2.0 in bottle.

The water at Station 3 combines all of the flows entering from Kahawainui and Laiewai Streams. At the time the May 8 sample was collected, the muliwai was experiencing a phytoplankton bloom. Station 6A had been established upstream of Station 6 in order to ensure sampling of Kahawainui Stream above the muliwai. However, once the stream mouth was completely blocked by sand at the end of April, the level of water in the muliwai continued to rise and Station 6A was "incorporated" into the pond. Thus, the high BOD value obtained here. Sampling for BOD was discontinued after May at Station 6A; Station 7 was then sampled to characterize Kahawainui Stream. Although upstream of the muliwai and potential contamination from the aquaculture operations and WWTP effluent, the BOD at Station 7 was sometimes higher than the BOD in Laiewai Stream.

pH

pH measurements were made at all stream and pond stations starting on March 11 (Table 13). Mean pH values are calculated based on the "wet" and "dry" seasons for consistency, although State of Hawaii water quality standards do not utilize pH measurements this way (see below). The pH of lower Kahawainui Stream tended to be slightly higher than Laiewai Stream. All stations on Kahawainui Stream above the confluence with Laiewai have mean values close to 7.5, although the November and December values at Station 8 were slightly elevated, and the dry season mean was only 7.2. Stations 4 and 5A (Laiewai Stream) gave mean values closer to 7.3 (the dry season mean for Station 5B was 7.2), although wet season means at Stations 5A and 5B were higher (7.4 and 7.6), these were based on only three measurements. The measurements of pH show that all of the stream and pond waters in the area are neutral to slightly basic and not acidic as suggested by a previous survey (see Table 2).

The notably elevated pH values obtained in the muliwai (Station 3) in May, June and July, and the elevated values from the marsh (Station 9) after September, would seem to be the result of a high photosynthetic rates in the somewhat stagnant waters. During photosynthesis, aquatic plants (here presumably phytoplankton) remove CO_2 from the water and produce oxygen. As CO_2 is removed, the pH rises (CO_2 dissolved in water produces a weak acid). The elevated oxygen concentrations (Table 10) obtained simultaneously are confirmation of the contribution of primary productivity in these bodies of water.

The Water Quality Criteria for streams (DOH, 1989) states that pH "...shall not deviate more than 0.5 units from ambient conditions and shall not be lower than 5.5 nor higher than 8.0." Assuming Stations 7 and 8 to be representative of "ambient" conditions for the stream system, none of the other stream stations showed deviations on average greater than 0.5 pH units. However, the situation within the muliwai during the dry season and in the marsh in September through December once phytoplankton blooms were underway, resulted in pH values greater than the criterion

Table 13. pH measurements (pH units) at all stream, pond, and marsh stations in March through August,1991.

	Sample Station						
	3 muliwai	4 Laiewai	5	6 -	7 Kahawainui	8 -	9 marsh
Mar. 5	no measurements taken						
Mar. 11	7.67	7.33	7.39	7.43	7.46	7.47	7.62
Mar. 19	7.37	6.97	7.05	7.04	--*	--*	7.23
Mar. 28	7.67	7.48	7.54	7.52	7.40	7.52	7.32
Apr. 15	7.98	7.35	7.72[1]	7.72	7.43	7.22	7.77
May 8	9.07	7.53	7.50[1]	8.31[2]	7.92	7.55	7.56
June 18	8.05	7.22	7.25[1]	7.54	7.49	7.37	7.43
July 22	8.16	7.04	7.11[1]	7.14	7.15	7.01	7.45
Aug. 12	7.59	7.34	7.21[1]	7.14	7.09	6.83	7.29
Sept. 9	7.19	7.02	6.95[1]	7.31	7.41	7.16	8.86
Oct. 7	7.52	7.37	7.45[1]	7.87	7.99	7.18	8.51
Nov. 22	7.64	7.32	7.34[1]	7.78	7.91	8.56	8.74
Dec. 20	7.77	7.34	7.38[1]	7.64	7.58	7.95	8.00
Mean Values							
Dry[3]	7.93	7.25	7.24[1]	7.55	7.51	7.18	7.85
Wet[4]	7.68	7.30	7.48[1]	7.52	7.56	7.74	7.78

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B pH was 7.88 in April, 7.66 in May, 7.06 in June, 6.88 in July, 7.21 in August, 6.70 in September, 7.65 in October, 7.40 in November, and 7.46 in December.
2 - Measured at Station 6A from May 8 onwards.
3 - Dry season: May through October measurements excluding special sampling on April 1 and April 3.
4 - Wet season: March, April, November, and December measurements.

limit of 8.0. Like dissolved oxygen, the pH in these cases would show diel fluctuation, with the highest values reached in the late afternoon and the lowest values occurring just before sunrise.

Nutrients - Nitrate

Measurements of nitrate plus nitrite (herein usually referred to as "nitrate") are presented in Table 14 for the stream, marsh, and pond locations. Considerable temporal variation is shown at all locations which partly reflects the variation in rainfall and stream flows experienced during the survey period. However, sources of nitrates in the watershed appear to be numerous. Nitrate levels were highest in Kahawainui Stream below (or sometimes including) Station 8. The April 15 measurements revealed an exceptional jump in nitrates at both Stations 7 and 8. A similar increase in concentration appeared at Station 5 from July through September. The geometric means show the tendency for low nitrate levels to characterize Laiewai Stream and high values to characterize Kahawainui Stream, particularly at Station 7. However, the rise in nitrates after July at Station 5A on Laiewai Stream blurred this pattern somewhat.

Values in the channel draining aquaculture ponds (Station 5B) were of the same order of magnitude as the values measured at Station 5A, except the aquaculture drainage did not show the same sharp rise in nitrate plus nitrite concentration in July, August, and September. Consequently, the geometric means for Station 5B (0.025 mg N/L and 0.092 mg N/L for the dry and wet seasons respectively) were similar to those recorded for Station 5A only during the wet season.

The analysis of nitrate presented in Table 2 from USFWS (1984) is not sufficiently sensitive (detection limit close to 1 ppm) to be of comparative value. Nitrate values presented in Table 7 from the Humboldt State study demonstrate several characteristics of the aquatic systems with respect to nitrate. Note that nitrate concentration in the raw sewage is low and is increased in the waste stream

Table 14. Nitrate plus nitrite measurements (mg N/L) at all stream, pond, and marsh stations in March through November 1991.

	Sample Station						
	3	4	5	6	7	8	9
	muliwai	Laiewai		-	Kahawainui	-	marsh
Mar. 5	0.056	0.007	0.019	0.024	0.556	0.018	0.022
Mar. 11	0.156	0.012	0.022	0.204	0.222	0.003	0.027
Mar. 19	0.028	0.033	0.051	0.012	--*	--*	0.196
Mar. 28	0.128	0.022	0.017	0.311	0.342	0.322	0.235
Apr. 15	0.073	0.048	0.003[1]	0.389[2]	2.34	1.28	0.092
May 8	0.402	0.074	0.003[1]	0.395	2.21	0.134	0.112
June 18	0.299	0.001	0.011[1]	0.390	0.140	0.001	0.010
July 22	0.443	0.019	0.690[1]	0.068	0.302	0.005	0.002
Aug. 12	0.142	0.102	1.68[1]	0.495	0.603	0.010	0.001
Sept. 9	1.62	0.084	1.58[1]	0.372	0.630	0.018	0.004
Oct. 7	0.169	0.014	0.066[1]	0.129	0.120	0.002	0.001
Nov. 22	0.204	0.065	0.049[1]	0.563	0.788	0.031	0.002

Geometric mean							
Dry[3]	0.357	0.024	0.126[1]	0.251	0.443	0.010	0.004
Wet[4]	0.088	0.024	0.012[1]	0.126	0.600	0.059	0.030

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B was 0.058 mg N/L in April, 0.042 in May, 0.009 in June, 0.015 in July, 0.047 in August, 0.030 in September, 0.031 in October, and 0.147 in November.
2 - Samples from Sta. 6A after April.
3 - Dry season: May through October measurements.
4 - Wet season: March, April, and November measurements.

by the treatment process. Nitrate values within the aquaculture ponds and the marsh vary from very low (<0.01 ppm) to levels comparable to what is found in the WWTP effluent (on the order of 0.02 to 0.05 ppm). However, on one occasion (October 26, 1990), an exceptionally high value (1.1 ppm) was recorded in the marsh off the Avea farm). The highest value recorded in the marsh in 1991 (March through November) was 0.23 ppm (Table 14). Low values here from July through November are further evidence of a phytoplankton bloom. The values measured at Station 9 in the marsh are too variable for the mean values to have much significance. Levels of nitrate in Laiewai Stream (usually 0.01 to 0.05 ppm) are within the range of the WWTP effluent.

The State Water Quality Criteria pertaining to nutrient parameters in streams (DOH, 1989) are given in Table 15. The geometric mean criteria for nitrate plus nitrite are exceeded during the wet and the dry seasons by the muliwai (Station 3) and lower Kahawainui Stream (Stations 6 and 7). Station 5B on Laiewai Stream exceeded the dry season criterion for nitrate plus nitrite.

Table 15. State of Hawaii, Water Quality Criteria for Streams, nutrient parameters (DOH, 1989).

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than ten percent of the time	Not to exceed the given value more than two percent of the time
$NO_3 + NO_2$ (mg N/L)	0.030 **0.070**	0.090 **0.180**	0.170 **0.300**
Total N (mg N/L)	0.180 **0.250**	0.380 **0.520**	0.600 **0.800**
Total P (mg P/L)	0.030 **0.050**	0.060 **0.100**	0.080 **0.150**

Criteria in bold type are wet season (November through April) values; others are dry season (May through October) values

Nutrients - Ammonia

Measurements of the inorganic nutrient, ammonia, are presented in Table 16. Like nitrate, these show considerable temporal and spatial variation, although a general pattern is present. Ammonia concentrations (geometric mean values exceeding 6 ppm) are significantly greater in Laiewai Stream (Stations 4 and 5) than in Kahawainui Stream (geometric mean values less than 0.07 ppm). The source of the high ammonia would certainly seem to be the WWTP effluent entering the marsh above Station 5. This fact is confirmed by the effluent values given in Table 7. High values at Station J (Kahawainui Stream at Kamehameha Highway) on some occasions would seem to trace to this source as well.

The single high value at Station 6 (on March 5) is an indication that this station is not always isolated by stream flow from the flood basin pond. The dry season mean for Station 6, which includes only samples from Station 6A, is the same as that from Station 7 upstream. The upper marsh (Station 9) is somewhat intermediate between Kahawainui and Laiewai Streams. However, as with nitrate, the ammonia levels in the marsh vary substantially from month to month, and the calculated means may or may not be indicative of any consistent pattern.

Ammonia is not included in the State of Hawaii Water Quality Criteria for inland waters (see Table 15). However, criteria for this parameter are part of the standards applicable to estuaries. For estuaries other than Pearl Harbor, the geometric mean value not to be exceeded is 0.006 mg NH_4-N/L. The level not to be exceeded more than two percent of the time is 0.020 mg NH_4-N/L. None of the locations sampled, with possibly the exception of Station 3, can be classified as estuarine. Concentrations of ammonia appeared to exceed the estuary criteria everywhere on the watershed. Low levels were found only for Kahawainui Stream above Station 6 during periods of low stream flow (no runoff).

Un-ionized ammonia (NH_3) is toxic to aquatic animals but the ammonium ion (NH_4^+) is not (Downing and Merkens, 1955). The proportion of NH_3 to NH_4^+ varies with pH: un-

Table 16. Ammonia measurements (mg N/L) at all stream, pond, and marsh stations, for March through November 1991.

	Sample Station						
	3 mullwai	4 Laiewai	5	6 -	7 Kahawainui	8 -	9 marsh
Mar. 5	7.65	7.80	7.90	5.48	0.122	0.019	0.193
Mar. 11	6.27	12.8	15.25	0.244	0.093	0.085	0.164
Mar. 19	0.792	3.80	7.85	0.016	--*	--*	0.322
Mar. 28	2.85	5.97	7.52	0.087	0.011	0.004	0.653
Apr. 15	2.21	4.58	6.55[1]	0.474	0.012	0.002	0.068
May 8	2.97	4.72	8.65[1]	0.212[2]	0.062	0.006	0.154
June 18	5.36	10.1	14.0[1]	0.159	0.037	0.075	0.028
July 22	4.67	11.1	11.1[1]	0.066	0.059	0.009	0.025
Aug. 12	5.10	9.47	9.22[1]	0.031	0.170	0.003	0.036
Sept. 9	5.15	9.1	13.4[1]	0.022	0.102	0.025	0.077
Oct. 7	4.49	8.33	7.16[1]	0.102	0.078	0.025	0.023
Nov. 22	3.39	8.22	10.9[1]	0.026	0.028	0.006	0.082
Geometric Mean							
Dry[3]	4.54	8.5	10.3[1]	0.07	0.065	0.012	0.048
Wet[4]	3.05	6.6	8.4[1]	0.17	0.033	0.010	0.163

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B on Apr. 15 was 0.37 mg N/L; on May 8 was 1.75, on June 18 was 5.01, on July 22 was 4.02, on August 12 was 1.21, on September 9 was 2.02, on October 7 was 1.28, and on November 22 was 0.987.
2 - All samples from May 8 on collected at Station 6A.
3 - Dry season: May through October measurements.
4 - Wet season: March, April, and November measurements.

ionized ammonia increases with increasing pH and increasing temperature. At a pH of 7.5 and a temperature of 26°C, 1.9% of the total ammonia nitrogen will be un-ionized ammonia (Boyd, 1979). If the pH is increased to 8.0, NH_3 rises to 5.7% of the total ammonia nitrogen.

Algae can be harmed or inhibited by ammonia nitrogen at concentrations on the order of 0.4 mg/L. The tolerance limit (96-hour TLm) reported for the snail, Physa heterostropha, is around 0.9 mg/L (Academy of Natural Sciences, 1960). Toxicity to fishes (short-term exposure) is in the range of 0.6 to 2.0 mg/L (total ammonia) according to the European Inland Fisheries Advisory Commission (1973). A concentration of 2.5 mg/L in the pH range from 7.4 to 8.5 has been considered generally harmful (McKee and Wolf, 1973). The toxicity of ammonia to fish is increased markedly at low tensions of dissolved oxygen, presumably because less CO_2 is excreted at the gills, raising the pH at the gill surface (and thus the concentration of un-ionized ammonia)(McKee and Wolf, 1973). This effect appears to be nullified in ponds where CO_2 concentrations are usually high when DO levels are low (Boyd, 1979).

The levels of total ammonia regularly measured in Laiewai Stream (Stations 4 and 5) are within concentrations expected to have acute and chronic effects on fresh water biota. Although only a fraction of this ammonia is present as toxic NH_3, the harmful concentrations provided above from the literature refer to total ammonia at pH and temperatures comparable to those measured in Laiewai Stream.

Nutrients - Total Nitrogen

Total nitrogen is a measure of all of the combined forms of nitrogen in the water, including ammonia, nitrate plus nitrite, and organic nitrogen (dissolved and particulate). Total N values (Table 17) are dominated in Laiewai Stream (Stations 4 and 5) and at Station 3 by the high ammonia levels in these waters. Similar values are given in Table 7 covering the period from October 1990 to February

Table 17. Total nitrogen measurements (mg N/L) at all stream, pond, and marsh stations in March, through November.

	Sample Station 3 muliwai	4 Laiewai	5	6 - Kahawainui	7	8 -	9 marsh
Mar. 5	7.68	9.01	10.6	7.25	0.94	0.23	1.58
Mar. 11	7.35	14.61	17.47	0.65	0.48	0.26	0.79
Mar. 19	0.95	5.24	9.92	0.27	--*	--*	1.73
Mar. 28	3.61	5.30	8.40	1.78	2.11	0.518	1.60
Apr. 15	2.99	6.60	8.77[1]	1.64	2.79	1.55	0.649
May 8[2]	4.70	5.68	9.62[1]	1.20[3]	2.52	0.334	0.725
June 18[2]	7.92	14.3	19.9[1]	2.43	5.47	0.955	1.70
July 22[2]	5.34	18.1	17.3[1]	0.402	0.917	0.215	1.80
Aug. 12	4.76	11.3	11.0[1]	0.697	2.51	0.130	0.135
Sept. 9	6.76	10.2	14.5[1]	0.760	0.900	0.288	2.78
Oct. 7	4.62	8.81	7.57[1]	0.595	0.413	2.68	1.66
Nov. 22	3.92	8.61	11.5[1]	0.860	0.973	0.270	2.43
Geometric mean							
Dry[4]	5.56	10.7	12.6[1]	0.85	1.42	0.41	1.19
Wet[5]	3.62	7.7	10.0[1]	1.21	1.21	0.42	1.26

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B on Apr. 15 was 4.71 mg N/L, on May 8 was 5.11, on June 18 was 70.5, on July 22 was 55.9, on August 12 was 9.75, on September 9 was 9.18, on October 7 was 3.52, and on November 22 was 4.40.
2 - Total N values based on a TKN analysis at Stations 3, 4, and 5A.
3 - Measured at Station 6A from May 8 onwards.
4 - Dry season: May through October measurements.
5 - Wet season: March, April, and November measurements.

1991. Thus, the pattern of total nitrogen in the aquatic systems in this part of the stream system generally follows the pattern shown by the ammonia measurements as discussed above.

Because of the high ammonia concentrations in some samples, it was believed that the total nitrogen method utilized (total persulfate nitrogen digestion or TPN; D'Elia, et al., 1977) might under-report TN values in some samples. Total Kjeldahl nitrogen (TKN = TN minus NO_2 + NO_3) measurements of the WWTP influent and effluent from Food Quality Labs were quite variable (Table 4). To test this possibility, the May 8, 1991 samples from Stations 3, 4, 5A, and 5B were analyzed for both TKN and TPN. The total nitrogen (reported in Table 17) is the sum of the TKN and the nitrate + nitrite concentrations for these station samples from May through December (inclusive). However, comparison of the TPN and TKN results (Table 18) do not indicate that the TPN method was missing a substantial amount of ammonia nitrogen in the high ammonia samples.

Table 18. Comparison of TPN and TKN methods of determining Total N in selected samples collected on May 8.

	Total N (mg N/L) by TKN	by TPN
Station 3	4.70	4.70
Station 4	5.68	6.08
Station 5A	9.62	9.87
Station 5B	5.11	4.41

The State of Hawaii, Water Quality Criteria (DOH, 1989) for total nitrogen in streams are shown in Table 15. The geometric means for all of the stations sampled exceeded the 0.180 mg N/L dry season and 0.250 mg N/L wet season limits on the geometric means.

Table 19. Total phosphorus measurements (mg P/L) at all stream, pond, and marsh stations in March through November 1991.

	Sample Station						
	3	4	5	6	7	8	9
	muliwai	Laiewai		-	Kahawainui	-	marsh
Mar. 5	0.765	1.14	1.36	0.887	0.039	0.020	0.185
Mar. 11	0.763	2.19	2.68	0.067	0.065	0.034	0.091
Mar. 19	0.25	1.11	2.44	0.089	--*	--*	0.052
Mar. 28	0.362	0.882	1.31	0.019	0.016	0.017	0.280
Apr. 15	0.697	1.12	1.52[1]	0.152	0.034	0.026	0.078
May 8	0.883	1.81	2.38[1]	0.669[2]	0.007	0.014	0.062
June 18	1.81	2.69	4.15[1]	0.204	0.078	0.146	0.189
July 22	1.68	3.55	3.00[1]	0.042	0.036	0.032	0.213
Aug. 12	1.02	2.52	2.60[1]	0.037	0.217	0.012	0.301
Sept. 9	1.23	2.78	3.37[1]	0.032	0.013	0.028	0.376
Oct. 7	0.907	1.70	1.45[1]	0.028	0.018	0.424	0.194
Nov. 22	0.958	3.10	4.94[1]	0.024	0.019	0.012	0.198

Geometric Mean							
Dry[3]	1.20	2.43	2.69[1]	0.073	0.065	0.038	0.195
Wet[4]	0.57	1.43	2.74[1]	0.169	0.033	0.020	0.149

* Station could not be reached because of flooded roads
1 - Station 5A; Station 5B on Apr. 15 was 0.740 mg P/L, on May 8 was 0.669, on June 18 was 10.9, on July 22 was 11.7, on August 12 was 1.88, on September 9 was 2.03, and on November 22 was 0.438
2 - Measured at Station 6A from May 8 onwards.
3 - Dry season: May through October measurements
4 - Wet season: March, April, and November measurements.

Nutrients - Total Phosphorus

Total phosphorus is a measure of all of the species of phosphorus in the water sample: inorganic orthophosphate, dissolved organic phosphates, and particulate organic phosphates. Measurements of total phosphorus are presented in Table 19. Total phosphorus is consistently highest in the samples from Laiewai Stream and may be interpreted as a signal of the WWTP discharge. Similar values were obtained in October 1990 through January 1991 measurements as presented here in Table 7. Values reported by Food Quality Labs (Table 4) for the WWTP influent and effluent are generally low by comparison. Concentrations in the muliwai (Station 3) are greater on average during the dry season than the wet season, probably reflecting changes in the relative contributions of water flow from Laiewai and Kahawainui Streams.

The mean values for Station 4 were 2.4 ppm (dry season) and 1.4 ppm (wet season); for Kahawainui Stream, mean values were under 0.2 ppm (under 0.07 ppm if Station 6 is disregarded). Total P is clearly higher at the upper end of the marsh (mean of 0.125 ppm) than in Kahawainui Stream, but well below aquatic systems directly influenced by the WWTP effluent. The total phosphorus at Station 5B, representing aquaculture pond drainages, was not substantially different from the total phosphorus at Station 5A during the dry season (geometric mean at 5B = 2.5 ppm). Insufficient data exists to generalize on the wet season phosphate levels at Station 5B. Dry season levels at most locations are greater than wet season levels.

The State of Hawaii, Water Quality Criteria (DOH, 1989) for total phosphorus in streams are shown in Table 15. The geometric means for all of the stations exceed the 0.030 mg P/L set as the limit on the dry season geometric mean for streams. Only the upper part of Kahawainui Stream (Stations 7 and 8) did not exceed the wet season criterion of 0.050 mg P/L. The other criteria are likewise exceeded at most stations except perhaps those on upper Kahawainui Stream. The marsh above the WWTP effluent pipe (Station 9) generally exceeded the water quality criteria for total phosphorus.

Microbiological Measurements

Although it is widely recognized that most water-borne diseases of concern from a human health standpoint are caused by microorganisms excreted from the intestines of warm-blooded animals, the pathogenic bacteria and viruses are difficult to culture and identify from samples taken from aquatic environments. Thus, the more common bacteria specifically present in feces are used to indicate fecal contamination (Kabler, et al., 1964). The most common such measure are the coliform bacteria, specifically either Escherichia coli or less specifically the fecal coliforms. Another indicator group are Streptococcus spp. also known as the enterococci. Because fecal streptococci may be more hardy in the natural water environment (at least in temperate environments) than fecal coliforms, and in this regard may better parallel the survival of enteric viruses (Cohen and Shuval, 1973), the measurement of fecal streptococci or enterococci is becoming the preferred indicator of fecal pollution.

The test for these indicator microorganisms, however, does not differentiate between coliforms from human feces (i.e., sewage effluent) and those from other warm-blooded animals such as cattle, horses, dogs, and rats which may reside on the watershed or have access to aquatic environments. Measurements of fecal coliform and streptococci (enterococci) were made at most stations sampled on the Kahawainui watershed. The results are presented in Tables 20 and 21.

The results of fecal bacteria counts on waters from Kahawainui and Laiewai Streams confirmed results reported by Food Quality Labs (Table 3) that high fecal coliform and fecal streptococci counts were present in waters not influenced by the discharge from the Laie WWTP. Measurements in Laiewai Stream had demonstrated the presence of fecal bacteria attributed to the WWTP discharge. The results reported here demonstrate that both fecal coliforms and enterococci are ubiquitous in the lowland parts of the watershed. At times, fecal bacteria counts in portions of Kahawainui Stream above the confluence with Laiewai Stream exceeded counts in the latter. Low counts in Laiewai Stream

Table 20. Fecal coliform measurements at all stream, pond, and marsh stations in 1991. Table values are (MF) colonies per 100 ml.

	Sample Station						
	3 muliwai	4	5 Laiewai	6 -	7 Kahawainui	8 -	9 marsh
Mar. 5	1900[1]	5500	3800	3600	1600	90	410[1]
Mar. 11	900	3000	9200	2900	13000	2600	100[1]
Mar. 19	3150	200	5250	3200	--*	--*	500
Apr. 3	600	2000	400	1080	700	3240	--
Apr. 20[2]	--	--	--[3]	130	--	--	70
May 8	< 100	910	< 100[4]	7200	800	2900	40
June 18[2]	500	>1600	>1600[4]	>1600	>1600	>1600	170
July 22	2000	10000	<10000[4]	4400	3800	400	500
Aug. 12	910	3600	3600[4]	5800	7000	28000	<100
Sept. 9	90	1500	3000[4]	2800	1200	890	45
Oct. 7	130	460	250[4]	820	790	26000	36
Nov. 22	3500	1300	350[4]	18000	2900	8200	2300
Dec. 20	6500	950	570[4]	7600	1900	2400	780
Geometric mean							
Dry[5]	400	1870	1390[4]	3350	1840	3940	190
Wet[6]	2620	1420	450[4]	4130	2400	1720	370

* Station could not be reached because of flooded roads
1 - coliform and noncoliform colonies >200 on plate.
2 - MPN method used for samples collected on this date.
3 - Station 5B was sampled: 60 MPN/100 ml.
4 - Station 5A; At 5B the count by MPN (in all cases) was 80 MPN/100 ml May 8, > 1600 on June 18, 8000 on July 22, < 2000 on August 12, 300 on September 9, > 1600 on October 7, 9000 on November 22, and 500 on December 20.
5 - Dry season: May through October measurements
6 - Wet season: March, April, November and December measurements.

Table 21. Enterococci measurements at all stream, pond, and marsh stations in 1991. Table values are (MF) colonies per 100 ml. except as noted.

	Sample Station						
	3 Kamuliwai	4	5 Laiewai	6	7 Kahawainui	8	9 Kamarsh
Mar. 5	60	230	220	260	320	50	50
Mar. 11	50	75	800	3800	480	430	80
Mar. 19	10000	5000	6100	7700	--*	--*	700[1]
Mar. 28	400	700	800	2000	1900	--	--
Apr. 20	130	260	400[2]	172	390	170	40
May 8	< 100	< 100	< 100[2]	600	200	400	30
June 18	< 10	520	420[2]	480	410	130	260
July 22	< 100	400	200[2]	400	< 100	100	< 100
Aug. 12	72	1400	< 100[2]	900	1200	1700	27
Sept. 9	100	2600	3400[2]	470	510	500	63
Oct. 7	260	730	510[2]	630	570	20000	72
Nov. 22	550	570	930[2]	6000	990	1300	135
Dec. 20	4200	120	290[2]	570	420	520	81
Geometric mean							
Dry[3]	123	888	618[2]	560	531	703	72
Wet[4]	448	377	476[2]	1368	601	301	103

* Station could not be reached because of flooded roads
1 - colonies poorly defined.
2 - at Station 5A; Station 5B was 160 colonies/100 ml on May 8, < 1000 on April 20, 200 colonies/100 ml on May 8, < 1000 on June 18, 7000 per 100 ml on July 22, 3600 on August 12, 2000 on September 9, 7100 on October 7, TNTC on November 22, and 210 on December 20.
3 - Dry season: May through October measurements
4 - Wet season: March, April, November and December measurements.

should not be surprising. The chlorination of the effluent should reduce or eliminate bacteria from the WWTP discharge. Also, residual chlorine may sometimes be present in the effluent (and has been detected downstream at Station 3; see Table 11), and this chlorine would further reduce bacteria counts in the water.

The highest mean fecal coliform counts were from Station 6 (6A for the dry season mean), a station not directly influenced by WWTP effluent. The next highest means occurred at Stations 7 and 8 on Kahawainui Stream. Comparable values were found at Stations 4 and 3. For enterococci, the results are extremely variable, with considerable range typifying all of the locations.

Although other evidence (notably high ammonia) was cited above as indicating the possibility that Station 6 water quality is occasionally influenced by water from the Laiewai branch of the flood basin, the single value at Station 6 responsible for the highest mean enterococci occurring at Station 6 was the March 19 measurement, taken during high stream flow (i.e., the wettest period during March and April). Thus, the March 19 value represents a time when Station 6 water was free from potential mixing with Laiewai Stream water. The Station 7 enterococci measurement on this date confirms that the high values in Kahawainui Stream are not coming from the WWTP effluent.

Only the station at the back of the marsh (Station 9) can be said to be characterized by low fecal coliform and enterococci levels with any regularity. This fact would seem to contribute to the presumption that much of the marsh is hydrologically isolated from the WWTP discharge which enters close to the northern end (the outlet) of the marsh. The Humboldt State measurements taken at "Avea farm" some 260 feet (80 meters) "upstream" of the effluent discharge point (EDP) did seem to indicate sewage pollution in this area on the basis of relatively high fecal coliform and enterococci concentrations (Table 5). Station 9 is over 800 feet (250 m) from the EDP. It is worth noting that the highest concentrations of enterococci at Station 9 coincided with the period of greatest runoff from the watershed (March 19 sampling). Although fecal coliform was also high on this

date, the highest fecal coliform measured at Station 9 was on November 22, when fecal coliforms were above average at many of the stations.

The State of Hawaii water quality standards include the following specific criteria for recreational areas (inland waters):

> (1) Fecal coliform content shall not exceed a geometric mean of two hundred per one hundred milliliters in ten or more samples collected during any thirty day period and not more than ten per cent of the samples shall exceed four hundred per one hundred milliliters in the same period (DOH, 1989).

Notwithstanding that a more frequent sampling would be required for statutory purposes, the results obtained during this study show that none of the stations on Kahawainui or Laiewai Streams would meet the fecal coliform standard for inland recreational waters.

Laie Bay

Water quality samples were collected from two stations along the shore of Laie Bay on either side of the mouth of Kahawainui Stream. Results are presented in Tables 22 through 27. Although the effects of outflow from Kahawainui Stream on Laie Bay is an important consideration in assessing potential impacts of the Laie WWTP effluent on the environment, the situation with respect to wave-driven and tidal currents in the Bay is too complex to be considered in detail here. Samples collected for the Humboldt State University study from all along the shore of Laie Bay point to either multiple sources of fecal contamination or complex eddy systems that would require an extensive spatial and temporal sampling program to resolve.

The purpose of the measurements made at our Stations 1 and 2 was to determine if indicators of the WWTP effluent could be detected along the shore near the mouth of the stream under conditions which can vary from strong outflow

during floods to no surface outflow when the stream mouth is blocked by sand. A wide range of flow conditions were observed during the study period (see Table 22), although most of the time the mouth of Kahawainui Stream was blocked by sand. After March, only a single station was sampled (Station 2), and the location was moved to directly in front of the muliwai whenever the sand beach blocked the stream after April 20.

Table 22. Salinity (ppt) measurements at two Laie Bay (ocean shoreline) stations and observed flow condition at the mouth of Kahawainui Stream.

	Salinity Sample Station 1	2	Stream Outflow Condition
Mar. 5	--	--	stream mouth blocked
Mar. 11	35	35	stream mouth blocked
Mar. 19	6	25	strong outflow
Mar. 28	29	31	strong outflow
April 1	--	--	outflow
April 3	--	--	outflow
April 15	--	34	weak outflow
April 20	--	--	weak outflow
May 8	--	34	stream mouth blocked
June 18	--	34	stream mouth blocked
July 22	--	--	stream mouth blocked
August 12	--	34	some stream outflow
September 9	--	35	stream mouth blocked
October 7	--	35	stream mouth blocked
November 22	--	35	outflow with debris
December 20	--	32	outflow

Measurements of salinity, turbidity, and temperature (Tables 22 through 24) at the shore show clear correlations with stream flow conditions. Turbidity increased when stream outflow was strong; temperature and salinity decreased. The geometric mean of the turbidity measurements from the wet season was greater than the geometric mean turbidity during the dry season. The relationships between dissolved oxygen and stream outflow, and pH and stream outflow are more complex, or at least not correlated using this limited number of measurements. Because the DO varies considerably within the muliwai, it cannot be used to indicate the degree

of stream water influence on the nearshore area. However, dissolved oxygen did not vary substantially at Station 2, except for one elevated value obtained on March 11.

One would expect pH to increase to the average pH of around 8.2 for seawater once the stream flow becomes blocked. In fact, the pH tended to remain above 8.0 under all conditions encountered. The mean of the pH measurements was essentially the same for the dry season and the wet season data.

Table 23. Temperature (^{o}C) and Dissolved Oxygen (mg O_2/L) measurements at La'ie Bay stations.

	Temperature Sample Station 1	2	DO Sample Station 1	2
Mar. 5	not measured		not measured	
Mar. 11	23	23	11.8	11.8
Mar. 19	20	21.2	7.2	7.6
Mar. 28	25	25	6.8	7.2
Apr. 15	--	25.5	--	7.2
May 8	--	25	--	6.1
June 18	--	26	--	6.3
July 22	--	28	--	6.2
August 12	--	26.7	--	6.1
September 9	--	28.0	--	6.4
October 7	--	27.5	--	7.2
November 22	--	27	--	6.5
December 20	--	23	--	7.2

The relationship between nutrients detected along the shoreline of Laie Bay near the stream mouth and stream out-

Table 24. Turbidity (NTU) and pH (pH units) measurements at La'ie Bay (ocean shoreline) stations.

	Turbidity Sample Station 1	2	pH Sample Station 1	2
Mar. 5	0.53	1.37	not measured	
Mar. 11	0.81	0.77	8.07	8.08
Mar. 19	22.0	11.3	8.21	8.12
Mar. 28	4.58	10.7	8.04	8.33
Apr. 15	--	7.06	--	8.40
May 8	--	3.02	--	8.41
June 18	--	1.18	--	8.12
July 22	--	3.81	--	8.16
August 12	--	1.91	--	8.01
September 9	--	1.12	--	8.17
October 7	--	5.87	--	8.16
November 22	--	7.52	--	8.13
December 20	--	3.41	--	8.22
Mean Values				
Dry[1]	--	2.4	--	8.17
Wet[2]	2.6	4.2	8.10	8.21

1 - Dry season: May through October measurements; geometric mean for turbidity.
2 - Wet season: March, April, November and December measurements; geometric mean for turbidity.

flow is not as obvious as with the other parameters. When, on March 19, stream flow into the bay was considerable, and the salinity and turbidity of the samples were indicative of brackish water, the ammonia concentration was high (although much less than the muliwai sample on this date) (Table 25). As the stream mouth became blocked over the period through

Table 25. Nitrate + nitrite and ammonia measurements at La'ie Bay (ocean shoreline) stations. Units are mg N/L).

	Nitrate + nitrite Sample Station 1	2	Ammonia Sample Station 1	2
Mar. 5	0.033	0.048	0.010	0.012
Mar. 11	0.008	0.008	0.010	0.009
Mar. 19	0.016	0.014	0.153	0.096
Mar. 28	0.041	0.022	0.129	0.025
Apr. 15	--	0.012	--	0.099
May 8	--	0.022	--	0.032
June 18	--	0.010	--	0.032
July 22	--	0.022	--	0.011
August 12	--	0.037	--	0.193
September 9	--	0.023	--	0.006
October 7	--	0.035	--	0.027
November 22	--	0.016	--	

Geometric Means				
Dry[1]	--	0.023	--	0.027
Wet[2]	0.036	0.017	0.037	0.033

1 - Dry season: May through October measurements
2 - Wet season: March, April and November measurements.

May 8, ammonia concentration in the sea water decreased. The low levels measured in early March when the sand barrier was in place were measured again in July. Possibly, moving the sample station (Station 2) to a position closer to the muliwai accounted for the elevated ammonia seen in May and June after the barrier was fully formed. Despite the temporal variability shown by the individual samples and the presumption that wet season measurements would produce a greater stream outflow influence on the shoreline

environment, the geometric means of the nitrate, the ammonia, and the total nitrogen (Table 26) do not show seasonal differences.

Table 26. Total Nitrogen (mg N/L) and Total Phosphorus measurements at La'ie Bay (ocean shoreline) stations.

	Total Nitrogen Sample Station 1	2	Total Phosphorus Sample Station 1	2
Mar. 5	0.14	0.14	0.008	0.005
Mar. 11	0.09	0.09	0.011	0.012
Mar. 19	0.35	0.28	0.113	0.084
Mar. 28	0.329	0.220	0.042	0.040
Apr. 15	--	0.240	--	0.052
May 8	--	0.186	--	0.282
June 18	--	0.117	--	0.018
July 22	--	0.163	--	0.027
August 12	--	0.276	--	0.052
September 9	--	0.153	--	0.009
October 7	--	0.277	--	0.024

Geometric Means				
Dry[1]	--	0.19	--	0.034
Wet[2]	0.20	0.19	0.034	0.029

1 - Dry season: May through October measurements
2 - Wet season: March and April measurements.

The concentration of phosphorus (Table 26) at the shoreline seems to follow a pattern similar to that for ammonia. When the stream outflow is great, elevated levels of phosphorus can be found in the brackish water. However, when surface flow is not occurring, elevated phosphorus still may be found at the shore directly opposite the

muliwai. Further, no seasonal difference in total phosphorus is evident in the geometric means.

Table 27. Fecal coliforms and enterococci measurements at Laie Bay (ocean shoreline) stations.

	Fecal coliforms Sample Station 1	Fecal coliforms Sample Station 2	Enterococci Sample Station 1	Enterococci Sample Station 2
Mar. 5	< 1	< 1	< 1	< 1
Mar. 11	< 1	< 1	< 1	< 1
Mar. 19	1200	500	3200	960
Apr. 15	--	30	--	--
Apr. 20	--	--	--	14
May 8	--	< 1	--	< 1
June 18	--	< 1	--	< 2
July 22	--	12	--	5
August 12	--	< 10	--	< 2
September 9	--	< 1	--	1
October 7	--	< 1	--	1
November 22	--	340	--	140
December 20	--	190	--	110
Geometric means				
Dry[1]	--	--	--	--
Wet[2]	--	318	--	245

1 - Dry season: May through October measurements
2 - Wet season: March, April, November, and December measurements.

For these samples, the presence of fecal coliforms and fecal streptococci appear to be directly related to the movement of stream water into the Bay (Table 27). Fecal bacteria were absent or not abundant in samples from days when the stream mouth was completely blocked by sand.

The State of Hawaii, Water Quality Standards which would apply to the La'ie Bay stations are not the same as those discussed above for inland waters. The waters of the bay are designated Class A, open coastal waters. For all of the parameters, the criteria are more stringent than the corresponding inland waters criteria. However, our stations are representative of a small part of La'ie Bay, and in part apparently influenced at times by stream outflow. Thus, for some parameters, comparison with the open coastal waters criteria can be expected to produce noncompliance. Because the geometric means for the nutrients do not show seasonal trends (suggesting that, on balance, stream outflow has no strong influence on these means), the means might well be characteristic of the coastal waters and could be compared with the standards (see Table 28).

Table 28. State of Hawaii, Water Quality Criteria (Nutrients only) for Open Coastal Waters (DOH, 1989).

Parameter	Geometric mean not to exceed the given value	Not to exceed the given value more than ten percent of the time	Not to exceed the given value more than two percent of the time
$NO_3 + NO_2$ (mg N/L)	0.0035 **0.005**	0.010 **0.014**	0.020 **0.025**
Total N (mg N/L)	0.110 **0.150**	0.180 **0.250**	0.250 **0.350**
Total P (mg P/L)	0.016 **0.020**	0.030 **0.040**	0.045 **0.060**

Criteria in bold type "wet criteria" apply to coastal waters which receive more than 3 mgd fresh water discharge per shoreline mile; others are "dry criteria" and apply when coastal waters receive less than 3 mgd of fresh water per coastal mile.

The La'ie area is considered a "seasonally wet" coastal environment (DOH, 1977), which means that the "wet" and "dry" criteria for coastal water quality will apply seasonally as was presented above for the water quality measurements made in stream environments. In general, the geometric mean criteria for nitrate plus nitrite, total nitrogen, and total phosphorus are all exceeded by the Station 2 geometric means. However, the total N and total P means are not far above the respective "wet criteria".

The State water quality standards (DOH, 1989) include the following criterion for marine recreational waters: "...enterococci content shall not exceed a geometric mean of seven per one hundred millliliters in not less than five samples equally spaced over a thirty-day period."

Wailele Stream

Wailele Stream drains Wailele Gulch located south of 'Ihi'ihi Gulch. The stream passes close behind the BYU campus before emptying into the ocean south of La'ie. Nmerous attempts were made to obtain water samples from this stream, but only the muliwai was observed to contained water during the dry season. Later observations during the wet season revealed that water only flows in the stream channel above the muliwai following a heavy rainfall. Attention was focused on this stream and the muliwai in a study of surface and ground water quality around the La'ie WWTP drain field (AECOS, 1992).

The results of a single monitoring on this stream in April 1991 are presented in Table 29.

Table 29. Water quality of Wailele Stream, Laie on April 15, 1991.

Temperature (^{o}C)	25
pH	7.85
DO (mg/L)	7.6
Turbidity (ntu)	6.31
Nitrate+Nitrite (mg N/L)	0.004
Ammonia (mg N/L)	0.002
Total N (mg N/L)	0.099
Total P (mg P/L)	0.016
Fecal coliforms (no./100 ml)	1640
Enterococci (no./100 ml)[1]	450

[1] - April 20 sample

DISCUSSION

The focus in this section of the report is on describing the streams and other aquatic environments of the Kahawainui floodplain using both the biological and water quality observations made during the period from March through December, 1991. The month of March represented an exceptionally wet period with respect to rainfall received by the watershed at La'ie. April and May covered the transition from wet season conditions to dry season conditions. Conditions remained generally dry through the late November, when the rains returned. The observations cover three-quarters of an annual period, and a wide range of weather conditions effecting the aquatic environments at La'ie. Continuation of the monitoring program on a monthly basis produced observations which modified some of the interpretations and conclusions reached earlier, and revealed variabilities in water quality measurements that themselves may be a significant characteristic of the aquatic environments on this watershed.

Upper Kahawainui Stream

Flow in Kahawainui Stream appears to be interrupted above and within the reach at Station 8. That is, between rainy periods, portions of the stream bed are without water. In early March, the water at Station 8 appeared to be essentially stagnant. After the heavy rains in mid and late March, this condition gradually returned. By May, aquatic features at this location were limited to a series of isolated pools in the boulder-filled bed of the stream.

As the environment changed from that of a flowing stream to one of small ponds, the water quality changed as well. Oxygen, temperature, and pH fluctuated more widely. These changes were probably accompanied by changes in the biota, although this aspect was not studied. In late March, the nitrate concentration started to rise, reaching a peak in April, then decreasing through May. Measurements after May gave low nitrate concentrations. The increase in nitrate accompanied the reduction in stream flow.

Lower Kahawainui Stream

Kahawainui Stream reaches the floodplain (elevation less than 20 feet) about midway between Stations 8 and 7. Portions of the stream flowing across the floodplain provide natural appearing aquatic habitat, although the stream is generally confined by levees. This lower reach is dominated by long, shallow pools with rock and sediment bottoms. Riffle areas separate the pools. At Station 6, the stream becomes an arm of the flood basin and muliwai: ponded water behind the beach berm which blocks the mouth during periods of low flow. Water was noted to back up above Station 6A in May, after the beach berm was fully formed (see below).

In many respects, the water quality in Kahawainui Stream is typical of lowland streams on Oahu. High turbidities occur during brief periods of strong flow associated with major rainfall events. Oxygen, temperature, and pH appear generally normal, although biologically stressful levels may occur in the dry season pools as water flow declines. Dissolved nitrates tend to be high in Kahawainui, particularly at Station 7. Nitrates increased substantially in April as the water at Stations 7 and 8 began to stagnate. However, nitrate concentrations at Station 7 were always substantially greater than at Station 8 located upstream. The source of the high nitrate may be agricultural fields adjacent to the stream. Also, a number of intermittent streams join Kahawainui between Stations 7 and 8.

Measurements of fecal coliform bacteria and fecal streptococci in Kahawainui Stream demonstrate that the La'ie WWTP is not the only source of these indicators of fecal contamination on the watershed. Average values for fecal bacteria counts at Stations 7 and 8 are as high or higher than average counts from parts of Laiewai Stream which receive the WWTP effluent.

Fishes noted to be present in this part of Kahawainui Stream include the common guppy (Poecilia reticulata), the tilapia (Orechromis mossambica), and Chinese catfish (Clarias fuscus). These are introduced (non-native) species.

The Muliwai of Kahawainui Stream

A muliwai is a pond formed at the mouth of a stream when stream flow is too weak to maintain an opening through a sand beach to the ocean. The base flow of Kahawainui Stream cannot maintain a channel across Hukilau Beach into La'ie Bay and a large muliwai forms here between major rainfall events. Presumably some stream water does continue to seep through the sand barrier into La'ie Bay (see below). Formation of the muliwai has significant consequences on the water quality of lower Kahawainui Stream.,

The salinity of the water in the muliwai is largely a function of stream flow from Kahawainui Stream and its tributary Laiewai. Salinities measured at Station 3, which was located downstream of the Kamehameha Highway bridge, are given in Table 30.

Table 30. Measurements of salinity (ppm) at Station 3 on the muliwai of Kahawainui Stream at La'ie.

March 19	0	(O)[1]	Aug. 12	5	(o)
April 1	0	(O)	Sept. 9	5	(C)
April 15	4	(o)	Oct. 7	2	(C)
May 8	1	(C)	Nov. 22	10	(O)
June 18	2	(C)	Dec. 20	4	(O)
July 22	--	(C)			

1 - (O) - Stream flowing out; (o) - Stream mouth open to sea, flow weak; (C) - Stream mouth blocked by sand.

When stream flow is above normal, Station 6 water quality reflects conditions as measured at Station 7 located further upstream. During such periods, the outlet to the sea is open, and water moves from Station 7, to Station 6, to Station 3, and then into La'ie Bay. As stream flow becomes reduced during drier periods, the sand beach reforms across the stream mouth and water backs up behind it. The water level at Station 6 rises. By May, even Station 6A had become part of this enlarged pond. The prevailing winds may promote a surface current moving "upstream". During these periods, the water quality at Stations 6 and 6A can acquire characteristics in common with Station 4, located on the

lower portion of Laiewai Stream, but also part of the muliwai.

The muliwai is a large, nearly stagnant body of water which receives nutrient-enriched water from both Kahawainui and Laiewai Streams. The latter is particularly high in ammonia and phosphates from the WWTP effluent discharging further upstream. Ammonia is oxidized to nitrites and nitrates, which are readily utilized by the phytoplankton. Phosphorus, which is frequently limiting in aquatic environments, is supplied in abundance. Potassium and minor nutrients are also probably abundant in the WWTP effluent. Conditions become ideal for phytoplankton blooms in the muliwai once the residence time of the water is extended by blockage of the stream mouth.

The dense growth of phytoplankton in the muliwai results in an increase in turbidity and chlorophyll. Oxygen and pH change over a broad range between night and day as rates of photosynthesis and respiration increase.

The only macrophyte present in abundance in the muliwai is the water hyacinth (Eichhornia crassipes). This plant is capable of phenomenal growth and could reduce phytoplankton populations in the water column by tying up nutrients and reducing light penetration. However, because water hyacinth is (usually) a floating plant, the density is reduced during periods of high stream flow such as occurred in March. Prior to March 19, water hyacinth covered the canal surface between Stations 4 and 5. Over time, this plant could cover a significant proportion of the muliwai surface, potentially affecting a change in the water quality as the dry season progresses. However, the supply of nutrients from the WWTP effluent is constant and at a relatively high level. Physical harvesting of the excess growth of this plant would be required to accomplish a removal of nutrients from the system. Otherwise, the nutrients must eventually become incorporated into a detrital layer on the bottom of the muliwai, later to be swept into the sea during major floods.

Two fishes are abundant in lower Kahawainui Stream: the common guppy (Poecilia reticulata) and the tilapia (Orechromis mossambica). Topminnows (Poecilia vittata) may

also be present. All three species are introduced fishes which are extremely common in lowland streams on Oahu. A conspicuous invertebrate found in these waters is the apple snail (Pomacea sp.), a large introduced species. The red-colored eggs of this snail were observed on water hyacinth plants during March. Individuals were extremely abundant between Stations 5 and 4 throughout the summer months. This snail was noted in August in the muliwai to extend downstream to about midway between Stations 4 and 3.

The Marsh

The marshland located behind La'ie is perhaps the most interesting aquatic environment on the Kahawainui floodplain. The marsh is dominated by California grass (Brachiaria mutica) and cattail (Typha latifolia), but includes three large open bodies of water. Adjacent to the marsh on the west are three aquaculture ponds. Similar marshy land (without California grass) probably characterized the entire floodplain prior to development of wetland agriculture (taro) by the Hawaiians, and later transformations into aquaculture and agriculture parcels through filling, dredging, and draining. However, the existing marsh appears to be developing in the remnants of three former ponds with the present open water areas being the deeper, central portions of these former ponds. Water depths are on the order of 4 to 6 feet and the depth of mud bottom varies between 1 and 2 feet (Humboldt State University, in prep.).

The water quality station regularly sampled during this study (Station 9) was at the shore of a pond at the south end of the marsh. This station should be removed from any water quality influence by the WWTP effluent which discharges into the north end of the marsh approximately 450 feet above the outlet. Water quality data appear to substantiate this assumption. The primary indicators of sewage (ammonia, phosphates, and fecal bacteria) do not show the elevated levels seen at stations downstream of the WWTP discharge. During the study, both ammonia and phosphorus were high relative to unpolluted stream samples (e.g., Station 8), but the marsh pond does receive flow from a nearby aquaculture pond (see Table 7). Average fecal

coliforms and fecal streptococci values were lowest at this station of all the fresh water stations sampled in the study.

The portion of the marsh receiving the WWTP effluent and areas downstream of the effluent discharge point (EDP) are densely covered by California grass (Brachiaria mutica) which forms a floating mat on the water surface. The dense mat of grass makes difficult observations of aquatic fauna, but mosquito larvae were found to be abundant 30 meters below the outfall. Young bullfrogs (Rana catesbiana) and a pond snail (Physella sp.) were observed here as well. The grass above the water surface harbors an abundance of spiders and insects, particularly earwigs (Dermaptera) but several other species as well. The abundance of arthropods appears to be greater than would normally be encountered in dense grass, and is probably tied somehow to the high level of particulate organics in the water below. The presence of mosquito larvae, despite the high concentrations of ammonia and at least occasional chlorine residual in the water may be because these aquatic larvae are air-breathing. The mosquito larva (and pupal stage) lives largely at the surface, drawing in air through a breathing tube (or tubes in the case of the pupa)(Frost, 1959). No fishes were seen here, but would have been easily missed within the tangle of stems and roots. The abundance of mosquito larvae might be an indication that predators (the common fresh water fishes) are absent.

Laiewai Stream

Laiewai Stream is a series of drainage ditches which serve the area between the marsh and the muliwai of Kahawainui Stream. If there was ever a natural stream in this area, it would have probably been the drainage from 'Ihi'ihi Gulch across the floodplain. The present configuration includes three small drainages above our Station 5. One drains the marshland and adjacent aquaculture ponds (Ponds 5 through 7) and includes the La'ie WWTP effluent; one drains a small wetland below aquaculture Pond 4 and appears to receive water draining from Ponds 3 and 4 as well as overflow from 'Ihi'ihi Gulch during exceptional

rainfalls; and one drains aquaculture Ponds 1 and 2 (Station 5B). As part of the drainage system improvements made during the summer, the ditch which had been receiving water from a small wetland below Pond 4 was extended along the roadway to better intercept overflow from 'Ihi'ihi Gulch during floods and outflow from Ponds 3 and 4 all of the time.

The segment of Laiewai Stream between the marsh and Station 5 shows the greatest water quality impact from the WWTP effluent. The banks of this ditch are covered with California grass, which reaches down into the water. Below the water surface, the sides and bottom of the ditch are blackened with iron sulfides and organic matter. Daytime dissolved oxygen concentrations are low. The ammonia concentration in this water is high and residual chlorine (from effluent chlorination) is detectable, at least some of the time.

The arrowhead plant (Sagittaria sagittaefolia), an obligate aquatic species, was seen growing in the ditch above Station 5. At Station 5, two other obligate aquatics, water hyacinth (Eichhornia crassipes) and duckweed (Lemna minor), are present floating on the water surface.

Despite the inhospitable conditions, the fauna of this section includes tilapia, guppies, bullfrogs (Rana catesbiana), and two species of snails (Pomacea sp. and Physella sp). The guppy (Poecilia reticulata) was observed to be abundant within a pool at the extreme north end of the marsh (just above culvert "A"). Tilapia (Orechromis mossambica), guppies, bullfrogs, and the snail (Pomacea sp.) were seen in the ditch between culvert "A" and Station 5.

The toxicity of sewage effluent to aquatic animals has been found to vary considerably from place to place (Tsai, 1975). Factors most commonly cited as harmful to stream fauna are decreased dissolved oxygen levels, high ammonia levels, and residual chlorine. All three factors appear to be significant within the water found between the WWTP discharge pipe and Station 5.

Low DO values were found on most visits to Laiewai Stream (Stations 4 and 5), although only daytime measurements were made. Dissolved oxygen can be expected to decrease after dark, although biological respiration may not be very great within the stream directly below the marsh. One effect of residual chlorine in the water is to retard bacterial decomposition of organics, with the result that oxygen concentrations are not as depressed as they might be in the immediate vicinity of the outfall (Chamberlin, 1948). There is, however, abundant evidence that chlorine and toxic compounds produced by the reaction of chlorine and other chemicals in the sewage, can have adverse effects on aquatic organisms (Manufacturing Chemists Association, 1972; Tsai, 1975).

Few actual measurements of total residual chlorine were made, so we have scant indication of the concentrations that the aquatic fauna is subjected to. Regular measurements of ammonia were made however, and show that within the reach between Stations 4 and 5 (and by implication, between Station 5 and the WWTP discharge) ammonia is nearly always greater than 5 ppm.

Because the toxicity of ammonia to aquatic animals is a function of pH and possibly several other factors, a wide range of tolerances are reported in the literature. Total ammonia levels recorded at Station 5 are potentially toxic to a wide range of organisms, but apparently not to the guppy, the tilapia, or the apple snail, since all are living here. Of course chronic effects would not be easily observed. Reproduction by the apple snail was confirmed, both by hatching eggs collected from Laiewai Stream just below culvert "C" (the highest point upstream that eggs were seen) and by the abundance of young snails seen in this area after March.

The concentration of toxic NH_3 (see page 29) can be determined from tables provided in Boyd (1979) for the temperature and pH of the water samples as shown in Table 31. The concentration of NH_3 appears relatively constant during this period, except for the drop which occurred on March 19 when runoff and stream flow were high. As with total ammonia, un-ionized ammonia increases upstream towards

the WWTP discharge pipe, but not as dramatically as might be expected considering that the concentration of total ammonia is some three times greater at Station 5A than at Station 3. And, during the period of May through July, un-ionized ammonia was greatest in the lower muliwai (Station 3) where rising pH resulted from the high primary productivity in the stagnant water.

Table 31. Concentration of NH_3 from pH, temperature, and total ammonia concentrations in Laiewai Stream.

	un-ionized ammonia (ppm)		
	Sta. 3	Sta. 4	Sta. 5
Mar. 11	0.13	0.14	0.18
Mar. 19	0.01	<0.02	<0.01
Mar. 28	0.09	0.11	0.15
Apr. 15	0.14	0.07	0.16[1]
May 8	1.34	0.10	0.17
June 18	0.35	0.10	0.16
July 22	0.40	0.08	0.09
Aug. 12	0.13	0.12	0.10
Sep. 9	0.05	0.06	0.09
Oct. 7	0.10	0.14	0.14
Nov. 22	0.11	0.13	0.14

[1] - Station 5A from April 15 on.

Comparison of Table 31 with Table 16 shows how small a proportion of total ammonia is the toxic NH_3 under the conditions of pH and temperature measured most of the time (< 1 to 2 %). However, when the water tends toward stagnation in the muliwai during the dry season, un-ionized ammonia can comprise a far greater proportion of total ammonia. As phytoplankton productivity increases in the

still water of the muliwai, a daytime rise in pH occurs. On May 8, with the pH at nearly 9.1, the percentage of un-ionized ammonia in solution was calculated to be some 45% of total ammonia (at 27 °C). The pH is not likely to rise this high above Station 5 or at the north end of the marsh where ammonia concentrations are sometimes greater than 10 ppm. However, where phytoplankton-rich water from the aquaculture ponds combines with the WWTP effluent at Station 5, high pH values are possible.

The lethal concentration of NH_3 for trout (which are extremely sensitive) is reported to be as low as 0.05 ppm (Herbert and Vandyke, 1964). Studies with mosquito fish (Gambusia) by Wallen et al. (1957) show much higher doses (3 to 11 ppm) for 24-, 48-, and 96-hour TLm's (median tolerance limit). Threshold concentrations proposed for various fishes as presented in Tsai (1975) range from 0.1 to 2.1 ppm.

Aquaculture Ponds

The other branches (drainage ditches) of Laiewai Stream drain areas northwest of the marsh. The flows are perennial because they originate from the aquaculture ponds, into which ground water is pumped regularly. Flows enter the marsh drainage canal just below culvert "A" and at Station 5 (just above culvert "C"). Samples collected from Ponds 5 and 6 for the Humboldt State University study (Table 7) and the analyses of samples from Station 5B provide a general characterization of the pond effluents.

The pond water is slightly warmer and considerably more turbid than the receiving water. High turbidity is probably due to phytoplankton abundance, but activities of the prawn that is cultured in the ponds may also contribute significantly to the turbidity of the effluent. Slightly elevated pH and BOD are presumably also indications of phytoplankton productivity within the ponds.

The nitrate and ammonia content of the pond effluent is variable, but mostly under 0.05 ppm NO_3-N and 2 ppm NH_4-N. This level of ammonia is high relative to unpolluted stream

water, and reached 5 ppm one day in June. The dry season geometric mean of total N for Station 5B (13.6 mg N/L) was actually greater than that for Station 5A (12.6 mg N/L). The mass loading contribution of aquaculture discharges to Laiewai Stream are probably less than the WWTP contribution, since the volume of water discharged by the ponds is thought to be less than the WWTP. Total phosphorus levels at Station 5B were variable, ranging from 0.5 to nearly 12 mg P/L. These measurements during the dry season produced a geometric mean (2.5 mg P/L) not much different from that for Station 5A (2.7 mg P/L). Fecal coliform and fecal streptococcus measurements of waters from the ponds (Table 5) and Station 5B are extremely variable.

CONCLUSIONS

The water quality and biological observations presented in this report for drainage systems on the north side of La'ie on the windward coast of O'ahu were designed to document some of the impacts of a waste water treatment plant (WWTP) discharge on aquatic environments in the valley. Also, the study was intended to compare the severity of the WWTP impacts relative to other water quality perturbations that might also be occurring.

In this drainage system, flow volumes vary appreciably from place to place and with time: dependent upon rainfall received on the watershed and perhaps other factors related to agriculture and aquaculture operations in the valley. A sophisticated network of flow measuring devices would be required to provide mass loading estimates for the analytes measured in this study. The concentrations of various analytes are certainly significant to the biota and the biotic processes occurring at the point in a stream where the measurements are made, but the mass loadings (the concentration times the water volume) are the more significant determinant of downstream impacts.

Although patterns in analyte concentrations related to stream flow volumes were often apparent, many parameters varied in seemingly unpredictable ways. At least for the period of measurements reported here (March through December, 1991), this variability rendered meaningless the calculation of wet season and dry season geometric means for some analytes that are ordinarily thought to be tied to rainfall and runoff.

Detection of the WWTP effluent downstream from the discharge point was not difficult: high phosphate and high ammonia concentrations were particularly characteristic. Observed water quality impacts included consistently reduced oxygen levels from excessive organic loading. Farther downstream, waste nutrients contributed to eutrophication of ponded water. Impacts on biota were not as evident. Most of the "normal" macrofauna of aquatic environments in this area was observed to inhabit the areas directly influenced by the

WWTP effluent. No native species were observed in the stream system, but this fact cannot be attributed to the WWTP discharge. Native aquatic animals are usually absent from modified stream systems in urban and agriculture areas on O'ahu.

Water quality measurements revealed that sources of "pollutants" were not limited to the WWTP effluent. Many non-point sources of phytoplankton nutrients and fecal bacteria appear to be present on this watershed. A complete assessment of the impacts of these other pollutant sources relative to the WWTP effluent would require estimates of mass loadings. Nonetheless, the results presented here suggest that while the planned diversion of the WWTP from the Laiewai wetlands will produce improvements in Laiewai Stream and lower Kahawainui Stream, water quality problems within the system will continue as a consequence of the non-point sources. Regular monitoring for a period of time after the diversion will provide information valuable to a perspective of the relative impacts of point source and non-point source pollutants of the Kahawainui Stream system with potential application to other Oahu streams.

The impact on La'ie Bay of the stream, or more specifically, the waste stream from the La'ie WWTP, can be addressed only tentatively. Many stations positioned along and off the shore would be required to define the influence of flow or seepage from Kahawainui on water quality in La'ie Bay. Measurements at a single station along the shore at or adjacent to the mouth of the stream suggest that parameters such as turbidity and microbes (coliforms and enterococci were measured) are tied to outflow from the stream. That is, without surface flow, occurences of fecal bacteria and/or suspended solids in La'ie Bay do not derive from Kahawainui Stream.

Other important water quality considerations, such as the nutrients, appear not to be tied to the observed surface flow of water from the stream. Average values at the shore are nearly the same in dry and wet seasons, or are slightly higher in the dry season. This result might indicate that nutrient concentrations in La'ie Bay are not strongly influenced by the stream. However, average nutrient values

tend to be higher in the muliwai in the dry season than in the wet season, reflecting presumably the greater proportion of WWTP effluent as well as non-point sources in the water flowing into the pond. Thus, the shoreline concentrations under low stream flow could represent seepage through the beach of a water with a relatively "high" concentration of nutrients; under high outflow conditions, values obtained at the shore reflect the contribution of a more dilute water flowing into the Bay.

BIBLIOGRAPHY

Academy of Natural Sciences of Philadelphia. 1960. The sensitivity of aquatic life to certain chemicals commonly found in industrial wastes. Acad. Natl. Sci. Phil.

AECOS, Inc. 1992. La'ie WWTP effluent drain field monitoring well studies. Baseline sampling and analyses. Prep. for Zions Securities Corp., Laie. AECOS No. 667A. 66 p.

Boyd, C.E. 1979. Water Quality in Warmwater Fish Ponds. Auburn University, Agricultural Experiment Station, Auburn, Alabama. 359 p.

Chamberlin, N.S. 1948. Chlorination of sewage. Sew. Works J., 20(2): 304-318.

Cohen, J., and H.I. Shuval. 1973. Coliform, fecal coliforms, and fecal streptococci as indicators of water pollution. Water, Air, and Soil Pollution, 2: 85-95.

Colwell, R.R. 1975. Bacteria and viruses -- indicators of unnatural environmental changes occurring in the nation's estuaries. p. 507 - 518, In: Estuarine Pollution Control and Assessment. Proceedings of a Conference. Vol. II. U.S. EPA, Office of Water Planning and Standards, Washington, D.C.

D'Elia, C.F., P.A. Steudler, and N. Corwin. 1977. Determinations of total nitrogen in aqueous samples using persulfate digestion. Limnol. Oceaongr., 22(4): 760-763.

DOH. 1989. Amendment and Compilation of Chapter 11-54, Hawaii Administrative Rules, November 20, 1989. Summary. State of Hawaii, Department of Health, Honolulu.

Downing, K.M., and J.C. Merkens. 1955. The influence of dissolved oxygen concentrations on the toxicity of unionized ammonia to rainbow trout (Salmo gairdnerii Richardson). Ann. Appl. Biol., 43: 243-246.

European Inland Fisheries Advisory Commission. 1973. Water quality criteria for European freshwater fish. Report on ammonia and inland fisheries. Water Res., 7: 1011-1022.

Frost, S.W. 1959. Insect Life and Insect Natural History. Second revised edition. Dover Publications, Inc., New York. 526 p.

Herbert, D.W.M., and J.M. Vandyke. 1964. The toxicity to fish of mixtures of poisons. II. Copper-ammonia and zinc-phenol mixtures. Ann. Appl. Biol., 53: 415-421.

Kabler, P.W., H.F. Clark, and E.E. Geldreich. 1964. Sanitary significance of coliform and fecal coliform organisms in surface water. Publ. Health Repts, 79: 58-60.

Manufacturing Chemists Association. 1972. The effect of chlorination on selected organic chemicals. U.S. E.P.A., Water Pollut. Contr. Res., Ser. 12020 EX GT 03/72, 112 p.

McKee, J.E., and H.W. Wolf. 1973. Water Quality Criteria. 2nd Edition, revised. The Resources Agency of California, State Water Resources Control Board, Publ. 3-A. 548 p.

Tsai, Chu-fa. 1975. Effects of sewage treatment plant effluents on fish: a review of literature. Chesapeake Research Consortium, Inc. Publ. No. 36., 229 p.

Stemmermann, L. 1981. A guide to Pacific Wetland Plants. U.S. Army Corps of Engineers, Honolulu District. 118 p.

USFWS. 1984. Final Coordination Act report, Kahawainui Stream Flood Control Study, Laie, Oahu, Hawaii. Prep. for Honolulu District, U.S. Army Corps of Engineers, Honolulu by U.S. Dept. of Interior, Fish and Wildlife Service, Honolulu Field Office.

Wallen, I.E., W.C. Greer, and R. Lasater. 1957. Toxicity to Gambusia affinis of certain pure chemicals in turbid waters. Sew. Ind. Wastes, 29: 695.

Botanical Survey, Laie Wastewater Treatment Plant Project Laie, Hawaii

BOTANICAL SURVEY
LA'IE WATER RECLAMATION FACILITY
KO'OLAU LOA DISTRICT, ISLAND OF O'AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical Consultants
Honolulu, Hawai'i

Prepared for: GROUP 70 INTERNATIONAL, INC.

November 1993

BOTANICAL SURVEY
LA'IE WATER RECLAMATION FACILITY
KO'OLAU LOA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

A new wastewater treatment system is planned for La'ie on land presently in agricultural use. The proposed facility will be located on the southern portion of the La'ie community. The water reclamation facility will be sited on fallow fields and a small planting of coconut trees. The irrigation water storage reservoirs, which will hold the treated water, will be sited on banana and papaya fields. The proposed La'ie Water Reclamation Facility will accommodate the planned development of a new residential area and limited commercial and institutional facilities expansion in La'ie.

Field studies to assess the botanical resources found on the water reclamation facility as well as the irrigation water storage reservoirs' site were conducted on 24 August 1993 and on 04 November 1993. The primary objectives of the survey were to: 1) describe the major vegetation types; 2) inventory the flora; 3) search for threatened and endangered species as well as rare and vulnerable plants; and 4) identify areas of potential environmental problems or concerns and propose appropriate mitigation measures.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. Topographic maps and a recent colored aerial photograph (1" = 400') were examined to determine vegetation cover patterns, terrain

characteristics, access, boundaries, and reference points. Access was from an unpaved road off of Kamehameha Highway; the road services the small farms in the surrounding area.

The less disturbed areas where the water reclamation facility and the reservoirs abut the coral outcroppings and the wooded foothills were more intensively surveyed; these uncultivated areas are more likely to harbor native plants. A walk-through survey method was used. Notes were made on plant associations and distribution, substrate type, drainage, exposure, etc. Plant identifications were made in the field. Plants which could not be positively determined were collected for later identification in the herbarium and for comparison with the most recent taxonomic literature.

DESCRIPTION OF THE VEGETATION

The vegetation on the water reclamation facility and on the irrigation water storage reservoirs' site have been mapped in two recent botanical studies for the La'ie lands (Char 1991a, 1991b). The cultivated areas were mapped as "agricultural lands and other disturbed areas", while "mixed forest and scrub vegetation" occurred on coral outcroppings and steep slopes.

About the same vegetation designations are recognized in this study and are discussed in more detail below. A list of all the plants observed during the field studies is presented at the end of the report.

Agricultural Land

On the proposed site for the water reclamation facility, the land has not been actively cultivated for some time and supports a weedy fallow field vegetation. Clumps of sugar cane (Saccharum officinarum) can still be found along the edges of the field. The vegetation on these old sugar cane fields form a mosaic of

different plant associations.

On the western end and in the low-lying area bordering the coral outcrop, the vegetation consists of low koa-haole shrubs (Leucaena leucocephala), 3 to 7 ft. tall. The native morning-glory or koali (Ipomoea indica) forms tangled mats over the koa-haole shrubs. On other parts of this site, the vegetation consists of a mixture of partridge pea (Chamaecrista nictitans) and white-flowered beggar's tick (Bidens alba), or an assemblage of Johnson grass (Sorghum halpense) and various, mixed, herbaceous species. The weedy cover is very dense except along the dirt road and within some eroded, small, swale areas. Scattered through this vegetation type are young trees of ironwood (Casuarina equisetifolia) and Java plum (Syzygium cumini). Several rows of fairly large coconut trees (Cocos nucifera), from 15 to 20 ft. tall, are also found on the water reclamation facility site. The ground cover beneath the trees is a weedy mixture of various grasses and herbs.

On the site proposed for the irrigation water storage reservoirs, most of the land is actively cultivated. Various banana cultivars (Musa X paradisiaca), including a few cooking types, and papaya (Carica papaya) are the main crops grown. Occasionally, there are a few other plants grown for the home table or use; these include coconut, soursop (Annona muricata), ti (Cordyline fruticosa), and Heliconia sp.

Weedy species associated with agricultural lands are numerous. The most frequently observed plants are white-flowered beggar's tick, Johnson grass, and California grass (Brachiaria mutica). Other species observed occasionally include Guinea grass (Panicum maximum), two species of rattlebox (Crotalaria incana, C. pallida), wire grass (Eleusine indica), spiny amaranth (Amaranthus spinosus), and swollen fingergrass (Chloris barbata). Woody components are found along the borders of the field and include koa-haole, Java plum, guava (Psidium guava), castor bean (Ricinus communis), and

ironwood. Small rows of wild cane (Saccharum spontaneum), often used as a windbreak planting, can also be found alongside the banana and papaya fields.

Mixed Forest and Scrub Vegetation

The reservoirs' site and the water reclamation facility abut two coral outcrops. These remnants of a coral reef formed in shallow ocean water during the time the ocean was at a higher level (Foote et al. 1972). The smaller coral outcrop to the north of the reservoirs supports koa-haole shrubs, 12 to 15 ft. tall, with a dense understory of Guinea grass along the edges of the outcrop. The larger outcrop found between the water reclamation facility and the reservoirs supports somewhat taller koa-haole (12 to 20 ft.), a few trees of Chinese banyan (Ficus microcarpa), and dense hau thickets (Hibiscus tiliaceus). The understory plant cover is sparse, with litter from the plants above and the weathered coralline substrate (karst) the most prominent features. Other species found occasionally in this vegetation type include noni (Morinda citrifolia), castor bean, Christmas berry (Schinus terebinthifolius), huehue haole (Passiflora suberosa), koali, and kaunaoa-pehu (Cassytha filiformis).

On the mauka (western) border of the water reclamation facility is a band of ironwood trees. Under the ironwood trees, the ground cover is sparse since the fallen "needles" tend to form a thick mat which smothers other smaller species. In the open, sunny patches upslope of the trees, the vegetation consists of California grass with scattered Christmas berry shrubs. Other plants found here include koa-haole, guava, owi (Stachytarpheta dichotoma), Java plum, and sour grass (Digitaria insularis).

DISCUSSION AND RECOMMENDATIONS

Old field or fallow field vegetation is found on the proposed La'ie Water Reclamation Facility; a few rows of coconut trees also occur here. On the site of the irrigation water storage reservoirs, the vegetation consists of actively cultivated fields of banana and papaya. The usual mix of weedy species associated with agricultural lands is found on the water reclamation site and the reservoirs' site. Uncultivated lands, that is, the coral outcroppings and the foothills mauka of the water reclamation site, support a mixed forest and koa-haole scrub.

A total of 76 plant species were inventoried on the two sites. Of these, 67 (88%) are introduced or alien species; 3 (4%) are originally of Polynesian introduction; and 6 (8%) are native. The six native plants are all indigenous species, that is, they are native to the Hawaiian Islands and also elsewhere. None of the plants found during the survey are listed threatened and endangered species; nor are any proposed or candidate for such status (U.S. Fish and Wildlife Service 1989, 1990, 1992). None of the plants are considered rare and/or vulnerable (Wagner et al. 1990). Introduced species form the dominant vegetaion types on the two sites.

Given the findings above, the proposed project should not have a significant negative impact on the botanical resources of the two sites or to the plant populations within the region. There are no botanical reasons to impose any restrictions, conditions, or impediments to the development of the two sites.

Soil erosion is of some concern, especially on the water reclamation facility site. Although the soils are well-drained, heavy rainfall can cause erosion on the more steeply sloping areas. It is recommended that disturbed areas be revegetated and landscaped as soon as possible to prevent soil loss. Ironwood trees can be planted to help screen parts of the water reclamation facility from view.

PLANT SPECIES LIST

A checklist of all those terrestrial, vascular plant species inventoried during the field studies is presented below. The species are arranged alphabetically within each of three groups: Ferns, Monocots, and Dicots. The taxonomy and nomenclature of the Ferns are in accordance with Lamoureux (1988); the flowering plants, Monocots and Dicots, follow Wagner et al. (1990).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   I = indigenous = native to the Hawaiian Islands and also elsewhere throughout the Pacific
   P = Polynesian = plants originally of Polynesian introduction prior to Western contact (Cook's discovery of the islands in 1778); not native
   X = introduced or alien = all those plants brought to the islands by humans, intentionally or accidentally, after Western contact; not native
4. Presence (+) or absence (-) of a particular species within each of two vegetation types recognized on the project site (see text for discussion):
   ag = Agricultural Land
   f-s = Mixed Forest and Scrub Vegetation

Scientific name	Common name	Status	Vegetation type ag	Vegetation type f-s
FERNS				
NEPHROLEPIDACEAE (Sword Fern Family)				
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern	X	-	-
THELYPTERIDACEAE (Wood Fern Family)				
Christella parasitica (L.) Levl.	downy wood fern	X	+	-
FLOWERING PLANTS				
MONOCOTS				
AGAVACEAE (Sisal Family)				
Cordyline fruticosa (L.) A. Cher.	ti, ki	P	+	-
ARACEAE (Aroid Family)				
Dieffenbachia picta Schott	dumb cane	X	+	-
COMMELINACEAE (Spiderwort Family)				
Commelina diffusa N.L. Burm.	honohono	X	+	+
CYPERACEAE (Sedge Family)				
Cyperus rotundus L.	nutgrass, nut sedge	X	+	-
HELICONIACEAE (heliconia Family)				
Heliconia sp.	heliconia	X	+	+
MUSACEAE (Banana Family)				
Musa x paradisiaca L.	banana, maia	X	+	-
POACEAE (Grass Family)				
Axonopus fissifolius (Raddi) Kuhlm.	carpetgrass	X	+	+
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	X	+	+
Brachiaria mutica (Forssk.) Stapf	California grass	X	+	+

Scientific name	Common name	Status	Vegetation type: ag	Vegetation type: f-s
Chloris barbata (L.) Sw.	swollen fingergrass, mau'ulei	X	+	-
Chloris divaricata R. Br.	stargrass	X	+	-
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	+	-
Dichanthium aristatum (Poir.) Hubb.	Wildergrass	X	+	-
Digitaria ciliaris (Retz) Koeler	crabgrass	X	+	+
Digitaria insularis (L.) Mez ex Ekman	sour grass	X	-	+
Echinochloa colona (L.) Link	jungle rice	X	+	-
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	X	+	-
Panicum maximum Jacq.	Guinea grass	X	+	+
Paspalum conjugatum Bergius	Hilo grass, mau'u Hilo	X	+	+
Paspalum fimbriatum Kunth	Panama paspalum, fimbriate paspalum	X	+	-
Paspalum scrobiculatum L.	ricegrass	I?	+	-
Pennisetum purpureum Schumach.	Napier grass, elephant grass	X	+	+
Saccharum officinarum L.	sugar cane, ko	P	+	-
Saccharum spontaneum L.	wild cane	X	+	-
Setaria verticillata (L.) P. Beauv.	bristly foxtail	X	+	-
Sorghum halpense (L.) Pers.	Johnson grass	X	+	+
DICOTS				
AMARANTHACEAE (Amaranth Family)				
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	-	-
Amaranthus viridus L.	slender amaranth, pakai	X	-	-
ANACARDIACEAE (Mango Family)				
Schinus terebinthifolius Raddi	Christmas berry	X	+	+
ANNONACEAE (Custard-apple Family)				
Annona muricata L.	soursop	X	+	-

Scientific name	Common name	Status	Vegetation type: ag	Vegetation type: f-s
ARALIACEAE (Ginseng Family)				
Schefflera actinophylla (Endl.) Harms	octopus tree, umbrella tree	X	+	+
ASTERACEAE (Sunflower Family)				
Bidens alba var. radiata (Schultz-Bip.) Ballard ex Melchert	white-flowered beggar's tick	X	+	+
Conyza bonariensis (L.) Cronq.	hairy horseweed, lani wela	X	+	-
Emilia fosbergii Nicolson	pualele	X	+	-
Emilia sonchifolia (L.) DC.	lilac pualele	X	+	-
Wedelia trilobata (L.) Hitchc.	wedelia	X	-	+
CARICACEAE (Papaya Family)				
Carica papaya L.	papaya, mikana	X	+	-
CASUARINACEAE (Ironwood Family)				
Casuarina equisetifolia L.	ironwood, paina	X	-	+
CONVOLVULACEAE (Morning-glory Family)				
Ipomoea alba L.	moonflower, koali pehu	X	+	-
Ipomoea indica (J. Burm.) Merr.	koali	I	+	-
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	-
Ipomoea triloba L.	little bell, pink bindweed	X	+	-
CUCURBITACEAE (Squash Family)				
Momordica charantia L.	wild bittermelon	X	-	-
EUPHORBIACEAE (Spurge Family)				
Chamaesyce hirta (L.) Millsp.	hairy spurge	X	-	-
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	-	-
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	-

Scientific name	Common name	Status	Vegetation type: ag	Vegetation type: f-s
Macaranga tanarius (L.) Mull. Arg.	macaranga	X	+	+
Phyllanthus debilis Klein ex Willd.	niruri	X	+	-
Ricinus communis L.	castor bean, koli	X	+	+
FABACEAE (Pea Family)				
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	+	+
Crotalaria incana L.	fuzzy rattlepod, kukae-hoki	X	+	-
Crotalaria pallida Aiton	smooth rattlepod, pikakani	X	+	-
Desmanthus virgatus (L.) Willd.	slender mimosa	X	+	+
Desmodium incanum DC.	Spanish clover, ka'imi	X	+	+
Desmodium triflorum (L.) DC.	three-flowered beggar-weed	X	+	-
Indigofera suffruticosa Mill.	indigo, 'iniko	X	+	-
Leucaena leucocephala (Lam.) de Wit	koa-haole	X	+	+
Macroptilium lathyroides (L.) Urb.	wild bushbean, cowpea	X	+	-
Mimosa pudica var. unijuga (Duchass. & Walp.) Griseb.	sensitive plant, pua hilahila	X	+	+
Senna pendula (Humb. & Bonpl. ex Willd.) H. Irwin & Barneby	senna	X	+	-
LAURACEAE (Laurel Family)				
Cassytha filiformis L.	kaunaoa-pehu	I	-	+
MALVACEAE (Mallow Family)				
Hibiscus tiliaceus L.	hau	I?	-	-
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X	-	-
MELASTOMATACEAE (Melastome Family)				
Clidemia hirta (L.) D. Don	clidemia, Koster's curse	X	+	+
MORACEAE (Mulberry Family)				
Ficus microcarpa L.f.	Chinese banyan	X	-	+

Scientific name	Common name	Status	Vegetation type: ag	Vegetation type: f-s
MYRTACEAE (Myrtle Family)				
Psidium cattleianum Sabine	strawberry guava	X	-	-
Psidium guajava L.	guava, kuava	X	+	-
Syzygium cumini (L.) Skeels	Java plum, palama	X	+	+
PASSIFLORACEAE (Passion Flower Family)				
Passiflora suberosa L.	huehue haole	X	+	+
PORTULACACEAE (Purslane Family)				
Portulaca oleracea L.	pigweed, common purslane	X	+	-
RUBIACEAE (Coffee Family)				
Morinda citrifolia L.	noni	P	-	+
SOLANACEAE (Tomato Family)				
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato, wild tomato	X	-	-
Solanum americanum Mill.	popolo	I?	+	-
STERCULIACEAE (Cacao Family)				
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	-
VERBENACEAE (Verbena Family)				
Stachytarpheta dichotoma (Ruiz & Pav.) Vahl	owi, oi	X	-	+
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, owi	X	-	-
Verbena litoralis Kunth	weed verbena	X	+	-

LITERATURE CITED

Char, W.P. 1991a. Botanical survey, La'ie Wastewater Treatment Plant Project, La'ie, Ko'olau Loa District, O'ahu. Prepared for Aqua/Waste Engineers. April 1991.

_____. 1991b. Botanical survey, La'ie Master Plan Project, La'ie, Ko'olau Loa District, O'ahu. Prepared for Group 70 International, Inc. November 1991.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C.

Lamoureux, C.H. 1988. Draft checklist of the Hawaiian pteridophyta, "Kupukupu O Hawai'i Ne'i". October 1988.

U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants. 50 CFR 17.11 & 17.12.

_____. 1990. Endangered and threatened wildlife and plants; Review of plant taxa for listing as Endangered and Threatened Species; Notice of review. Federal Register 55(35): 6184-6229.

_____. 1992. Endangered and threatened wildlife and plants; Proposed endangered status for 11 plants from the Koolau Mountain Range, island of Oahu, Hawaii. Federal Register 57(199): 47028-47039.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. 2 vols. University of Hawai'i Press and B.P. Bishop Museum Press, Honolulu. B.P. Bishop Museum Press Special Publication 83.

Report on a Faunal Survey of Wetland Habitat Associated with the Laie Wastewater Treatment Plan Project, Laie, Hawaii

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS FOR THE LAIE WATER RECLAMATION FACILITY, LAIE, OAHU

Prepared for

Group 70

by

Phillip L. Bruner
Assistant Professor of Biology
Director, Museum of Natural History
BYU-Hawaii
Environmental Consultant - Faunal (Bird & Mammal) Surveys

25 August 1993

INTRODUCTION

The purpose of this report is to summarize the findings of a one day (23 August 1993) bird and mammal field survey of approximately 15 acres for the proposed Laie Water Reclamation Facility at Laie, Oahu (Fig. 1). Also included are references to pertinent literature as well as unpublished faunal reports.

The objectives of the field survey were to:

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

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

3- Determine the presence or likely occurrence of any native fauna particularly any that are considered "Endangered" or "Threatened".

4- Evaluate the quality of the habitat for native wildlife and note any special or unique habitat features that may require protection.

GENERAL SITE DESCRIPTION

Figure One indicates the limits of the lands surveyed for birds and mammals. Diversified agriculture of bananas and papayas dominate the habitat. Coral outcrops with second growth exotic forest and grass/weed choked ditches also occur in the vacinity. These ditches did not contain any running water at the time of the survey, however, isolated puddles were found near Kamehameha Highway.

Weather during the field survey was partly cloudy. Winds were from the east at 10-15 mph.

STUDY METHODS

Field observations were made with binoculars and by listening for vocalizations. These observations were concentrated during the peak bird activity period of early morning. This was done in order to gain a more acurate estimate of bird populations. The subject property and nearby adjacent lands were walked and at several scattered locations eight minute counts were made of all birds seen or heard (Figl. 1). Between these count (census) stations any unusual observations of birds or mammals were also noted. These data provide the basis for the relative (estimated) abundance figures

given in this report (Table 1). Published and unpublished reports of birds known from similar habitat were also consulted in order to acquire a more complete picture of the possible species that might be expected (Pratt et al. 1987; Hawaii Audubon Society 1989; Bruner 1991). Records of feral mammals were limited to visual sightings and to the presence of scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative (estimated) abundance and distribution.

Scientific names used herein follow those given in Hawaii's Birds (Hawaii Audubon Society 1989; Field guide to the birds of Hawaii and the Tropical Pacific (Pratt et al. 1987) and Mammal Species of the World (Honacki et al. 1982).

RESULTS AND DISCUSSION

Resident Endemic (Native) Land Birds:

No endemic land birds were recorded on the survey. The Short-eared Owl or Pueo (Asio flammeus sandwichensis) occurs in grassland habitat, agricultural fields and forests (Pratt et al. 1987). Pueo are listed as an endangered species on Oahu by the State of Hawaii Division of Forestry and Wildlife (DOFAW) and could potentially

forage in this area. The introduced Common Barn Owl (Tyto alba) is often mistaken for the Pueo and is more likely to be seen.

Resident Endemic (Native) Waterbirds:

The project site contained no habitat suitable for waterbirds. The drainage ditches in this region were mostly dry. Following Periods of heavy rainfall there may be temporary suitable habitat in these ditches for waterbirds such as the endemic and endangered Koloa (Anas wyvilliana) and the indigenous Black-crowned Night Heron (Nycticorax nycticorax). These two species are quite opportunistic and will forage in a wide variety of wetland habitats.

Migratory Indigenous (Native) Birds:

Migratory shorebirds winter in Hawaii between the months of August through May. Some juveniles will stay through the summer months as well (Johnson and Johnson 1983). Of all the shorebird species which occur in Hawaii, the Pacific Golden Plover (Pluvialis fulva), also known in the older literature as Lesser Golden Plover (pluvialis dominica fulva), is the most abundant. Plover prefer open areas such as exposed intertidal reef, rocky shorelines, mud flats, lawns, plowed fields, pastures, upland grasslands and roadsides.

Their diet consists primarily of insects and other invertebrates. They arrive in Hawaii in early August and depart to their arctic breeding grounds during the last week of April (Johnson et al. 1981). Plover are extremely site-faithful on their Hawaiian wintering grounds and most establish foraging territories which they defend vigorously. Such behavior makes it possible to acquire a fairly good estimate of the abundance of plover in any one area. These populations likewise remain relatively stable over many years (Johnson et al. 1989). Three plover were recorded on the survey. These birds were found along the roadside makai of the fields recently planted with papayas. Ruddy Turnstone (Arenaria interpres) were not observed but will also utilize open fields.

Resident Indigenous (Native) seabirds:

No nesting seabirds were observed on the property. The presence of predators probably renders this site unsuitable. One male Great Frigatebird (Fregata minor) was seen flying overhead.

Exotic (Introduced) Birds:

A total of 12 species of exotic birds were recorded during the field survey (Table 1). The most abundant were Red-vented Bulbul (Pycnonotus cafer), Zebra Dove (Geopelia striata) and Japanese White-

eye (Zosterops japonicus).

Based on the location and type of habitats found on the property as well as information provided in Pratt et al. 1987; Hawaii Audubon Society 1989; Bruner 1991) the following species may also occur at this site: Barn Owl (Tyto alba), Ring-necked Pheasant (Phasianus colchicus), Rock Dove (Columba livia), Japanese Bush-warbler (Cetia diphone), Hwamei (Garrulax canorus), Java sparrow (Padda oryzivora), Chestnut Mannikin (Lonchura malacca), House Sparrow (Passer domesticus) and Eurasian Skylark (Alauda arvensis).

Feral Mammals:

Small Indian Mongoose (Herpestes auropunctatus) were noted along with tracks of cats and dogs. No trapping was conducted in order to assess the relative abundance of feral mammals.

Oahu records of the endemic and endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) are limited (Tomich 1986; Kepler and Scott 1990). No bats were found on this survey. Whether or not this species occurs in this area is unknown. Our understanding of the bat's distribution and behavior is extremely limited. They are thought to roost solitarily in trees and occur in upland forests as well as in coastal habitats. This species feeds on flying insects at dusk using echolocation.

CONCLUSION

A brief field survey such as this one can provide only a limited perspective of the wildlife which utilize the area. The number and relative abundance of each species may vary throughout the year due to available food resources and reproductive success. Exotic species sometimes prosper only to later disappear or become a less significant part of the ecosystem (Williams 1987; Moulton et al. 1990). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. Nevertheless, some general conclusions related to bird and mammal activity at this site can be drawn. The following comments summarize the findings of this survey.

1- All major habitats on and near the property were visited and census stations were distributed so as to provide a reasonable sample from which relative estimates of bird populations could be derived.

2- No endemic land birds were recorded. The only possible species in this category is the Pueo or Short-eared Owl. This species is listed as endangered on Oahu by DOFAW.

3- No native waterbird species were recorded. The endemic endangered Koloa and the indigenous Black-crowned Night Heron may forage in the drainage ditches in this region following periods of significant rainfall. These ditches were mostly dry during this survey.

4- Three Pacific Golden Plover were the only migratory shorebirds recorded on the survey. The Ruddy Turnstone may also occur in open fields in this region.

5- The property supports the typical array of exotic birds one would expect at this locality and in this type of habitat on Oahu. No particularly unusual or unexpected species were found. Some birds that usually can be found in this environment were not recorded. This may be due to several factors some of which are: survey too brief, too few individuals to detect or presently no localized populations of these species. Red-vented Bulbul were particularly abundant. This pestivorous species has caused damage to agricultural and flower crops on Oahu.

6- A trapping program would be required in order to obtain more definitive data on mammals. The brief observations of this

survey did not reveal any unusual observations of mammals. It is likely that the number of rats, cats, mice and mongoose are typical of similar habitats elsewhere. The endangered Hawaiian Hoary Bat was not recorded at this site but it is known from Oahu. The potential for this species at this site is unknown due to our limited knowledge of this animals distribution and ecology.

7- No special or unique habitat essential for native birds were found on the survey. The drainage ditches north and south of the property may provide limited temporary foraging opportunities for native waterbirds such as Koloa and Black-crowned Night Heron.

8- If ponds or collection basins are created as part of the proposed development this resource may also be exploited by waterbirds such as American Coot (Fulica americana alai) and Black-necked Stilt (Himantopus mexicanus knudseni). These two federally listed endangered species prefer ponds and other flooded habitats. The endangered Common Moorhen (Gallinula chloropus sandvicensis) is shy and normally uses ponds with emergent shoreline vegetation.

TABLE 1

Exotic (introduced) birds recorded at the proposed site for the Laie Water Reclamation Facility, Laie, Oahu.

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*
Cattle Egret	Bubulcus ibis	R = 5
Spotted Dove	Streptopelia chinensis	C = 7
Zebra Dove	Geopelia striata	A = 15
Common Myna	Acridotheres tristis	C = 6
Red-vented Bulbul	Pycnonotus cafer	A = 20
White-rumped Shama	Copsychus malabaricus	R = 4
Northern Cardinal	Cardinalis cardinalis	U = 4
Red-crested Cardinal	Paroaria coronata	R = 3
Japanese White-eye	Zosterops japonicus	A = 10
House Finch	Carpodacus mexicanus	C = 8
Common Waxbill	Estrilda astrild	R = 9
Nutmeg Mannikin	Lonchura punctulata	R = 7

*(see page 12 for key to symbols)

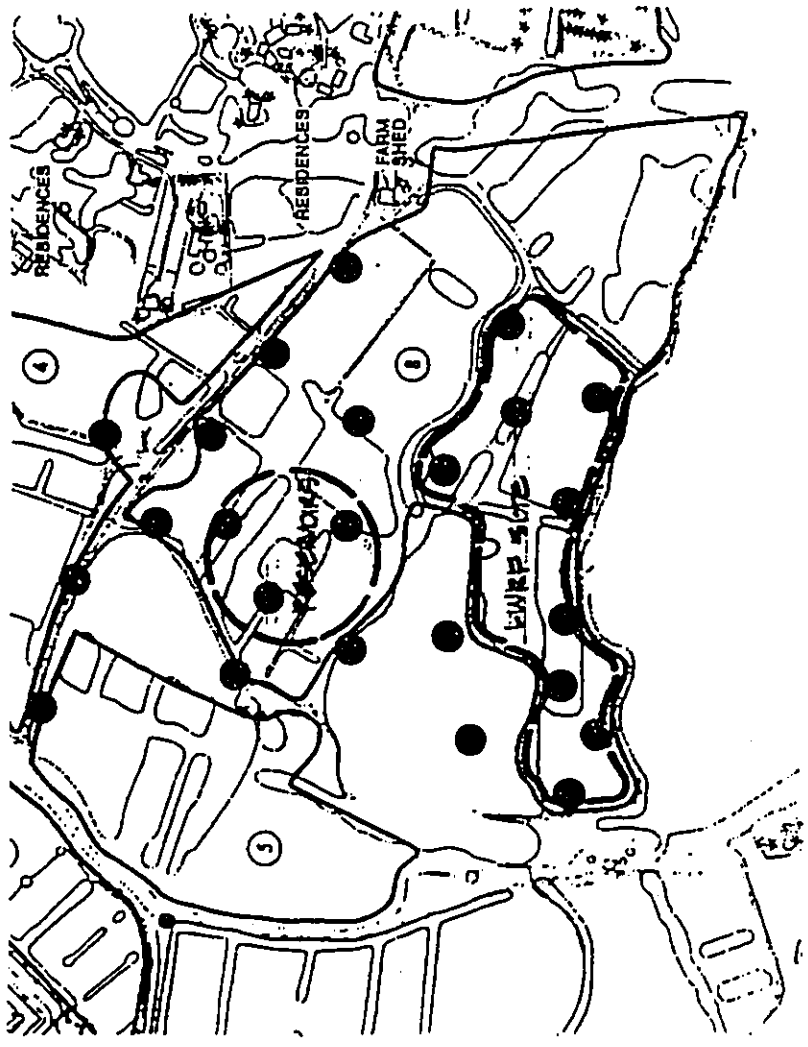


Fig. 1. Location of faunal survey with census stations shown as solid circles.

KEY TO TABLE 1

Relative (estimated) abundance = Number observed on eight minute counts in appropriate habitat.

A = abundant (10+)

C = common (5-10)

U = uncommon (less than 5)

R = recorded only once on survey or not on census stations

SOURCES CITED

Bruner, P.L. 1991. Report on a faunal survey of wetland habitat associated with the Laie Wastewater Treatment Plant Project, Laie, Hawaii. Unpubl. ms. Prep. for Group 70, Honolulu.

Hawaii Audubon Society. 1989. Hawaii's Birds. Fourth Edition. Hawaii Audubon Society, Honolulu.

Honacki, J.H., K.E. Kinman and J.W. Koeppl ed. 1982. Mammal Species of the World: A taxonomic and geographic reference. Allen Press, Inc. and the Association of Systematic Collections. Lawrence, Kansas.

Johnson, O.W., P.M. Johnson and P.L. Bruner. 1981. Wintering behavior and site-faithfulness of Golden Plovers on Oahu. 'Elepaio 41(12):123-130.

Johnson, O.W., and P.M. Johnson. 1983. Plumage-molt-age relationships in "over-summering" and migratory Lesser Golden-Plovers. Condor 85:406-419.

Johnson, O.W., M.L. Morton, P.L. Bruner and P.M. Johnson. 1989. Winter range fat cyclicity in Pacific Golden Plovers (Pluvialis fulva) and predicted migratory flight ranges. Condor 91:156-177.

Kepler, C.B. and J.M. Scott. 1990. Notes on distribution and behavior of the endangered Hawaiian Hoary Bat (Lasiurus cinereus semotus) 1974-1983. 'Elepaio 50(7):59-64.

Moulton, M.P., S.L. Pimm and N.W. Krissinger. 1990. Nutmeg Mannikin (Lonchura punctulata): a comparison of abundance in Oahu vs. Maui sugarcane field: evidence for competitive exclusion? 'Elepaio 50(10):83-85.

Pratt, H.D., P.L. Bruner and D.G. Berrett. 1987. A field guide to the birds of Hawaii and the Tropical Pacific. Princeton Univ. Press.

Tomich, P.Q. 1986. Mammals in Hawaii. Bishop Museum Press.

Williams, R.N. 1987. Alien Birds on Oahu. 1944-1985. 'Elepaio 47(9):87-92.

APPENDIX B

ARCHAEOLOGICAL STUDIES

Archaeological and Historical Assessment Study-Water Reclamation Facility

Report 1325-110893

Archaeological and Historical Assessment Study Laie Wastewater Reclamation Facility

Land of Laie
Koolauloa District, Island of Oahu

PHRI Paul H. Rosendahl, Ph.D., Inc.
Archaeological • Historical • Cultural Resource Management Studies & Services

Report 1325-110893

Archaeological and Historical Assessment Study Laie Wastewater Reclamation Facility

Land of Laie
Koolauloa District, Island of Oahu

BY

Susan T. Goodfellow, Ph.D. • Laboratory Director
and
Paul H. Rosendahl, Ph D. • President and Principal Archaeologist

PREPARED FOR

Group 70 International, Inc.
924 Bethel Street
Honolulu, Hawaii 96813-4393

NOVEMBER 1993

PHRI Paul H. Rosendahl, Ph.D., Inc.
Archaeological • Historical • Cultural Resource Management Studies & Services
HAWAII: 305 Mahoull Street • Hilo, Hawaii 96720 • (808) 969 1765 • GUAM: P.O. Box 23305 • G.M.F., Guam 96921 • (671) 472 3117

Contents

Illustrations

Table

INTRODUCTION

At the request of Group 70 International, Inc., for their client, Zion Securities Corporation, Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological and historical assessment study of the Laie Wastewater Reclamation Facility parcel, situated in the Land of Laie, Koolauloa District, Island of Oahu. The primary purpose of the project was to produce a document (a) for inclusion in an Environmental Impact Statement and (b) for submittal with other land use approval applications. The overall objective of the study was to provide information sufficient for satisfaction of all current historic preservation regulatory review requirements of the Department of Land and Natural Resources-State Historic Preservation Division (DLNR-SHPD) and the City and County of Honolulu (CCHONO).

SCOPE OF WORK

The following specific tasks were determined to constitute an adequate and appropriate scope of work for the assessment study:

1. Review archaeological and historical literature relevant to the project area, and conduct historical documentary research (emphasis on readily available literature and documentary sources) and interviews with local informants; and
2. Analyze field and historical research data, and prepare appropriate reports.

The tasks were formulated based on (a) a review of readily available background literature, (b) basic familiarity with the general vicinity of the project area, (c) extensive familiarity with the current requirements of review authorities, (d) the findings of a recent field inspection (Rosendahl 1992), and (e) discussions with Mr. Jeffrey Overton of Group 70 International, Inc. and Dr. Tom Dye of DLNR-SHPD.

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

PROJECT AREA DESCRIPTION

The current project area is situated within the western portion of an overall c. 72-acre study area previously inspected by PHRI (Rosendahl 1992). Figure 1 shows the boundaries of the current project area, while Figure 2 shows the project area in greater detail. Elevation in the parcel ranges from 40-120 feet above mean sea level. Temperatures in the project area vicinity range from 65 to 85 degrees F., and average annual rainfall is c. 45-50 inches (Armstrong

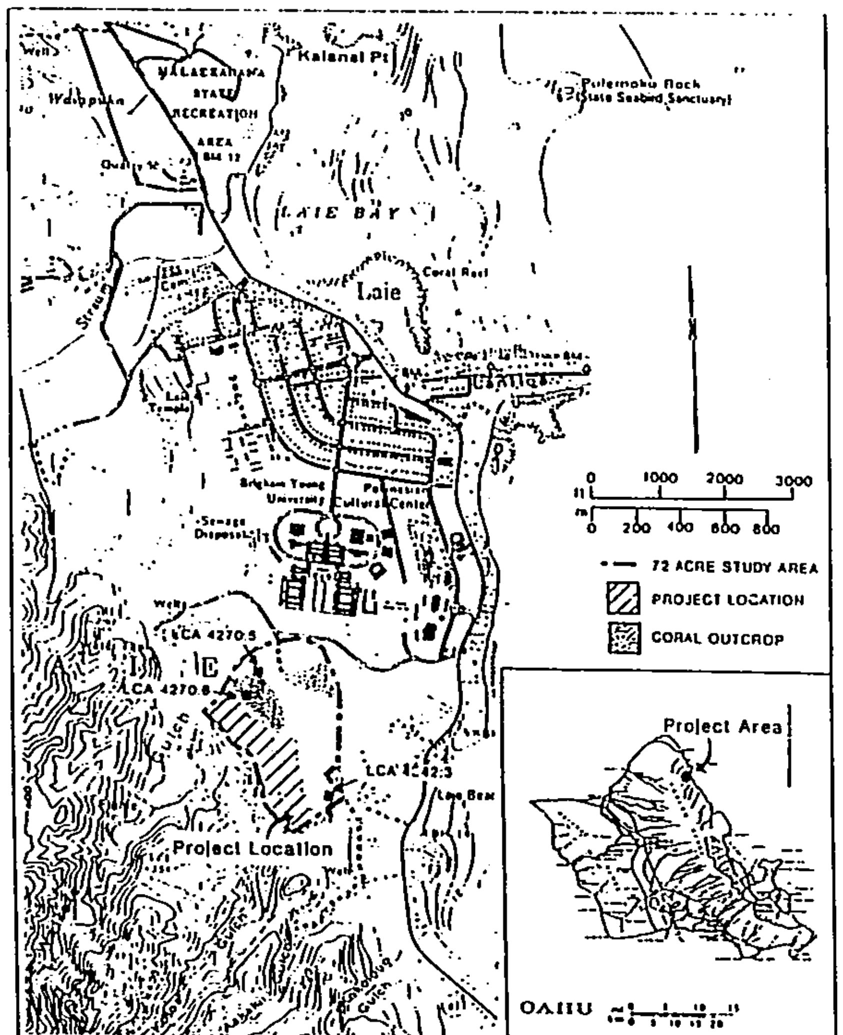


Figure 1. Project Area and LCA Locations

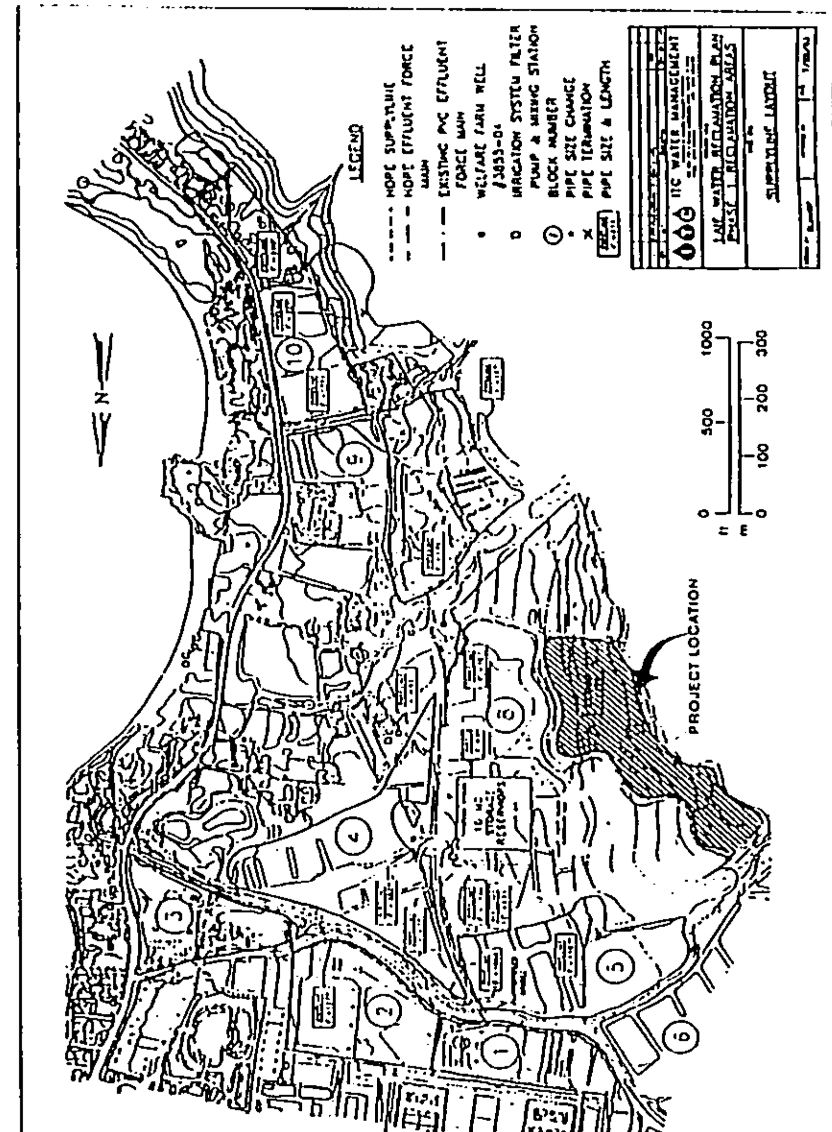


Figure 2. Project Area, Detail

1983:63-65). Soils in the project area are dominated by silty clays from the Lahaina series, ranging from 7-15% slopes (Foote et al. 1972).

Vegetation in the general vicinity of the project area includes banana (*Musa* sp.), papaya (*Carica papaya* L.), and coconut palms (*Cocos nucifera L.*). All of the project area was, at one time, cleared of natural vegetation and planted in sugar cane (*Saccharum officinarum*); this was confirmed by a 1951 aerial photograph showing the project area (provided to Dr. Tom Dye by Jeffrey Overton of Group 70 International, Inc.).

PREVIOUS ARCHAEOLOGICAL WORK

With the exception of the 1992 field inspection of the 72-acre study parcel (Rosendahl 1992), discussed below, no other archaeological work has been conducted within the project area. Archaeological investigations in the immediate vicinity of the project area include reconnaissance surveys, subsurface testing, and data recovery work (Table 1). A full summary of these investigations is provided in PHRI Report 878-012292 (Dunn and Rosendahl 1992), which has been previously submitted to Group 70 International, Inc.

Table 1. Summary of Previous Archaeological Work

Date*	Investigator/Reference	Project Type	Project Area
1930	McAllister (1933)	General survey	Laie
1980	Yent and Estioko-Griffin (1980)	Survey, testing and excavations	Malaekahana State Recreation Area
1979	Clark (1979)	Recon. survey	Laie Beach Park
1980	Connolly (1980)	Subsurface testing	Laie Beach Park
1982	Yent and Ota (1982)	Excavations	Malaekahana State Recreation Area
1981	Ahlo and Hommon (1981)	Recon. survey	Flood Control Study Kahawainui Stream
1984	Neller (1984)	Recon./field inspection	Flood Control Study Kahawainui Stream
n.d.	Berge†	Excavation	Laie Plantation Sugar Mill
1985	Bath (1985)	Testing and mapping	Kahawainui Stream
1989	Jensen (1989)	Inventory survey	Koolauloa District
1989	Hammatt (1989)	Recon. survey	(TMK:5-5-01:51)
1991	Hammatt (1991)	Inventory survey	Laie Sewer Plant
1992	Dunn and Rosendahl (1992)	Inventory survey	Laie Master Plan Site

* = Date of Field Work
† Berge = personal communication

A review of the previous archaeological work indicates that the Laie area may have been occupied as early as AD 1000. This date was obtained during the 1988-1989 PHRI survey at Punamano and Malaekahana (Jensen 1989), from a cave site (4089) located c. 4,000 ft inland of the coast in Malaekahana. Additional samples obtained by Bath in 1985, by Yent and Estioko-Griffin in the late 1970s (1980), and by Dunn and Rosendahl in 1992 yielded calendric ranges between AD 1260 and 1955 for coastal Malaekahana and Laie.

Subsistence in the area apparently included exploitation of marine resources and dryland agriculture. Agricultural sites indicate extensive and intensive use of the land for agriculture throughout prehistoric and historic times. Prehistoric and early historic agriculture focused on dryland and irrigated taro, while historic agriculture included coffee, tobacco and sugar cane.

SUMMARY OF HISTORICAL DOCUMENTARY RESEARCH

As part of the PHRI 1992 survey of the Laie Master Plan project area, Historian Lehua Kalima, B.A., conducted historical documentary research on the *ahupua'a* of Laie (IN Dunn and Rosendahl 1992). Although the current parcel does not lie within the Laie Master Plan survey area, Kalima's findings provide relevant information concerning past land use within the coastal and floodplain areas of Laie. This information is briefly summarized below.

Due to the frequent rains and numerous streams in the area, native cultivation within Laie Ahupua'a consisted mainly of irrigated taro. Handy and Handy (1972) mention the various streams and the many terraces along the streams, and they note the different types of land within the *ahupua'a*. McAllister lists a number of previously discovered archaeological and historical sites within Laie Ahupua'a, including a house site, fishing shrines, ponds and pools, *heiau*, taro lands, and a *puuhonua* (McAllister 1933).

Missionary journals include a few observations relating to the native population in Laie between 1780 and 1850. One such journal is by Chamberlain (1956) in which two schools in Laie and Malaekahana are mentioned. At the time, the "head man" of Laie was Peka. An earlier diary note adds that Laie school had 60 pupils, from both "Laiewai" and "Laimoro".

Mormon missionaries settled in Laie in the mid 1800s and recorded that Laie was a small village reputed to be a city of refuge until King Kamehameha II rescinded the sanctuary. The population in 1831 was 452, but decreased by 210 between 1831 and 1835 (Bath 1985).

After Kamehameha established control of Oahu, he gave Laiemalo'o and Laiekawai (which make up Laie Ahupua'a) to his half-brother Kalaimamahu. From Kalaimamahu, control passed to his daughter, Kekauluohi, and finally to his grandson, Lunalilo. It remained under Lunalilo's control until the Great Mahele of 1848.

When the Great Mahele took place, numerous *kuleana* awards were granted within Laie Ahupua'a. Kalima lists testimonies for awards within the Master Plan project area (Appendix B, Dunn and Rosendahl 1992). The testimonies indicate most of the awardees cultivated taro, along with small crops of tobacco and sweet potato.

Two L.C.A. claims involving three parcels are in the immediate vicinity of the current parcel, within the boundaries of the overall Laie Waste-Reclamation Facility project area (Rosendahl

1992) (Figure 1). The following information on these awards was provided by PHRI Cultural Resources Specialist Kepa Maly*:

LCA 4270 - Keao
Native Register Vol. 4:235

I ka po'e Ho'onā kuleana. Aloha 'oukou, ke ha'i aku nei au i kuleana; 5 lo'i kalo, aia i Puapua nei; 1 lo'i aia i Kawai'eli; 1 ho'okāhi moku weuweu aia i Kapaka; 1 moku weuweu aia i ka'ili o Kauakāhi; 3 moku weuweu aia i Pōhakumo'o; 1 moku mo'o aia j'ka Haumalo'o, 1 moku weuweu aia mauka i ka Haumalo'o, 5 koa aia ma ka Haumalo'o, aia ma Hukukae. Mai nā mākua a me nā kūpuna.

Lā'ie Ianuali 5, 1848

Na Keao X hailona

To the people who quiet land titles. Greetings to you, I now tell you of my land claim: 5 taro pond fields are at Puapua; 1 pond is at Kawai'eli; 1 grass parcel [pasture] is at Kapaka; 1 pasture is in the land parcel of Kauakāhi; 3 pastures are at Pōhalumo'o; 1 dry land cultivated parcel [moku mo'o] is at Kahaumalo'o; 1 pasture is at upland Kahaumalo'o; there are also 5 koa [trees] at Kahaumalo'o at Hukukae [? spelling]. Land is from the parents and grandparents.

Lā'ie, January 5, 1848

By Keao X his mark

LCA 4270 - Keao
Foreign Testimony, Vol. 11:308

Ma'i'i sworn: Says he knows the 6 kalo [taro] patches of claimant in Lā'ie. They are bounded on Hau'ula side by Konohiki [chief's land agent]; mauka by Koi's land; Waialua side by Kahua'ilua's land; makai by Kalua's land.

Claimant has also 4 pieces of kula [dry land agricultural parcels] land, planted. The first piece is bounded mauka by Kahili's land, on the other sides by the Konohiki; planted with tobacco. The second piece is bounded on all sides by the Konohiki; planted with tobacco. The third piece is planted with wauke [for kapa making]; bounded on all sides by the Konohiki. The fourth piece is planted with coffee trees; bounded on all sides by the Konohiki.

* *On Figure 1, two parcels of LCA 4270 are shown (Parcels 5 and 6). However, it is not clear in the LCA testimonies how the parcels were used.*

Claimant has a house site distinct from his land, not enclosed. He derived the land from his ancestors and has held it 4 years. The agent of the Konohiki had no other objection to this claim than to No. 3696, page 281. The objection from LCA No. 3696 states:

John Harbottle, agent for C. Kana'ina objected to this claim and to all others on Lā'ie on the ground of an arrangement said to have been made between Kana'ina and the maka'āinanas in regards to their lands (LCA 3696, Foreign Testimony Vol. 11:281).

LCA 4342 - Kapuaokahala
Jan. 10, 1848 Native Register, Vol. 4:285

E nā Luna Ho'onā Kuleana 'Āina e, Aloha 'oukou me ka mahalo 'ia. Owau nei o Kapuaokahala, ke ha'i aku nei au i ko'u kuleana 'āina ma Malaekahana, he 'āina kula, he 'umi māla ma Pāmoa, ho'okāhi kula ma kauhiloa, 'elima māla ma Makanikeo lo'i, he kula 'āina ma Umauma'alaea, ho'okāhi māla ma Kūkuluamalolo, aia mauka he mau māla 'awa 'elua. Aia ma Lā'ie ia wahi o'u, 'ehā lo'i. He kau li'ili'i ka waiho ana o kēia mau lo'i o'u. E pili ana kekāhi 'ao'ao me ko Keli'iwaiwai'ole, 'oia lo'i e pili ana kāhi lo'i me ko Pūlehu, e pili ana kāhi lo'i me ko Māhoe, e pili ana kāhi lo'i me Kokalimakāhi no. Mai o Kamehameha II mai ko'u noho kuleana ana mai

Na Kapuaokahala

O Land Commissioners who Quiet Title Land Claims, Respectful greetings to you. I am Kapuaokahala and I tell you of my land claim at Malaekahana, it is a kula [dry land] parcel. There are ten māla [garden plots] at Pāmoa; there is one kula at Kauhiloa; there are five garden plots at Makanikeo's lo'i; there is a kula land at Umauma'alaea; there is one māla at Kūkuluamalolo; and in the uplands are two 'awa patches. There at Lā'ie my place consists of four lo'i [pond fields]. There locations of my lo'i are scattered. One is along side Keli'iwaiwai'ole's; a lo'i is along the lo'i of Pūlehu, a lo'i is along side Māboe's, and another is along side Kokalimakāhi's. My right to dwelling has come from Kamehameha II.

By Kapuaokahala

LCA 4342 - Kapuaokahala
(Deceased) Foreign Testimony, Vol. 11:295

Kalimakuhi sworn says he knows the land of claimant in Lā'ie. It consisted of 4 kalo patches which did not belong to Clt. He got leave from other people to plant on their patches, and when he died the patches reverted to them.

Witness knows the land of claimant in Malaekahana. It consists of 4 separate pieces of kula land The first piece is planted in wauke etc., and

surrounded by the Konohiki's land. The second, third, and fourth pieces are surrounded by the Konohiki's land, and planted with potatoes, noni, bananas, wauke, etc. Claimant's house lot is not enclosed. He derived this land from his ancestors. He died in 1848, leaving his land to Kaumanu. He was the Konohiki's agent on Malaekahana.

In 1861 the entire lands of Laiewai and Laimaloo, excluding the private *kuleana*, were sold to Henry H. Howland by the guardians of Lunalilo's estate. In 1863 Howland sold 298.5 acres in Laiewai to Robert Moffitt of Kahuku. Five months later Moffitt sold that property to Charles Hopkins of Honolulu. At that time the Malaekahana and Kahuku ranches probably extended to Laie (Bath 1985).

Ten Mormon missionaries of the Church of Jesus Christ of Latter Day Saints settled in Laie in 1850. By 1865 the Church had bought 6,000 acres in the area for agricultural use (Ahlo and Hommon 1981). Initially, a variety of small crops were cultivated there, but by the end of the 19th century the predominant crops were sugar cane and pineapple. Sugar cane produced by Laie Plantation and later by Kahuku Plantation was the main crop in the area until the plantation closed in 1970. Land in the area is currently used mostly for pasture and truck farming. The population of Laie is still predominantly Mormon. The BYU-Hawaii campus, along with the Mormon temple and the Polynesian Cultural Center, provide activities and jobs for the Mormon students and attract many visitors to the area.

SETTLEMENT PATTERNS

Based on the distribution of sites noted in previous reports, the prehistoric population of Laie settled in coastal areas in order to exploit the marine environment and the fertile floodplains. Where historic period development has not occurred, expected site distribution patterns include temporary and permanent habitation sites along the coast, with agricultural sites located within floodplains and along terraces in gulches. Ceremonial sites would generally be found on the coast, in association with permanent habitation sites or, in the case of burials, be located in the dune areas.

As noted in the summary of historic documentary research above, much of Laie has been modified by historic and recent activities. Land along the coast has been used for residential development. Alluvial floodplains and lower foothills have been cleared for historic agriculture, ranching, and housing developments. These modifications have destroyed much of the evidence necessary for a comprehensive understanding of prehistoric settlement patterns in Laie.

Given the location of the current parcel, near the coast and along the floodplain of Wailele Gulch, the project area was probably utilized for agriculture, and possibly for temporary habitation. Because historic period and recent use of the parcel has focused on sugar cane cultivation, however, it is unlikely that any evidence of previous land use survives intact on, or within a meter of, the present ground surface.

FINDINGS OF THE 1992 FIELD INSPECTION

As documented in Rosendahl (1992), field inspection of the current project area and vicinity was conducted on September 18, 1992 by Projects Supervisors Amy E. Dunn and Bee

Burgett, B.A. The field work took approximately 12.0 man-hours to complete. The primary objectives of the inspection were (a) to determine the general nature and extent of archaeological remains in the project area, (b) to determine the implications of any such remains with regard to the feasibility of development, and (c) to estimate the general scope and cost of any subsequent archaeological work that might be appropriate and/or required for future development.

During the field work, the current project area was inspected by automobile and on foot. No structural remains or surface cultural deposits were observed. Three open backhoe trenches, excavated by Zion Securities Corporation along the west boundary of the 72-acre parcel were inspected for cultural deposits, but none was identified. Sugar cane disturbance was noted to extend at least 50-70 cm below the surface in these trenches. It is highly likely the stratigraphy in the current parcel is the same as in the trenches.

Two unmodified areas near the current project area, identified as coral outcrops on Figure 1, were inspected using pedestrian transects. Surface structural features were identified on top of and around the perimeters of the coral outcrops. The features included low walls, terraces, overhang shelters, paved areas, and modified outcrops with cleared planting areas. General site descriptions and locational information were noted in field notebooks, but no detailed recording or mapping took place. The features appeared to be for temporary habitation and agriculture.

CONCLUSION

As expected from the findings of the review of previous archaeological work and historical documentary research, no surface indicators of prehistoric or early historic period land use were encountered in the current parcel. Examination of the open trenches along the western boundary of the overall 72-acre parcel indicated extensive subsurface modification from sugar cane cultivation, and provided no evidence of intact cultural deposits below the surface. It is highly likely the stratigraphy in the current parcel is the same as in the trenches. In view of the negative results of the field inspection, it is concluded that no further archaeological work of any kind is necessary in the current project area.

Given the identification of sites on top of and around the perimeters of the coral outcrops near the current parcel, however, it is recommended that a buffer zone of five meters be established between the edge of the coral outcrops and any construction zone. Should plans for future development include the area of the coral outcrops, it is recommended that an inventory-level survey be conducted before any development takes place.

The significance evaluations and recommended treatments presented here are based on the findings of the literature review and field inspection, and involved no subsurface testing. Therefore, these evaluations and recommendations are given with the general qualification that during any development activity involving the extensive modification of the land surface, there is always the possibility, however remote, that previously unknown subsurface cultural remains might be encountered. In such a situation, archaeological consultation should be sought immediately.

REFERENCES CITED

ACHP (Advisory Council on Historic Preservation)
1985 Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review. Advisory Council on Historic Preservation, Washington D.C. (Draft report, August)

Ahlo, H.M., and R.J. Hommon
1981 An Archaeological Reconnaissance Survey of the Flood Control Study Area, Kahawainui Stream, Laie, Oahu, Hawaii. Scientific Management, Inc. Prepared for the U.S. Army Engineer Division, Pacific Ocean, Fort Shafter, Hawaii.

Armstrong, R.W. (ed.)
1983 *Atlas of Hawaii*. Honolulu: University of Hawaii Press. (Second Edition)

Bath, J.E.
1985 Archaeological Testing and Mapping at Kahawainui Stream in Laie, Oahu, Hawaii. J. Stephen Athens, Arch. Consultant, Honolulu. Prepared for U.S. Army Engineer Division, Pacific Ocean, Corps of Engineers.

Board of Commissioners
1929 Indices of Awards made by the Board of Commissioners to Quiet Land Titles in the Hawaiian Islands. Star Bulletin Press, Honolulu.

CFR (Code of Federal Regulations)
36 CFR Part 60: National Register of Historic Places. Dept. Interior, National Park Service. State Historic Preservation Division, Department of Land and Natural Resources. Washington D.C.

Chamberlain, L.
1956 Tour Around Oahu, 1828. Annual Report of the Hawaiian Historical Society for the Year 1956.

Clark, S.
1979 Scope of Work for Archaeological Investigations at La'ie Beach Park. Prepared for City and County of Honolulu, Department of Parks and Recreation.

Connolly, R.D., III
1980 Intensive Sub-Surface Archaeological Reconnaissance Survey of the Laie Beach Park Site (TMK:5-5-01:3,4,5,6,48,49), Laie, Island of Oahu. Archaeological Research Associates, Honolulu. Prepared for City and County of Honolulu, Department of Parks and Recreation.

Dunn, A.E., and P.H. Rosendahl
1992 Archaeological Inventory Survey, Laie Master Plan Project, Lands of Malaekahana and Laie, Koolauloa District, Island of Oahu. PHRI Report 878-012292. Prepared for Group 70 International, Inc.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens
1972 Soil Survey of the Islands Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. U.S. Dept. Agriculture - Soil Conservation Service and University of Hawaii Agriculture Experiment Station. Government Printing Office, Washington, D.C.

Fornander, A.
1918-19 Hawaiian Antiquities and Folk-Lore. *B.P. Bishop Museum Memoirs*, Vol 5 B.P. Bishop Museum Press, Honolulu.

Hammatt, H.H.
1989 Archaeological Reconnaissance of a 2.8-Acre Parcel at Laie, Oahu, TMK:5-5-01:51, Site 80-02-4049. Cultural Surveys Hawaii. Prepared for Stone & Stone.

1991 Archaeological Survey of the La'ie Sewer Plant with Historical Background on La'ie Ahupua'a. Cultural Surveys Hawaii. Prepared for Mr. James Pedersen.

Handy, E.S.C., and E.G. Handy
1972 Native Planters in Old Hawaii: Their Life, Lore and Environment. *B.P. Bishop Museum Bulletin* 223. B.P. Bishop Museum Press, Honolulu. (With M.K. Pukui)

Jensen, P.M.
1989 Archaeological Inventory Survey, Punamano and Malaekahana Golf Courses Lands of Ulupehupehu, Punalau, Kahuku, Malaekahana, and Laie, Koolauloa District, Island of Oahu. PHRI Report 489-040489. Prepared for Kuilima Resort Company.

McAllister, J.G.
1933 Archaeology of Oahu. *B.P. Bishop Museum Bulletin No. 104*. B.P. Bishop Museum Press, Honolulu.

Neller, E.
1984 Comments on the Kahawainui Stream Flood Control Study's Archaeological Reconnaissance Survey, Including the Results of an Archaeological Reconnaissance Survey Along Laiewai Stream, Laie, Oahu (TMK: 5-5-05:9). Prepared for Dept. Land and Natural Resources - State Historic Preservation Office.

Rosendahl, P.H.
1992 Archaeological Field Inspection, Laie Wastewater Reclamation Facility (LWRF), Land of Laie, Koolauloa District, Island of Oahu. PHRI Letter Report 1314-092892. Prepared for Group 70 International, Inc.

Sterling, E.P., and C.C. Summers
1978 *Sites of Oahu*. Dept. Anthro., B.P. Bishop Museum.

Yent, M., and A. Estioko-Griffin
1980 Archaeological Investigations at Malaekahana (50-80-02-2801), Windward Oahu. Dept. Land and Natural Resources, State of Hawaii. Prepared for Division of State Parks, Outdoor Recreation, and Historic Sites.

Yent, M., and J. Ota
1982 Results of Auger Coring Conducted at Malaekahana State Recreation Area, Phase II, Koolauloa, Oahu. TMK:5-6-01:24,45-47,49, 51,53,55-65.

Archaeological Survey of the Laie Sewer Plant with Historical Background on Laie Ahupua'a

Archaeological Survey of the Lā'ie Sewer Plant with Historical Background on Lā'ie Ahupua'a

by

Hallett H. Hammatt, Ph.D.

Prepared for

Mr. James Pedersen

Prepared by

Cultural Surveys Hawaii
September 1991

Abstract

An archaeological survey was conducted of a 6-acre parcel surrounding the existing Lā'ie Sewer Plant. This parcel is proposed for expansion of the existing facilities No archaeological or historical sites were found and no sites have been previously recorded in this area. In conjunction with this survey an archaeological/historical review was conducted to locate and describe archaeologically sensitive areas within the *ahupua'a* of Lā'ie. These areas include: 1) former *lo'i* at Kaho'oleināpea Stream, 2) *lo'i* along Kōloa Stream, 3) Wailele Stream *lo'i*, 4) *lo'i* on the flatlands around the Mormon temple, 5) Kahawainui Stream *lo'i* , 6) Paeo fishpond, 7) Waikuukuu (a limestone crevice), 8) Moohehiki *Heiau*, 9) Nioi *Heiau* , and 10) the Ko'olau Railroad Line. Most of the surface features of these site areas have been destroyed by development except for areas *mauka* of the floodplains (upper Wailele, Kahawainui and Kōloa Stream valleys). However, terrace remnants survive in the Kahawainui floodplain (from rice cultivation?)and some developed areas may have intact buried sediments which are significant for chronology and human paleoecology.

Acknowledgements

The author would like to thank Mr. James Pedersen, Land Use Consultant, for his coordination and for providing maps and photographs of the project area. Mr. Don Kleinman of Zion Securities accompanied the Cultural Surveys Hawaii survey team in the field for the survey of the sewer plant. Typing and report design was performed by Dr. Vicki Creed of Windword Processing and drafting by Mr. Rodney Chiogioji.

Table of Contents

List of Figures

I. Introduction, Scope of Work

This project included overview research o the history of Lā'ie to designate existing and former site areas. Fieldwork was limited to a 6-acre parcel surrounding the present Lā'ie Sewer Plant which is proposed for plant expansion (Figs 1 through 3).

1. Literature search of relevant documents related to past land use, history and previous archaeological studies in Lā'ie.
2. Archaeological inventory survey of the 6-acre parcel adjacent to the existing sewer plant and including the existing sewer plant.
3. Preparation of a report detailing all findings to be included as part of an Environmental Assessment Study.
4. Coordinate our Scope and Findings with the State Historic Preservation Division as appropriate.

The background search is intended to be a general overview of Lā'ie *ahupua'a*. Historic maps and Land Commission Award documents, as well as commonly available references were consulted.

This overview is not exhaustive and considerably more information is available which was not consulted or only briefly examined. For example, although study of Land Commission Award testimonies could result in reconstruction of many traditional *'ili* names and Hawaiian subsistence. One major source - Mormon church records - could prove to be a wealth of information on the transformation of an isolated Hawaiian settlement into a thriving modern community.

Although much of modern Lā'ie shows no surviving surface remnants of

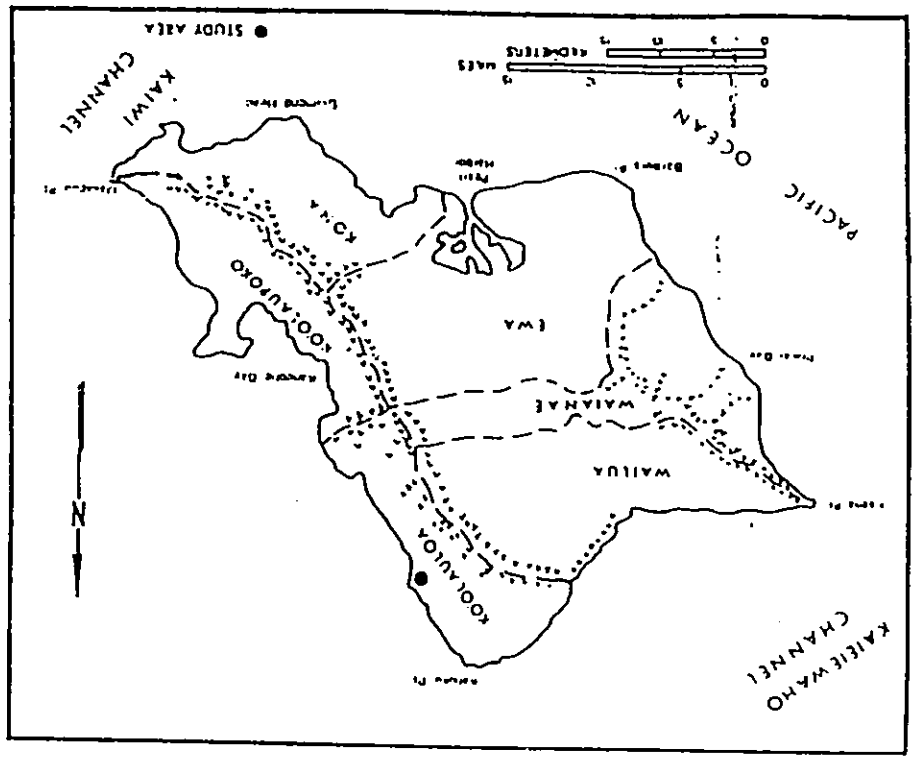


Fig 1 State of Hawaii

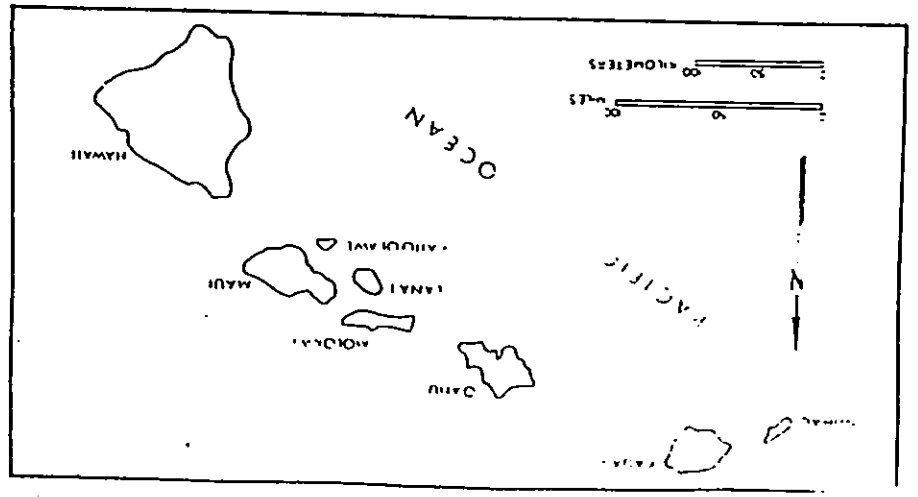
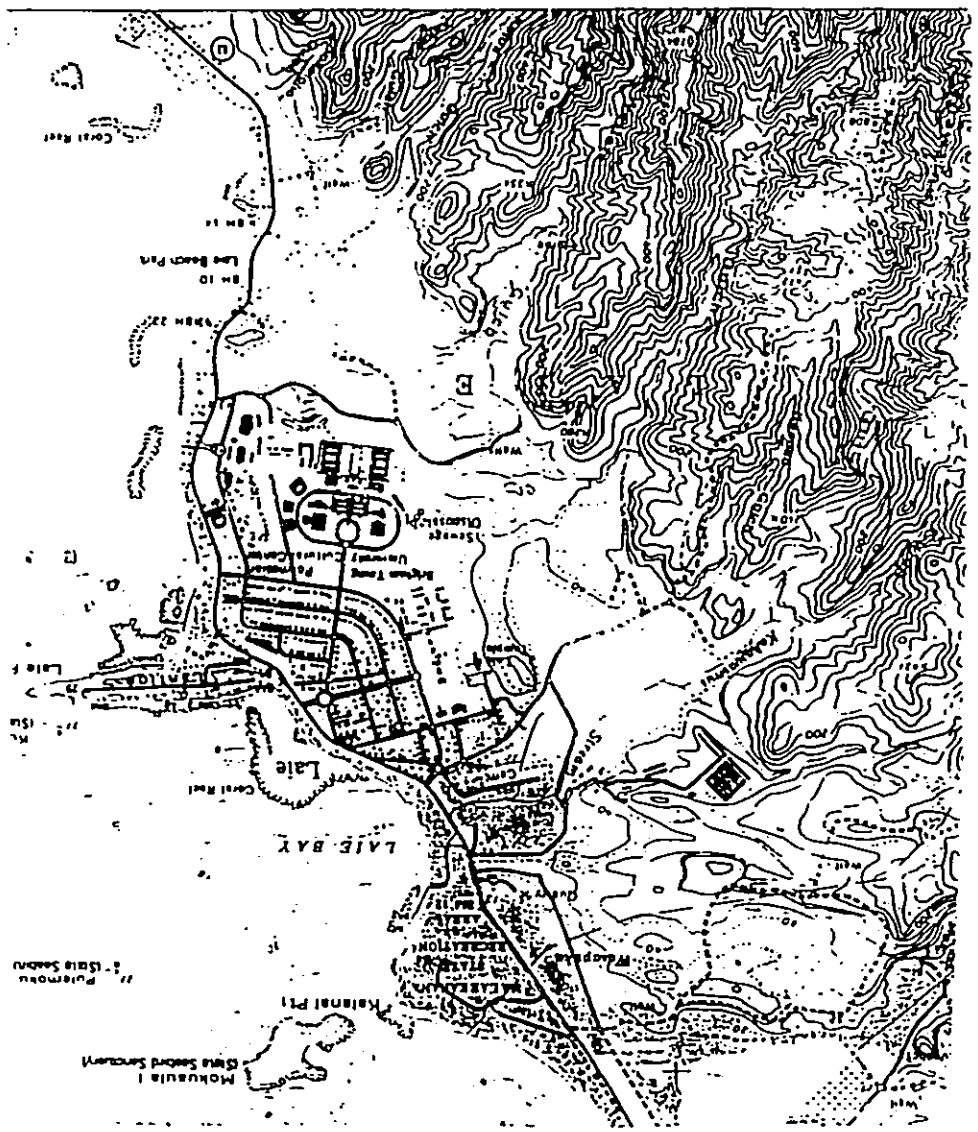


Figure 3 Project Location, 1983 USGS Kahuku Quad Map



prehistoric or early historic periods, considerable significant buried evidence of former land use may survive in selected areas.

The texts consulted are listed in the References Cited section of this report. Maps consulted include the Jackson (Alexander) map of 1884 (Fig. 4), the 1922 USGS Map (Fig 5), a map of Lā'ie Town by Al Ivins dated 1927 (Fig. 6), the 1929 USGS map of Lā'ie (Fig. 7), and a recent master plan map of Lā'ie (Fig. 8).

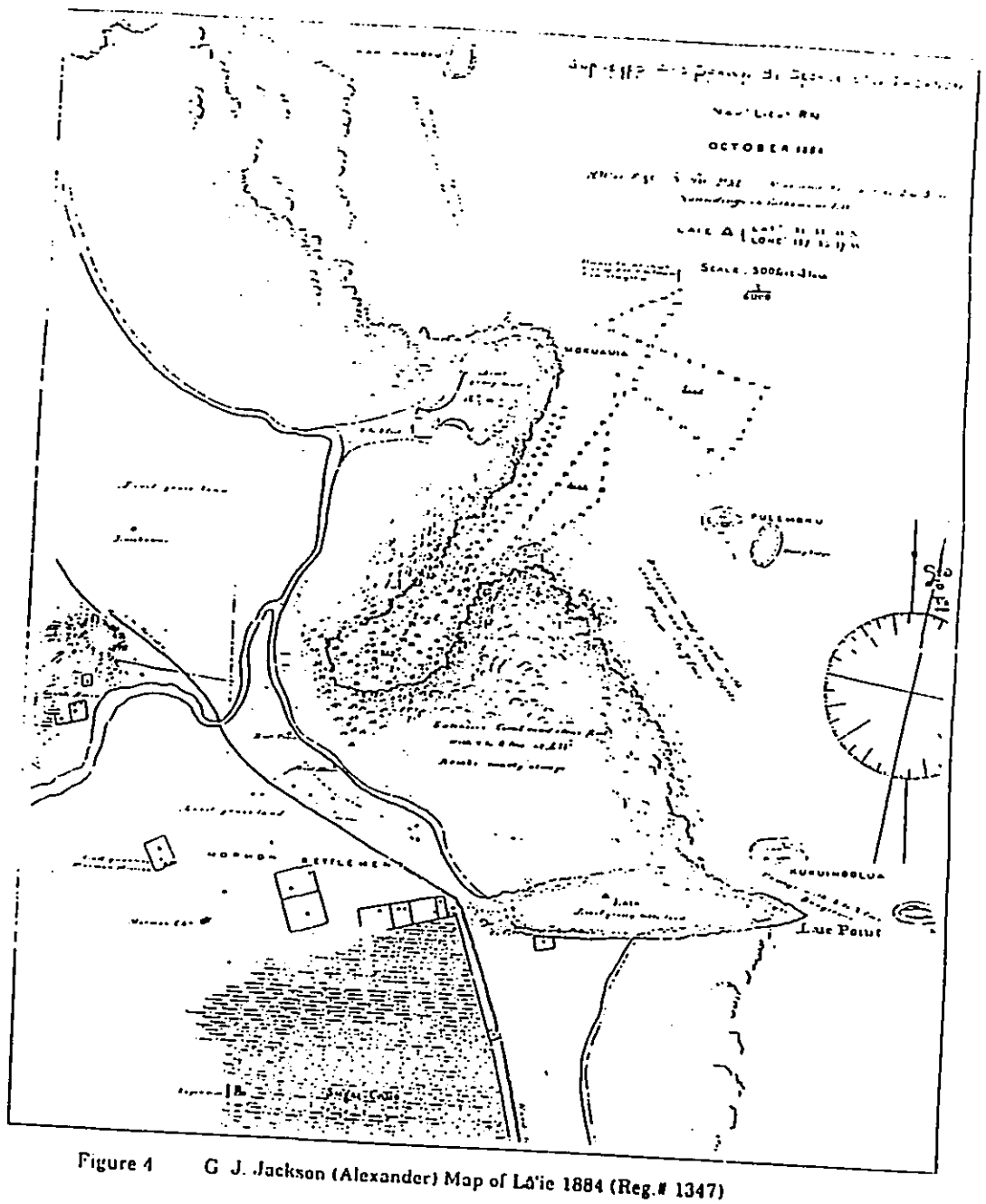


Figure 4 G. J. Jackson (Alexander) Map of Lā'ie 1884 (Reg.# 1347)

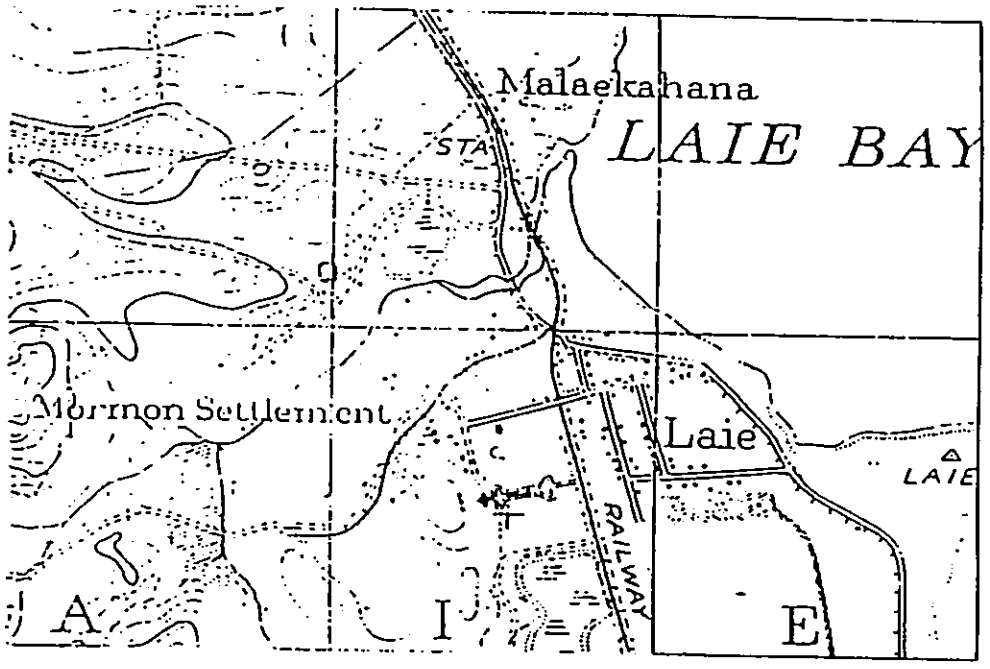


Figure 5 U.S.G.S. Map of La'ie, 1922

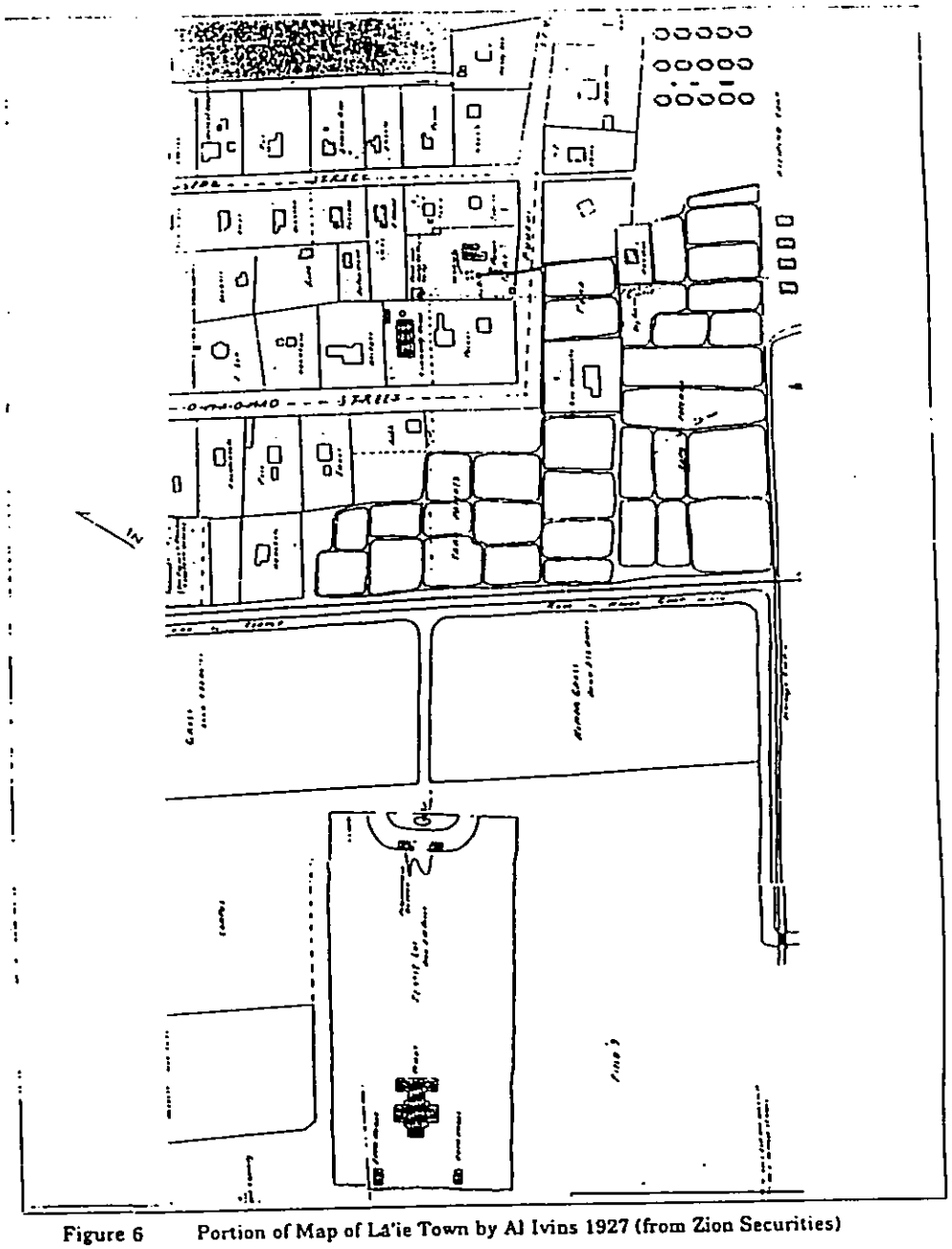


Figure 6 Portion of Map of La'ie Town by Al Ivins 1927 (from Zion Securities)

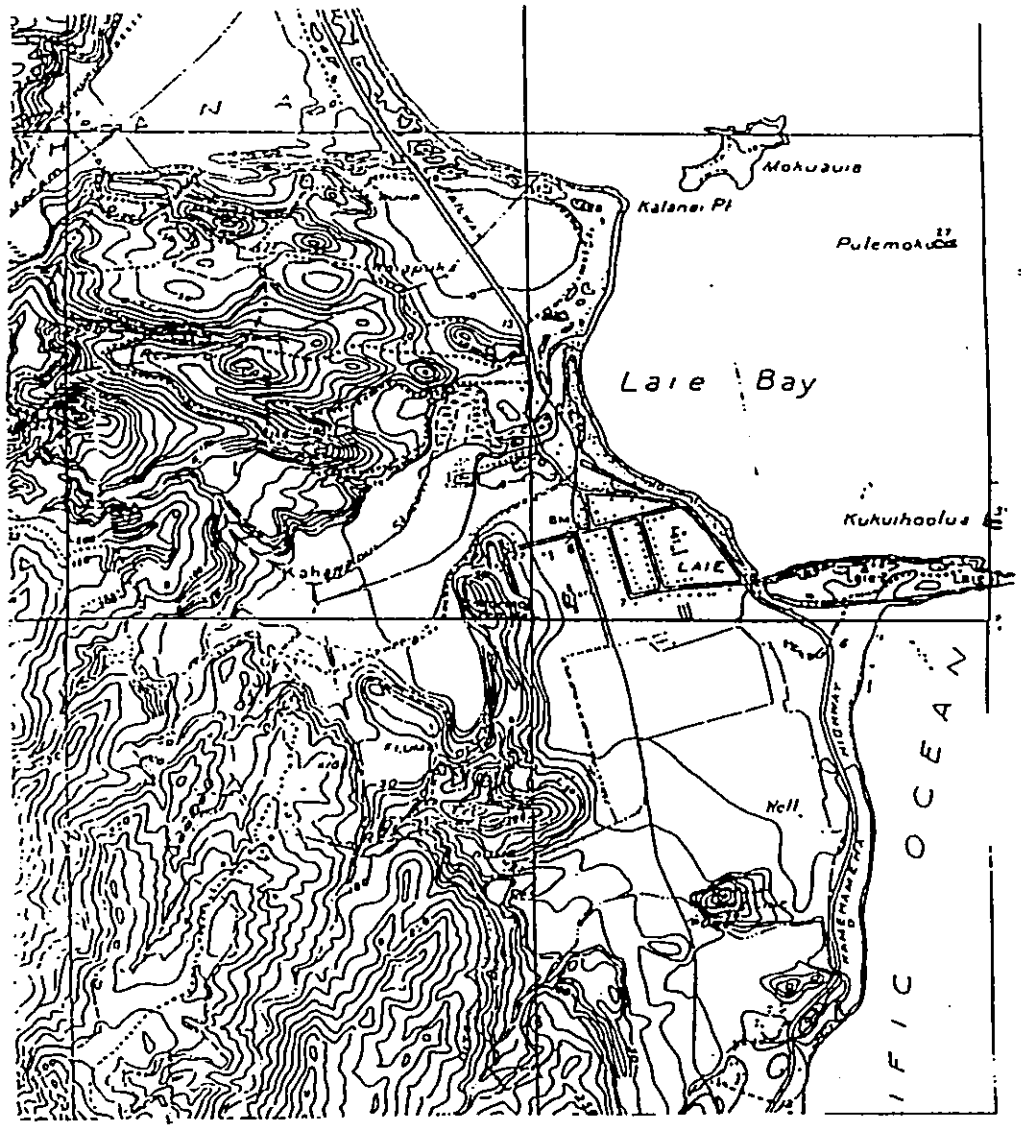


Figure 7 USGS Map of La'ie 1929

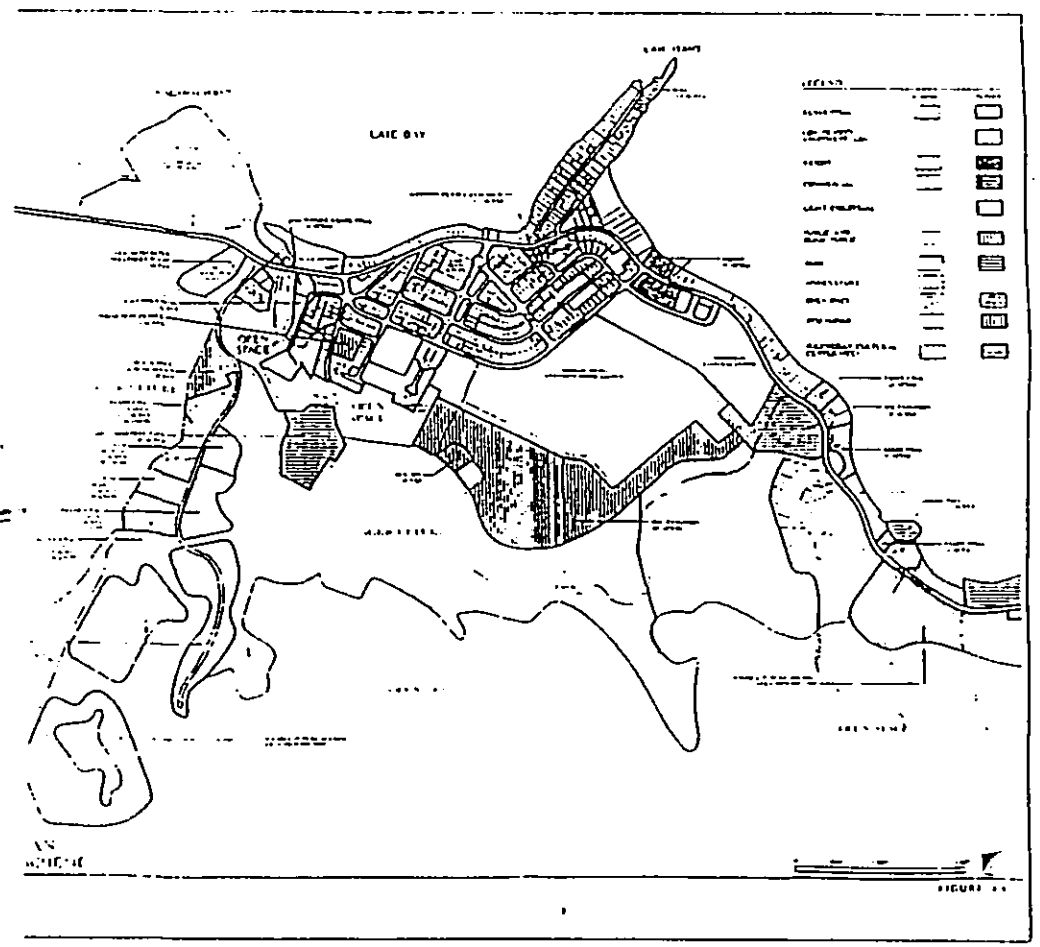


Figure 8 Recent Master Plan Map of La'ie

II. Archaeological and Historical Background

A. Introduction

The *ahupua'a* of Lā'ie has seen little in the way of systematic archaeological investigation. The modern community is a stable one and there has been comparatively little development there to trigger extensive archaeological work.

Early archaeological observations were made by J. Gilbert McAllister (1933) who recorded sites and accounts of Hawaiian activity. These and other early sources are listed in Sterling and Summers (1978).

In 1981 Hamilton Ahlo and Robert Hommon prepared a brief reconnaissance study of the Kahawainui Stream floodplain area for a proposed Army Corps of Engineers Flood Control project (Ahlo and Hommon, 1981). Their study also included the floodplain itself along a one-mile stretch of the stream inland from the outlet into Lā'ie Bay.

No prehistoric sites were noted but historic-era sites were observed including: two cemeteries, a Shinto shrine, and a scatter of historic occupation debris.

Earl Neller took issue with what he considered somewhat cavalier significance evaluations on the part of Ahlo and Hommon in two separate studies (Neller, 1984; Neller, N.D.). Despite the advocacy nature of his writing, he makes valuable comments on the following issues:

1. The historic and cultural importance of the historic cemetery, the Shinto shrine, and the former Japanese temple.
2. The archaeological importance of historic dwellings which in this particular example is associated with a cemetery.

3. Tracing of the history of the elusive Paeo Fishpond and other sites on the early USGS maps.
4. Noting the surviving remnant of the sugar train bed on the *makai* side of Kamehameha Highway. Neller identifies this as the O'ahu Rail and Land Co. (OR&L) Line but it is actually the Ko'olau Railway Co. Line.

At the south end of the *ahupua'a* at Lā'ie Beach Park a subsurface testing project was conducted by R.D. Connolly in 1980 (Connolly, 1980). Auger testing and excavation of one-meter square test pits showed a buried cultural layer distributed over much of the sand deposit *makai* of Kamehameha Highway. No radiocarbon dates were obtained from the testing but the layer is almost certain to be prehistoric. More recent investigations of the limestone outcrop at the southern boundary of the beach park showed no cultural layer but a human burial was encountered in a limestone cave (Hammatt, 1987). A rock shelter at the south end of the same formation was tested by Aki Sinoto in 1980 but no C14 dates were obtained.

More extensive excavations were undertaken north of Lā'ie in adjacent Mālaekahana State Park by Martha Yent and Agnes Estioko-Griffin (1980). Quantitative dates showed prehistoric occupation postdating A.D. 1600. One can apply this age range to Lā'ie shoreline occupation only with great caution and it appears highly probable that Hawaiians inhabited both areas well before the period given the extensive fisheries and available agricultural lands.

In 1985 Joyce Bath conducted a subsurface testing investigation project within the floodplain of Kahawainui Stream (Bath, 1985). The specific study area was the historic house site and cemetery identified by Ahlo and Hommon (1980) and further explicated by Neller (1984). Both findings indicated that the fenced cemetery is possibly connected to the Chinese ethnic group and is post-contact.

However, the lot adjoining it to the north is indicated as having more graves, possibly having functioned as a long-term burial place. A prehistoric cultural layer was found in one nearby locality at the base of the limestone scarp and was dated by C14 to A.D 1415 to 1645. A later historic-era occupation is interpreted as being connected to Hawaiian inhabitants and is associated with the surrounding graves outside the fenced cemetery (Bath, 1985).

B. Documentary Sources for Past Land Use and History

The sources consulted for the present study are not all that is available for the *ahupua'a*, but they do represent most of what is shown in existing documents and what has been available to the author through various contacts. The documents which are used here to interpret Lā'ie land use patterns other than the archaeological sources listed above are as follows:

1. G.J. Jackson map of Lā'ie Bay (Reg. #1347), dated 1884.
2. USGS Map of O'ahu showing Lā'ie Bay, dated 1922.
3. Map of Lā'ie Town by A.I. Ivins, dated 1927 (from Zion Securities).
4. USGS map of Lā'ie, dated 1929.
5. Lā'ie Tax maps showing Land Commission Awards.
6. Land Commission Awards for Lā'ie (selective).
7. Modern plan map for Lā'ie (recent, but no date).
8. 1990 aerial photograph of Lā'ie, supplied by R.M. Towill.

C. Archaeological Sites with Their Present Condition

The known archaeological sites in the areas *mauka* of the immediate shoreline are listed below with observations on history and present condition as

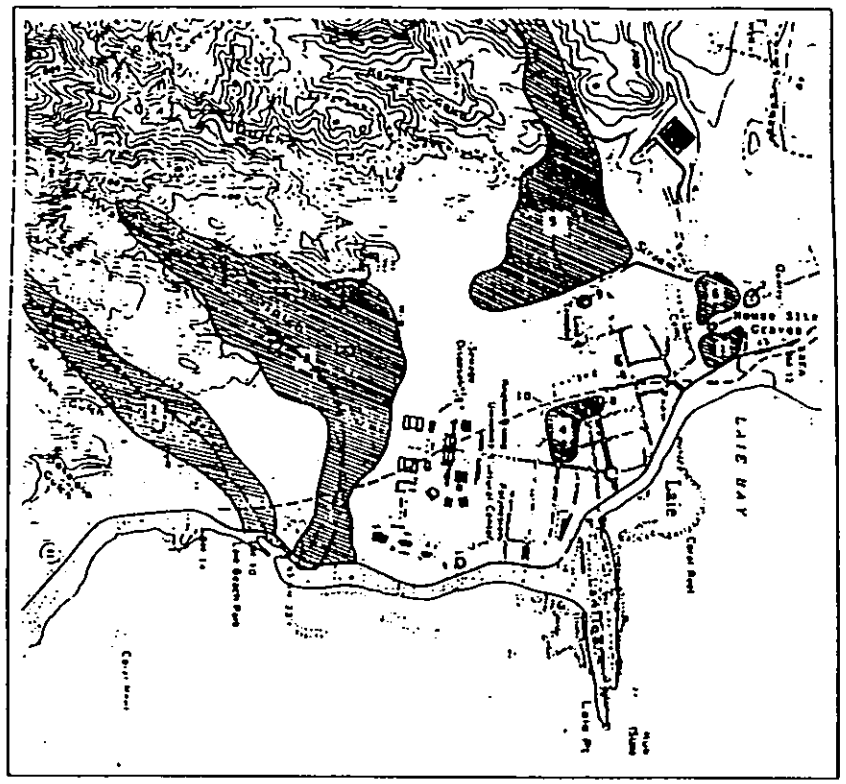
documented in the sources listed above (see Fig. 9):

1. Taro terraces at Kahooleināpea Stream adjacent to Mālaekahana. The area is called Wailele and is in the lower part of Kahawainui Stream (now cane land; from Handy, 1940:89-96). Kaho'oleināpea Stream is not shown on the USGS map but is assumed to be the short tributary entering Kahawainui stream from the north near its outlet to the ocean.

   This area is not shown on Jackson's 1884 map or on any more recent maps as wetland taro and there is no other known source that shows *lo'i* land here. The terraces were probably destroyed by cane cultivation and later land modification. There are two Land Commission Awards on the north side of Kahawainui Stream in this general location (LCA 2346 and LCA 3859). The testimony for these should be consulted to determine whether they were house lots or *lo'i*.

2. Taro terraces about 2 miles inland along Kōloa Stream at the south end of the *ahupua'a*. In one area there are 15 terraces, in another there are 11 terraces. There are associated dwelling sites and the area is covered with large mango trees (Handy, 1940:89-90).

   This terraced land in Kōloa Stream valley does not show on the early maps; however, its existence is well documented in Land Commission Awards which are distributed near the mouth of the stream (called Lā'iemaloo Stream on the tax map) and refer to *lo'i* as well as sweet potato plantings (for example Testimony for LCA 3939). Other testimonies mention *lo'i*, *wauke*, and sweet potato in upper Kōloa Gulch. The tax map for the upper part of the gulch does not show the mapped location of LCAs but lists 17 unlocated awards. These are assumed to be in Kōloa Gulch or possibly the next small valley to the north, Wailele Stream. What is the disposition of these agricultural sites? Jackson's map of 1884 shows cane fields *mauka* of the beach road in all *makai* areas of Kōloa Stream. It is probable that the *makai* lands of this complex were modified by cane planting.



LEGEND

1 - Taro Terraces of Kahooleinapea Stream
2 - Taro Terraces along Kolon Stream
3 - Wailele Stream Terraces and Potential Habitation Sites
4 - Taro Lands in Lowlands around the Hawaii Temple
5 - Taro Lands on Kahawainui Stream floodplain
6 - Paeo Fishpond
7 - Waikuukuu (narrow crevice with water at bottom)
8 - Moohehiki Heiau
9 - Nioi Heiau
10 - Koolau Railroad Line

Figure 9 Map of La'ie Showing 10 Site Areas Mentioned in Text (Map based on 1983 USGS 7.5 Minute Quad Map of Kahuku)

However, it is highly likely that terraces are extant in upper Kōloa Gulch. The 1990 aerial photograph shows no modern land modification. These terraces were extant in 1952 as related by H Whitten in the *Star Bulletin* (see Sterling and Summers, 1978 159)

3 Wailele Stream terraces. Terraces and habitation in this stream valley are mentioned by Handy (1940) and are said to extend 2.5 miles up the streambed.

Land Commission Awards plotted on the tax map show only 2 scattered awards in the *makai* section of the stream. A quick perusal of a selection of La'ie Testimonies show no reference to Wailele but the Testimony for LCA 4298 mentions a place, Kawailele, where there is a *lo'i*. This could be an alternative name for Wailele. Also some of the 17 unlocated awards in La'ie *mauka* could be in Wailele Stream Gulch. The 1990 aerial photo shows small rectangular active agricultural plots in the middle of Wailele Valley. Remnants of older terraces could be associated with these modern plots and terraces may well be extant farther up the valley.

4. Taro lands are present in the flat lowlands around the temple. Seven (7) separate areas are named by Handy (1940:89-90) as follows:

   a. Kapuna (the Spring) a 60-acre plot lying back of (west or southwest of?) the Mormon Temple (McAllister's Site 282).

   b. Seaward of Kapuna was Kaholi, another taro growing area, now abandoned (1940).

   c. Kuamoo was a large taro growing area *makai* of Kaholi which was still in taro in 1940.

   d. Naueluli was still seaward of Kuamoo.

   e. Makali'i was to the west of Naueluli.

   f. Poohaili was a mound surrounded by mango trees with cultivated terraces, 8 of which were still used. This area was the largest old

to the south of the cemetery which may mean that the eastern portion of this *lo'i* land may have been drained and planted in cane. However, the western and southern portions of this wetland survive today as ponds as shown on the 1990 aerial photo The central portion which is in pasture today shows clear vegetation lines marking the old terraces on the aerial photo. It appears that the traditional irrigated wetlands were confined mainly to the south side of the Kahawainui Stream. Only four Land Commission Awards are shown on the floodplain at the north side of the stream. Taro cultivation certainly traditionally extended far up the stream valley.

6. Paeo Fishpond (Site 277) is described by McAllister (1933) as having been a horseshoe-shaped pond at the mountain side of the bridge on the Kahuku side of La'ie. In 1933, it was reported as dry and overgrown with weeds. McAllister also mentioned the association of the legendary goddess Huawahine (Haowahine?) to this pond. She divided her time between this pond and Kawainui pond in Kailua. On the north side of the pond was said to be a chalice-shaped stone, 3 feet high, where Huawahine combed her long hair.

The pond is not shown on the 1884 Jackson map. On the 1922 USGS map is the clear outline of a circular marsh area (with enclosing walls?) by a north meander of Paeo Pond which had filled in by the early 1920s. The 1929 USGS map shows a slightly less defined but longer marsh area with a house at the southern end and the center of the meander as dry land. Clearly, the meander channel of the stream had been cut off early in the 20th century and the pond began the slow process of in-filling.

There is apparently no surface trace of the pond today (Ahlo and Hommon, 1981) and modern disturbance has been extensive in this area. However, as Neller (1984:17) and Bath (1985) both state, it is likely that buried sediments associated with this pond still exist and until the area is tested this potential cannot be

dismissed. Today, there is a small pond on the north side of Kahawainui Stream at the site of the former pond The relationship of this modern pond to the ancient one is unclear Bath (1984:6) is puzzled that the ancient parcel does not appear on Jackson's 1884 map and considered that it may have been covered by that time. The present author is of the opinion that the outline shown on the 1922 USGS map is convincing as the remnant of a pond and that the pond was extant in the late 19th century and Jackson simply did not show it.

7 Waikuukuu (Site 276) located on the Kahuku side of the old Paeo fishpond, is a narrow crevice with water at the bottom. The water level was affected by tides and the depths of the water in Waiapuka (McAllister, 1933).

This feature is thought to have been modified in modern times and may be presently used for sewage disposal (Ahlo and Hommon, 1981).

8. Moohehiki *heiau*, Site 283. McAllister describes this site as having been "in the taro patches on the sea side of the Mormon Temple. The slight elevation of the ground, the occasional sound of the drums, and the name are all the traces that remain according to the oldest Hawaiians of the District" (McAllister, 1933).

A quick inspection of some LCA Testimonies produced no reference to this name. The structure or place does not appear on any old maps and all traces of it appear to be lost-possibly destroyed by cane cultivation.

9. Nioi *heiau*, Site 281. McAllister describes this as being on a small limestone ridge on mountain side of the temple. In the early 1930s all that remained were "disturbed coral platforms." It was said to have been dismantled by the plantation and was originally built on the Kahuku side of a coral outcrop. The *heiau* was one for offering of human sacrifice. "On the Kahana side of the ridge are several rock shelters which were probably used as abodes of the *kahunas*" (McAllister, 1933).

This site does not appear on any of the early maps but the limestone ridge is still present behind the temple. Judging from the 1990 aerial photograph the area has been heavily modified. Since human sacrifice is mentioned, this *heiau*

terrace area and was inland and west of Kapuna.

g Mahana was inland and west of the Mormon Temple and was the most *mauka* of the terraces. Above this, the *kula* (dryland planting areas) began.

Some of these *'ili* are mentioned in the LCA Testimony: Kapuna (LCA 3939, 4334) Naueluli (spelled Naueloli in LCA 4061 and 4336 Testimonies) and Kuamoo (4061). LCA 4298 mentions Mahana (spelled Mahani). All of these references mention *lo'i* except for one reference to a *kula* (dryland plot) in Mahana.

The tax map shows only 6 Land Commission Awards in this vicinity to the east, south, and southwest of the Mormon Temple (5-5: plot G). Most of the land to the east was incorporated into the residential community of Lā'ie. This large parcel of wetland cultivation was probably fed from Kahawai Stream by an *'auwai* which was tapped from the stream and headed south and east following the contour of the slope. Jackson's 1884 map does not show this wetland area but shows cane land up to within 500 feet south of the temple. There is still plenty of non-cane land to the east and west of the temple which could have been *lo'i* and Jackson probably simply did not designate this on his map. The 1922 USGS Map shows wetland to the west of the temple at the base of Kahawai Stream which may be the *'ili* Mahana, the most *mauka* of the plots. The wetlands do not show up on the 1929 USGS map but are carefully designated on the 1927 Lā'ie Town map of A.R. Ivins. This map shows 32 rectangular taro patches *makai* of the Ko'olau Railway. All other land to the south of the temple is shown as numbered fields (Fields 4, 6, and 9) presumed to be sugar fields. The taro fields shown are watered by an *'auwai* crossing through the cane fields and under the railroad bed. These

lo'i to the east could be the *'ili* of Kuamoo referred to by Handy (1940) or more likely Kanaana, an adaptation of the Old Testament "Canaan" (see McAllister, 1933 Site 282). This *'ili* and that of Mahana were probably the last remnants of a once large *lo'i* complex. Today, as the 1990 aerial photo shows, most of this land is taken up by residential development.

5. Taro lands on the floodplain of Kahawainui Stream to the northwest of the Temple. This extensive complex is probably one and the same as the wetland complex of 7 *'ili* referred to by Handy (1940) but is considered separate here because it is northwest of the Mormon Temple, not east and west. Here, between Kahawainui Stream and Pohaili Street in the floodplain (TMK 5-5-_:8), are between 40 and 50 small Land Commission Awards (generally less than one acre) which represented the richest traditional *lo'i* lands of Lā'ie.

In terms of density of LCAs-as a reflection of land productivity-this area is comparable to Kāne'ohe Stream and other well-known former wetland areas of O'ahu. This land could well have been the *'ili*(s) of Kapuna, Kuamoo, Naueluli and others mentioned by Handy and, although the directions are unclear, the densities of Land Commission Awards would certainly indicate this. The quick perusal of Testimonies of Land Commission Awards here has plentiful mention of *lo'i*. Jackson's map of 1884 does not designate this wetland area and the 1922 USGS map shows only the *mauka* portion of the break in the stream valley. However, a few scattered house sites are shown on this map. As Neller (1984) points out, the houses are shown in a line which probably indicates the location of the *'auwai* which is probably the predecessor of the drainage ditch which is present today. The 1929 USGS map shows this *'auwai* clearly as it parallels the south side of the stream and joins the stream by the cemetery.

The 1927 map of Lā'ie Town does not show this extensive wetland but the map ends at the cemetery east of the wetlands. The map does designate "Field 10"

may have been a *luakini* class temple.

10. The Ko'olau Railroad Line. As pointed out by Neller (1984) portions of a sugar train berm still exist in Lā'ie. Neller found a segment paralleling Kamehameha Highway on the *makai* side.

This railroad berm is not shown on Jackson's 1884 map but (unlike Paea fishpond) is assumed not to be extant at that time. This line was built within a few years of 1900 and eventually extended southward to Kahana, a distance of 11 miles. This line was intended to be part of an ambitious plan for a trans-Ko'olau Railroad but these grandiose plans never materialized and the train was used to haul cane to the Kahuku Mill (Condé and Best, 1973). The controlling company was called the Ko'olau Railway Company.

The railroad is shown on the 1922 USGS map and on the 1929 USGS map as well as on the 1927 Lā'ie Town map. By 1928 there were two spur lines: one which went up Kahawainui Valley on the south side of the floodplain wetland agricultural plots and the other extending *mauka* south of the temple to a well and reservoir at the north side of Wailele Gulch. These spurs, as well as cane land shown on the historic maps, give a good indication of the extent of sugar growing in Lā'ie. The railroad berm followed a route through Lā'ie which is far *mauka* of the present coast road. Much of its former route has been covered by residential development.

D. Sugar Growing in Lā'ie

The Lā'ie Sugar Plantation was founded in the mid- to late- nineteenth century by the Mormon missionaries. The Mormons arrived in Lā'ie in the 1850s

and by 1865 had purchased 6,000 acres of the *ahupua'a*, mostly in the *makai* section. By 1884 the Lā'ie Plantation had large tracts of cane south of the Mormon settlement. Jackson's 1884 map shows cane fields *mauka* of the beach road and south of the mission settlement. This map also shows a sugar mill at the *mauka* end of the fields. The maximum extent of sugar planting in Lā'ie is not shown on any map in the author's possession but it is apparent that most of the cultivated fields were in the southern dryer portion of the *ahupua'a* (Lā'iemaloo) and probably in the kula land above the Kahawainui Stream floodplain (served by the northern spur of the Ko'olau Railway which went to the base of this valley). Expansion of sugar planting was mainly to the south of the community of Lā'ie. The enterprise involved reservoirs and ditch systems for field irrigation, as shown on the 1929 USGS map. Except for some areas south of the Mormon Temple, sugar was probably never planted in the irrigated wetland taro lands of the Kahawainui floodplain (Lā'iewai) and the systems of *'auwai* and terraces survived the plantation modifications. In many cases the traditional *'auwai* systems south of the temple were probably adapted for sugar irrigation.

The 1927 map of Lā'ie Town shows the plantation infrastructure as well as fields south and west of the 30 or so extant taro terraces. Three fields are shown along with a Filipino Camp of 23 houses and a *mauka* camp of 17 houses. This era must have been the apex of the Lā'ie Sugar Plantation. In 1931, leases of the Lā'ie Plantation fields were assigned to the Kahuku Plantation (Condé and Best, 1973), and sugar growing in Lā'ie continued only for twenty or so years after that.

E. Rice Cultivation in Lā'ie

Although no specific information was obtained for this brief study to confirm rice cultivation in Lā'ie, it is probable that the *lo'i* lands were converted to wetland rice growing in the late-19th century confirming to the general economic pattern demonstrated for other *lo'i* in windward O'ahu (Kāne'ohe, Kailua, Kahalu'u) and Hawai'i in general (e.g., Hanalei on Kaua'i). In these cases the major wetland plots were converted to rice cultivation for a 30 to 40 year period in the late-19th and early-20th centuries because of the high demand for rice. Eventually California out-competed the Hawaii suppliers and rice-growing became unprofitable. This aspect of Lā'ie land use could be researched further since rice and taro have much the same growing environment: the taro fields were generally converted to rice with the original field systems still intact, although there was a historic tendency to enlarge and combine terraces to increase efficiency.

III. Assessment of Archaeological Resources in Lā'ie (particularly related to wetlands)

In general, there appears to be relatively little in the way of surviving surface features of Hawaiian settlement in the densely used portion of Lā'ie. Residential expansion, construction of the Brigham Young University-Hawaii campus, long-term sugar cultivation, and other impacts have dramatically altered the landscape. Large segments of former wetland have been modified. In cases where the modification has included filling over, the underlying sediments would survive. This could be the situation at Paeo Pond near the mouth of Kahawainui Stream as well as at former *lo'i* around the Mormon Temple and along the Kahawainui floodplain. In fact, buried sediments of former traditional wetlands have definite potential for yielding valuable information on chronology and paleoecology (see Hammatt, 1990, for Kawainui) and all that is required is intact stratified deposits, not necessarily surviving surface features. Information can be extracted through stratigraphic sampling of test pits and or sediment cores.

The same consideration would apply to *lo'i* lands in which intact complexes of surface features still survive, except in these cases information can also be gained from mapping and excavation of the surface features themselves. (Traditional Hawaiian agricultural terraces, *lo'i* and *kula*, with associated habitation sites, are known to survive in upper Kahawainui, Wailele and Kōloa Gulches.) Some of these complexes may be worthy of complete preservation as excellent examples of site types.

Within the floodplain of Kahawainui, south of the stream, there are still surface features of the traditional terraces visible in land converted to pasture and the original course of the *'auwai* survives as a modern drainage. These features

and their associated sediments are important for reconstructing past land use and chronology

Clearly, all lands which have been dredged or mixed to coral substrate (fairly shallow in Lā'ie) have lost all potential archaeological value. This would include all heavily modified lands and dredged aquaculture ponds.

There is another factor in historic preservation concerns: structures associated with the early sugar industry in Hawai'i have matured beyond the 50-year (and in some cases 100-year) age mark which may qualify them as significant historic sites. These structures include ditches, railroad berms and other works of engineering, as well as locations of former camps in which tangible remains may survive on or below the surface. These features are known to exist in Lā'ie.

IV. Survey Results

A. Description of the Project Area

The entire project area is located on a limestone knoll 50 feet above the flood plain within the boundary fence of the recently expanded but existing sewer plant *mauka* of the BYU Campus (Fig. 10). The west portion is occupied by the existing plant which includes a building, filtration tanks and a pond. To the southeast a new tank is under construction and there are exposed construction cuts through the clay and limestone sediments and the surrounding terrain has been recently graded to expose the clay topsoil. The north section of the parcel is, in places, heavily vegetated but the bulk of the ground surface has been previously graded and cultivated. Vegetation consists of *koa haole*, feral cassava, bananas, vines and California grass. This area, according to Mr. Kleinman of Zion Securities, who accompanied the Cultural Surveys Hawaii crew on the survey was farmed until recently. Modern trash, car parts, etc. were observed under the vegetation mat.

According to the Plant Manager, the present plant has been in operation since 1983 and the former plant (which appears on the 1983 USGS Kahuku Quad Map) was located approximately 1,000 feet to the east.

B. Results

The only undisturbed land within the project area is a small portion of limestone outcrop surrounding 5 banyan trees to the east of the existing pond. No archaeological or historic materials were observed here. Other portions of the property to the east which were recently graded were inspected for evidence of archaeological and historic occupation deposits [illegible] found.

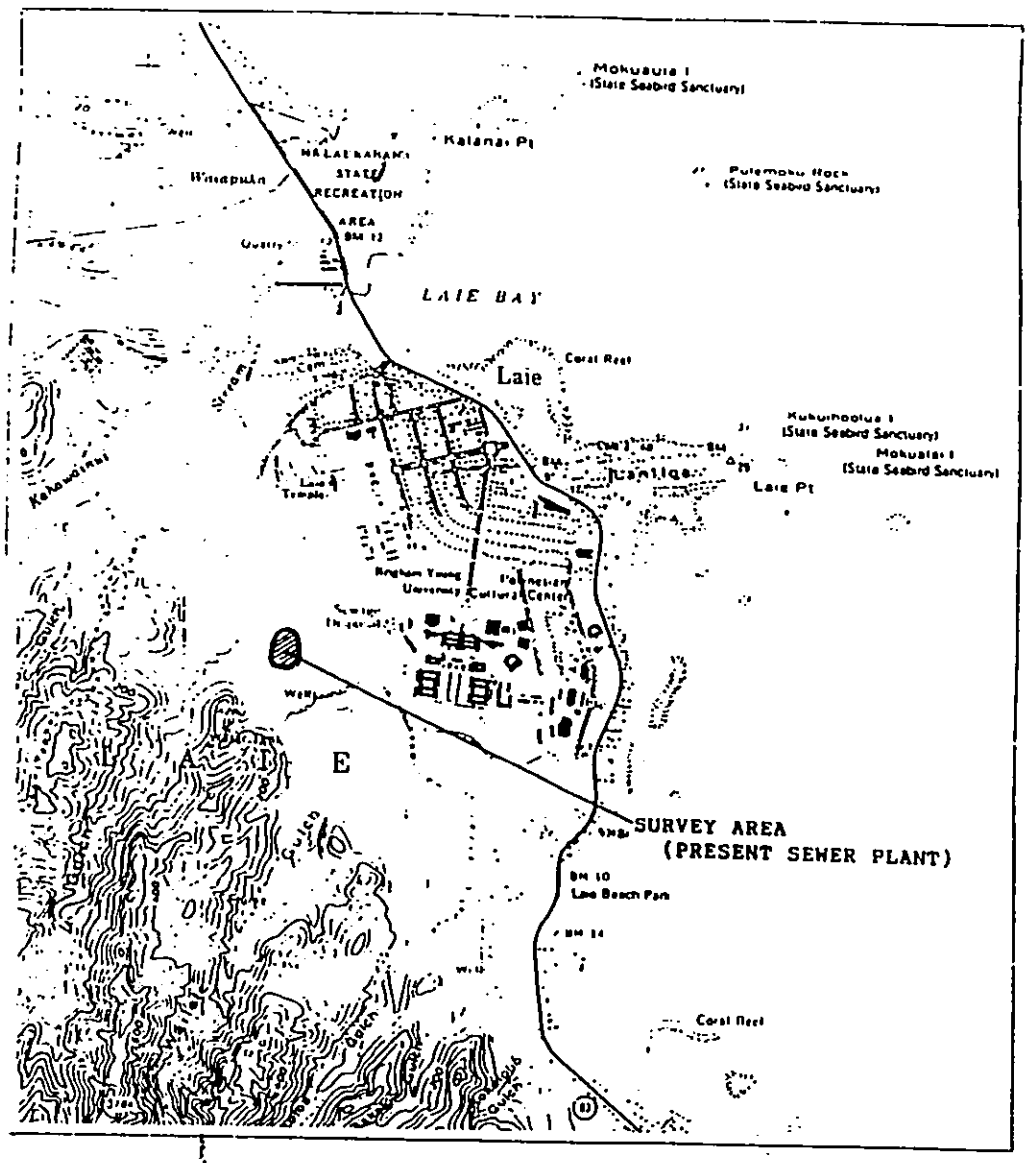


Figure 10 1983 USGS Kahuku Quad Map Showing Survey Area and Present Sewer Plant

C. Summary and Recommendations

In summary, the entire site is devoid of archaeological resources. Historical research on the parcel indicates that there are no previously recorded sites in or near this parcel.

Cultural Surveys Hawaii believes that ongoing and proposed construction within this 6-acre area will have no impact on archaeological resources. However, if in the unlikely event that inadvertent finds are uncovered during grading, work should be stopped and the State Historic Preservation Division should be notified immediately

V. References Cited

Ahlo, Hamilton M., Jr., and Robert J. Hommon
1981 An Archaeological Reconnaissance Survey of the Flood Control Study Area, Kahawainui Stream, Laie, Oahu, Hawaii. Prepared for U.S. Army Engineer Division, Pacific Ocean.

Bath, Joyce
1985 Archaeological Testing and Mapping at Kahawainui Stream in Laie, Oahu, Hawaii.

Clark, Stephen D.
1979 Scope of work for Archaeological Investigations at La'ie Beach Park. Manuscript on file. City and County of Honolulu, Parks and Recreation.

Condé, Jesse C. and Gerald M. Best
1973 *Sugar Trains: Narrow Gauge Rails of Hawaii*, Glenwood Publishers, Felton Calif.

Connally, III, Robert D.
1980 Intensive Subsurface Archaeological Reconnaissance Survey of the La'ie Beach Park. Manuscript on file. City and County of Honolulu Parks and Recreation.

McAllister, J.G.
1933 *Archaeology of O'ahu*. Bishop Museum, Bulletin 104, Honolulu.

Hammatt, Hallett H.
1989 "Archaeological Reconnaissance of a 12.8-Acre Parcel at La'ie, O'ahu (TMK 5-5-01:51)," Cultural Surveys Hawaii.

Hammatt, Hallett H.
1987 Soil Analysis for Archaeological Investigation of Malaekahana State Park, Cultural Surveys Hawaii.

Handy, E S. Craighill
1940 *The Hawaiian Planter*. Volume 1, Bishop Museum, Bulletin No. 161., Honolulu.

Neller, Earl
1984 Comments on the Kahawainui Stream Flood Control Study's Archaeological Reconnaissance Survey, Including the Results of an Archaeological Reconnaissance Survey Along Laiewai Stream, Laie, Oahu (TMK: 5-5-05 and 09). State Historic Preservation Division.

Neller, Earl
n d. Comments on the Kahawainui Stream Flood Control Study from the Perspective of Historic Preservation and Cultural Resources Management. State Historic Preservation Division.

Sterling, Elspith P. and Catherine C. Summers
1978 *Sites of O'ahu*. Dept. of Anthropology, B.P. Bishop Museum, Honolulu.

Yent, Martha and Jason Ota
1982 Results of Auger Coring Conducted at Malaekahana State Recreation Area, Phase II, Koolauloa, Oahu, TMK: 5-6-01:24, 45-47, 49, 51, 53, 55-65. Department of Land and Natural Resources, Division of State Parks.

Yent, M , and A. Estioko-Griffin
1980 Archaeological Investigations at Mālaekahana (50-80-02-2801), Windward Oahu. Report prepared for Department of Land and Natural Resources, Division of State Parks, Outdoor Recreation, and Historic Sites.

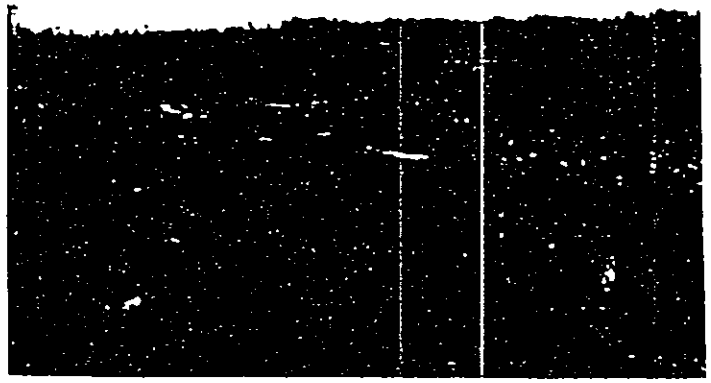


Figure 11 Sewer Plant Survey Area, South End, View to North Showing Grading

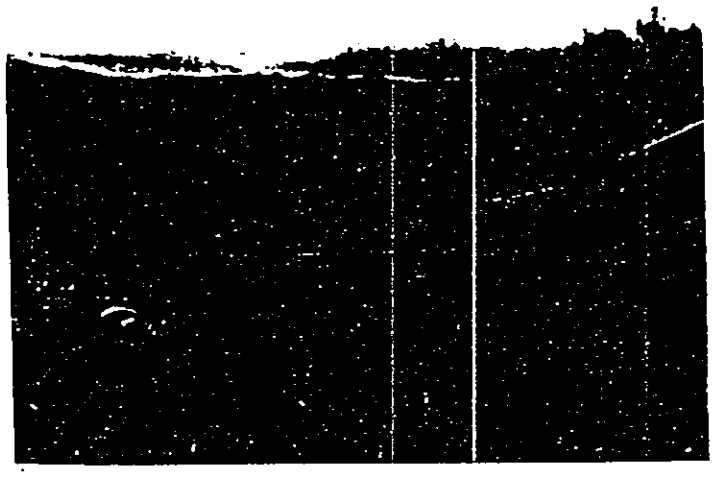


Figure 12 North End of Survey Area Enclosed by Fence, View NW

Figure 13 Recent Cut in Decomposed Limestone Showing Bedrock South of Sewer Plant

Figure 14 Existing Sewer Plant, View to South

APPENDIX C

COMMENTS & RESPONSES TO
DRAFT ENVIRONMENTAL ASSESSMENT
30-DAY PUBLIC REVIEW PERIOD

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810

LETTER NO (P)1450.0

AUG - 4 2000

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Review of Draft Environmental Assessment (DEA)
For Laie Wastewater Collection System, Phase 1

We received the subject project DEA on July 24, 2000.

Your proposed project does not appear to impact any of our facilities. However, please note that Laie Elementary School is within the district. Please assure that the mitigative measures you proposed minimizes potential odor, noise, and visual impacts to surrounding facilities.

Should you have any questions, please call Mr. Alan Sanborn of the Planning Branch at 586-0499.

Sincerely,

GORDON MATSUOKA
Public Works Administrator

RSY:mo
c: Office of Environmental Quality Control
Department of Design and Construction

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Raymond Sato, Comptroller
Dept. of Accounting and General Services
State of Hawaii
1151 Punchbowl St.
Honolulu, HI 96813

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Sato:

Thank you for your letter dated August 4, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion.

Mitigative measures will be employed during construction and during normal operations of the expanded wastewater facilities to minimize potential odor, noise, and visual impacts to the surrounding area.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

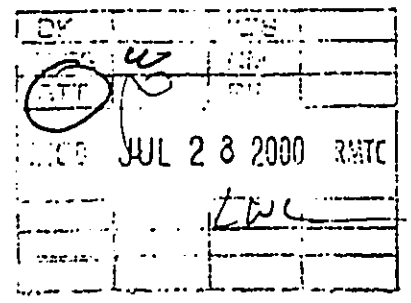
JN:LL

BENJAMIN J. CAYETANO
GOVERNOR
STATE OF HAWAII

RAYNARD C. SOON
CHAIRMAN
HAWAIIAN HOMES COMMISSION

JOBIE M. K. M. YAMAGUCHI
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. BOX 1879
HONOLULU, HAWAII 96805



July 26, 2000

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, HI 96817

Dear Mr. Mukai:

Subject: Laie Wastewater Collection System Expansion, Draft Environmental Assessment, TMK 5-5-6:05 por., Laie, Oahu, Dated July, 2000

Thank you for the opportunity to review the subject application. The Department of Hawaiian Home Lands has no comment to offer.

If you have any questions, please call Daniel Ornellas of our Planning Office at 586-3836.

Aloha,

Raynard C. Soon, Chairman
Hawaiian Homes Commission

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Raynard Soon, Chairperson
Hawaiian Homes Commission
State of Hawaii
P.O. Box 1879
Honolulu, HI 96805

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Soon:

Thank you for your letter dated July 26, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge that you have no comments at this time.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

BRUCE S. ANDERSON, Ph.D., M.P.H.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:
File:

September 25, 2000 00-149/epo

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Draft Environmental Assessment (DEA)
Laie Wastewater Collection System Expansion, Phase I
Laie, Oahu
TMK: 5-5-06:por. of 5

Thank you for allowing us to review and comment on the subject project. We have the following comments to offer:

Wastewater

The project proposes the expansion of the existing wastewater collection system to include homes currently serviced by cesspools. Construction of the new wastewater pump station and force main (Phase I) will allow for the expansion of this existing collection system (Phase II).

We are pleased with the improvements and expansion which will better serve the wastewater disposal concerns of the community. Every effort should be made to increase the areas used for wastewater reclamation.

Should you have any questions on this matter, plesse contact the Planning/Design Section of the Wastewater Branch at (808)586-4294.

Water Pollution

1. The Army Corps of Engineers should be contacted to identify whether a Federal permit (including a Department of Army permit) is required for this project. If it is determined that a Federal permit is required, then a Section 401 Water Quality Certification would also be required from the Department of Health;

2. If the project will involve any of the following discharges into state waters, a NPDES general permit is required for each activity:

   a. Storm water runoff associated with construction activities, including clearing, grading, and excavation that result in the disturbance of five (5) acres or more of total land area (Note: After March 10, 2003, an additional NPDES general permit will also be required for discharges of storm water associated with construction activities, that result in the disturbance of one (1) acre or more but less than five (5) acres);

   b. Hydrotesting water; and

   c. Construction dewatering effluent.

3. If there will be any discharge of treated wastewater into state waters, a NPDES individual permit will be required.

The Department requires that Notices of Intent (NOIs) for NPDES general permits be submitted thirty days before the discharge is to occur. NOIs can be picked up at the Clean Water Branch, 919 Ala Moana Blvd., Room 301 or downloaded from our website at

http://www.state.hi.us/doh/eh/cwb/forms/index.html.

Should you have any questions on these comments, please contact Ms. Kris Poentis, Engineering Section, the Clean Water Branch, at 586-4309.

Air Pollution

The Department of Health's Clean Air Branch, has some concerns regarding possible nuisance odors which may be generated at the new pump station. These concerns should be addressed in the EA.

The Clean Air Branch also has concerns about potential dust problems. There is a significant potential for fugitive dust to be generated during clearing and removal of debris, grubbing, grading, and excavation.

Implementation of adequate dust control measures during all phases of construction is warranted. Construction activities must comply with provisions of Chapter 11-60.1, Hawaii Administrative Rules, Section 11-60.1-33 on Fugitive Dust.

Possible requirement of an air permit from the Department of Health:

The Clean Air Branch issues permits for air pollution sources. An air permit may be required for an odor control system or any combustion source. For questions on permitting issues, please contact the Engineering Section at 586-4200. If you have any questions on fugitive dust issues, please contact Ms. Crystal Peltier at 586-4200.

Sincerely,

GARY GILL
Deputy Director
Environmental Health Administration

c: WWB
CWB
CAB

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Gary Gill
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, HI 96801

SUBJECT: Environmental Assessment (EA) for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Gill:

Thank you for your letter dated September 25, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. In response to your comments we offer the following information:

Wastewater

We acknowledge your support for the proposed improvements and note our shared interest in efforts to better support the wastewater disposal concerns of the Lai'e community.

Water Pollution

1. The proposed improvements do not involve waters of the State, therefore a Department of the Army permit is not required.

2. As noted in Chapter 6 of the Final EA, National Pollutant Discharge Elimination System (NPDES) permits will be obtained from the Department of Health for construction dewatering and for hydrotesting of sewer lines.

3. Wastewater collected in the proposed system will be conveyed to the existing Lai'e Wastewater Treatment Facility where it will be treated and discharged in compliance with the facility's current NPDES individual permit.

Air Pollution

1. Odor will be controlled through the use of a carbon filtration system installed at the pump station. Wastewater entering the pump station will be collected in a sealed, lined, wet-well into which two pumps and two air filtration units will be constructed. One of the air filtration units will remain in continuous operation, the other will serve as a back-up system.

   The air filtration units use an exhaust fan to draw air out of the air space in the wet-well and through an activated carbon filter which traps and absorbs odorous compounds before

venting to the outside air through a dispersion stack. Activated carbon absorbs a variety or organic and inorganic compounds including hydrogen sulfide (H_2S), the most common odorous gas found in wastewater collection and treatment systems. When the capacity of this type of carbon is reached, it can be regenerated in place by means of a water wash.

Emission rates from the odor control system will be kept below the exempt amounts established in HAR, Chapter 11-60, "Air Pollution Control". The Department of Health will verify emission rates when an application is made to obtain an air pollution permit for the project. This information will be included in the Final EA.

2. Dust control measures will be employed during all phases of construction. Construction activities will comply with provisions of Hawaii Administrative Rules, Chapter 11-60.1-33, Fugitive Dust.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

BEN. AMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

HISTORIC PRESERVATION DIVISION
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

TIMOTHY E. JOHNS, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JANET E. KAWELO

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND RESOURCES
ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS
WATER RESOURCE MANAGEMENT

AUG 23 2000

August 16, 2000

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96717-4941

LOG NO:25967 ✓
DOC NO: 0008SC01

Dear Mr. Mukai:

SUBJECT: Chapter 6E-42 Historic Preservation Review of a Draft Environmental Assessment (DEA) for Laie Wastewater Collection System Expansion, Phase I

Thank you for the opportunity to comment on the DEA prepared for the proposed expansion of the Laie Wastewater Collection System in La`ie, O`ahu. The Phase I expansion is intended to establish new sewer connection points for several existing wastewater systems in La`ie. The proposed actions include the following: construction of a new Brigham Young University Hawai`i (BYUH) pump station; a new pump station access road through existing Poohaili Street; installation of a 12-inch diameter force main; installation of a trunk sewer line from the pump station to Naniloa Loop; installation of a trunk sewer main along Naniloa Loop from around Hale Laa Street to Iosepa Street. .

As noted in the subject DEA, our office has previously reviewed reports and fieldwork documenting the number and kinds of historic properties in the La`ie area. We note, however, that the discussion presented on pages 3-6 through 3-8, and Figure 3.2-1, lack some available information. Our records indicate that an additional historic site, the Nioi Heiau complex (SIHP No. 50-80-02-281) is adjacent to the project area, and includes SIHP Nos. –4458 and 4460. Only Site –4458 is depicted on your figures and discussed in the text. You are correct, however, in stating that these and the other previously identified historic sites lie outside the project area as shown in the DEA.

The 12-inch pipeline section between the Laie Water Reclamation Facility (LWRF) and the proposed pump station will pass through previously surveyed areas that were also under sugar cane cultivation. The soils in this area include clays, loams, and silts. Consequently, we believe that this portion of the proposed project will have "no effect" on significant historic sites since none are known to be present nor are any likely to be present, due to past land alterations.

However, we are concerned about the section of the trunk sewer main along Naniloa Loop because at least a portion of the main may run through Jaucas sands deposits. Jaucas sands are known to contain significant historic sites such as subsurface cultural deposits and human burials. Human burials were uncovered during construction work at La`ie Elementary School. Consequently, we believe that the installation of a sewer main may potentially have an "adverse effect" on significant historic sites in this area. Therefore, we would recommend that a qualified archaeologist conduct archaeological monitoring during excavations in the Jaucas sands deposits. Prior to beginning work, an acceptable archaeological monitoring plan must be submitted to our office for review and approval. An acceptable archaeological monitoring plan will have the following components:

> (1) The kinds of remains that are anticipated and where in the construction area the remains are likely to be found; (2) How the remains and deposits will be documented; (3) How the expected types of remains will be treated; (4) The archaeologist conducting the monitoring has the authority to halt construction in the immediate area of a find in order to carry out the plan; (5) A coordination meeting between the archaeologist and construction crew is scheduled, so that the construction team is aware of the plan; (6) What laboratory work will be done on remains that are collected; (7) A schedule for report preparation; and (8) Details concerning the archiving of any collections that are made.

Thus, if an acceptable archaeological monitoring plan is implemented for the construction of the sewer main along Naniloa Loop, we believe that the proposed Phase I expansions to the La`ie Wastewater Collection System will have "no adverse effect" on significant historic sites.

As a further aid to developing a comprehensive and accurate monitoring plan, we would also request any additional information on soils testing and geology that you may have available.

Should you have any questions, please feel free to contact Sara Collins at 692-8026.

Aloha,

DON HIBBARD, Administrator
State Historic Preservation Division

SC:an

c: Chair, O`ahu Island Burial Council
Kala`au Wahilani, Burial Sites Program

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Don Hibbard, Administrator
Historic Preservation Division
DLNR, State of Hawaii
601 Kamokila Blvd, Room 555
Kapolei, Hawaii 96707

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Hibbard:

Thank you for your letter dated August 16, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge your concern about the section of trunk sewer main along Naniloa Loop and related excavation work conducted in Jaucas sand deposits. We note that Jaucas sands are known to contain significant subsurface cultural deposits and human burials.

In response to these concerns, a qualified archaeologist will be employed to monitor excavations in the Jaucas sand deposits along Naniloa Loop. Prior to beginning work in this area, an archaeological monitoring plan will be prepared by a qualified archaeologist and submitted to your office for review. Additionally, available information on soils testing and geology in the area will be provided to your office.

We understand that a "no adverse effect" determination is dependent upon implementation of an acceptable archaeological monitoring plan

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

BENJAMIN J. CAYETANO
GOVERNOR

GENEVIEVE SALMONSON
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL

235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

August 22, 2000

Mr. Po Chan
City and County of Honolulu
Department of Design and Construction
650 South King Street
Honolulu, Hawai'i 96813

Dear Mr. Chan:

We have reviewed the draft environmental assessment for the La'ie Wastewater Collection System Expansion, Phase I, La'ie, District of Ko'olauloa, Island of O'ahu, TMK 5-5-06: 5 (por.), and offer the following comments for your consideration and response.

1. SANDY SOILS AND HUMAN BURIALS - Section 3.1.3 acknowledges that the soils consist of dense coral sands. Sandy areas are often the sites of native burials. Although Section 7 of the DEA indicates that consultation took place with the State Historic Preservation Division, it is not known whether this consultation was recent. Please consult with the State Historic Preservation Division for any updated site information and possible mitigative measures.

2. SERVICE CATEGORY C (PHASE II) - Table 2.2-1 indicates that for Service Category C there may be additional development or expansion on existing properties. Please discuss these additional developments or expansions on existing properties and their impacts on the wastewater system and the environment.

If there are any questions, please call Leslie Segundo at 586-4185. Thank you for the opportunity to comment.

Sincerely,

GENEVIEVE SALMONSON
Director

c: Dr. Leighton Lum, Project Manager
R. M. Towill Corporation

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Ms. Genevieve Salmonson, Director
Office of Environmental Quality Control
235 S. Beretania Street
State Office Tower, Suite 702
Honolulu, HI 96813

SUBJECT: Environmental Assessment (EA) for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Ms. Salmonson:

Thank you for your letter dated August 22, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. In response to your comments we offer the following information:

1. The State Historic Preservation Division was consulted during the Environmental Assessment review period. Archaeological monitoring following an approved monitoring plan will be undertaken during excavation work in areas containing Jaucas sand deposits.

2. This EA is prepared for Phase I of the proposed Laie Wastewater Collection System Expansion Masterplan. Phase I comprises a complete system itself and does not necessitate additional development, thus, it is treated independently from subsequent phases of development. Separate EAs will be prepared to address subsequent developments, including proposed Phase II work, and their environmental impacts as funding becomes available.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

AUG 15 2000

IN REPLY REFER TO:

HWY-PS
2.9672

Mr. Derek Mukai
R. M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Draft Environmental Assessment, Laie Wastewater Collection System Expansion, Phase I, Laie, TMK: 5-5-06: Por. 5

The proposed expansion to the Laie wastewater collection system will not impact our State highway facilities.

Plans for construction work within the State highway right-of-way must be submitted for our review and approval. These plans should include details of the highway crossing for any underground sewer lines.

If there are any questions regarding these comments, please contact Ronald Tsuzuki, Head Planning Engineer, Highways Division, at 587-1830.

Very truly yours,

KAZU HAYASHIDA
Director of Transportation

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Kazu Hayashida, Director
Department of Transportation
State of Hawaii
869 Punchbowl St.
Honolulu, HI 96813

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Hayashida:

Thank you for your letter dated August 15, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge that the proposed project will not impact State Highway facilities.

Plans for any construction work within the State highway will be submitted to your office for review and approval.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

August 14, 2000

DK		KTS	
WES		NM	
RTT		RF	

REC'D AUG 15 2000 RMTC

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

Dear Mr. Mukai:

Subject: Your Transmittal of July 21, 2000 Regarding the Draft Environmental Assessment for the Laie Wastewater Collection System Expansion, Phase I

Thank you for the opportunity to review and comment on the Draft Environmental Assessment for the proposed project.

We have no objections to the proposed project since it is served by a private water system.

If you have any questions, please contact Kathryn Kami at 527-5221.

Very truly yours,

CLIFFORD S. JAMILE
Manager and Chief Engineer

cc: Department of Design and Construction

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Clifford S. Jamile, Chief Engineer
Board of Water Supply
City & County of Honolulu
630 S. Beretania Street
Honolulu, HI 96813

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Jamile:

Thank you for your letter dated August 14, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge that you have no comments at this time.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 523-4564 Fax: (808) 523-4567
Website: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

GARY Q. L. YEE, AIA
DIRECTOR

ROLAND D. LIBBY, JR., AIA
DEPUTY DIRECTOR

August 25, 2000

WWDE.P 00-589

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817

Attention: Dr. Leighton Lum

Subject: Laie Wastewater Collection System Expansion, Phase I
Draft Environmental Assessment (DEA) – Review Comments

We have reviewed the subject DEA, and our comments are as follows:

The proposed action is not included in the North Shore Facilities Plan since the Laie system was designated "Private" when this plan was developed. It is unknown as to whether the proposed action will meet the requirements for collection, treatment, and disposal for the year 2020.

The Laie basin was not included in the Sewer Rehabilitation and Infiltration & Inflow Plan, since this system was designated as "Private" during the development of this plan. As per the City's agreement with the U.S. Environmental Protection Agency and the State of Hawaii Department of Health, flows within City systems resulting from a 2 year, 6-hour storm must be contained within the system. The proposed system improvements must meet this requirement.

Other comments are annotated on the attached copies of the report.

Should there be any questions, please contact Richard Leong at the Wastewater Planning Branch at 527-5863.

Very truly yours,

for GARY Q. L. YEE, AIA
Director

Attachment

cc: WWDED

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 6, 2000

Mr. Gary Q. L. Yee, AIA
Director
Department of Design & Construction
City and County of Honolulu
650 S. King St., 11th Floor
Honolulu, HI 96813

SUBJECT: Environmental Assessment (EA) for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Yee:

Thank you for your letter dated August 25, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. In response to your comments (*in italic*) we offer the following information:

1. *The proposed action is not included in the North Shore Facilities Plan since the Laie system was designated "Private" when this plan was developed. It is unknown as to whether the proposed action will meet the requirements for collection, treatment, and disposal for the year 2020.*

The proposed waste water collection system is designed within the capacity limits of the La'ie Water Reclamation Facility (LWRF). The LWRF is sized for a design average flow of 0.90 million gallons a day (mgd). Currently, the treatment facility handles a design average flow of approximately 0.30 mgd. The proposed Phase 1 improvements will not expand sewer service nor result in increased waster water flows to the LWRF.

2. *The Laie basin was not included in the Sewer Rehabilitation and Infiltration & Inflow Plan, since this system was designated as "Private" during the development of this plan. As per the City's agreement with the U.S. Environmental Protection Agency and the State of Hawaii Department of Health, flows within the City systems resulting from a 2-year, 6-hour storm must be contained with the System. The proposed system improvements must meet this requirement.*

The proposed improvements will comply with U.S. Environmental Protection Agency and State of Hawaii Department of Health requirements for system capacity to contain a 2-year, 6-hour storm.

Additional comments submitted by your office as annotations to review copies of the DEA have been integrated, where appropriate, into the Final EA. We are herewith returning your review copies of the DEA marked with our responses.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

attachments

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, HONOLULU HI 96813

Jeremy Harris
Mayor

Kenneth E. Sprague, P.E., Ph.D.
Director

Barry Fukunaga
Deputy Director

PRO 00-40

August 23, 2000

Mr. Derek Mukai
R. M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Draft Environmental Assessment (DEA) for the Laie Wastewater Collection System Expansion, Phase I, Laie, Oahu, Hawaii

Thank you for allowing us to review and comment on the subject project. We have the following comments:

1. On page 6-1, under "Necessary Permits and Approvals", please add the Department of Environmental Services (ENV) to the list of approving agencies. An approval sign-off line for the Director of ENV should be provided on the plans for the project.

2. We request that the new wastewater pump station (WWPS) in Phase I be named the "Laie Wastewater Pump Station".

3. On page 2-4, under "2.3.1 New Collection System", please provide details on what is meant by "dual service laterals" for the homes fronting Naniloa Loop. Also, a general site plan should be provided that shows the lots to be serviced by Phase I, the approximate location of Phase I service line connections, and future tie-in points of the Low-Pressure Sewer System (LPSS) of Phase II. Please describe the steps involved in the transition from the old to the new system, including whether the remainder of the existing system will remain serviced by the Naniloa Loop WWPS and Moana Street WWPS while waiting for the LPSS of Phase II to be complete.

4. In the discussion of economic impacts from this project, it should be noted that there will be economic impacts to the sewer customers served by the Phase I project due to the start of

billing and collection of City and County of Honolulu sewer service fees, to begin when the Phase I project is complete.

If you have any questions, please call Mr. Jack Pobuk, Program Coordinator, at 527-6696.

Sincerely,

KENNETH E. SPRAGUE
Director

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Dr. Kenneth E. Sprague, Director
Environmental Services
City & County of Honolulu
650 S. King St.
Honolulu, HI 96813

SUBJECT: Environmental Assessment (EA) for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Dr. Sprague:

Thank you for your letter dated August 23, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. In response to your comments (*in italics*) we offer the following information:

1. *On page 6-1, under "Necessary Permits and Approvals", please add the Department of Environmental Services (ENV) to the list of approving agencies. An approval sign-off line for the Director of ENV should be provided on the plans for the project.*

The Department of Environmental Services will be added to the list of approving agencies in Section 6 of the Final EA. An approval sign-off line will be provided on project plans.

2. *We request that the new wastewater pump station (WWPS) in Phase I be named the "Laie Wastewater Pump Station".*

The wastewater pump station in Phase 1 will be named the "Laie Wastewater Pump Station".

3. *On page 2-4, under "2.3.1 New Collection System", please provide details on what is meant by "dual service laterals" for the homes fronting Naniloa Loop. Also, a general site plan should be provided that shows the lots to be serviced by Phase I, the approximate location of Phase I service line connections, and future tie-in points of the Low-Pressure Sewer System (LPSS) of Phase II. Please describe the steps involved in the transition from the old to the new system, including whether the remainder of the existing system will remain serviced by the Naniloa Loop WWPS and Moana Street WWPS while waiting for the LPSS of Phase II to be complete.*

The term "dual service laterals" is used whenever two adjoining lots are serviced by a common lateral. The shared cost of this lateral is significantly less than if each lot was to have its own lateral. A general site plan will be provided showing the Phase 1 service area, the approximate location of Phase 1 service line connections, and future tie-in points of the Low-Pressure Sewer System (LPSS) of Phase 2. During Phase 1 construction, only BYUH and PCC will be connected to the new collection system. The existing TVA and Moana pump stations will remain in operation until all service connections (gravity and LPSS) are completed.

4. *In the discussion of economic impacts from this project, it should be noted that there will be economic impacts to the sewer customers served by the Phase I project due to the start of billing and collecting of City and County of Honolulu sewer service fees, to begin when the Phase I project is complete.*

Improvements proposed under Phase 1 will not expand the existing sewer system service area and do not include residential sewer connections. Phase 1 improvements are designed to replace a portion of the existing sewer collection system with an upgraded trunk line, and new pump station and force main. Sewer connection and service fees would be determined during Phase 2 of the project through the establishment of a sewer improvement district (SID). The SID is a City government funding mechanism for public improvements that assesses each property owner a fair portion of the benefits they derive from the service provided. The SID process is governed by City ordinance.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
3375 KOAPAKA STREET SUITE H425 • HONOLULU, HAWAII 96819-1869
TELEPHONE: (808) 831-7761 • FAX (808) 831-7750 • INTERNET www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

ATTILIO K. LEONARDI
FIRE CHIEF

JOHN CLARK
DEPUTY FIRE CHIEF

August 4, 2000

Mr. Derek Mukai
R. M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Public Review of Draft Environmental Assessment (EA) for
Laie Wastewater Collection System Expansion, Phase I

We received a letter from Leighton W. K. Lum, dated July 21, 2000, regarding the above-referenced project.

The Honolulu Fire Department (HFD) requests that the following be complied with:

1. Maintain fire apparatus access throughout the construction site for the duration of the project.

2. Notify the Fire Communication Center (523-4411) of any interruption in the existing fire hydrant system during the project.

3. Submit construction plans for the diesel fuel tank to the HFD and the Department of Planning and Permitting.

Should you have any questions, please call Battalion Chief Kenneth Silva of our Fire Prevention Bureau at 831-7778.

Sincerely,

ATTILIO K. LEONARDI
Fire Chief

AKL/KS:jo

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Attilio Leonardi, Chief
Fire Department
City & County of Honolulu
3375 Koapaka Street
Honolulu, HI 96819

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Chief Leonardi:

Thank you for your letter dated August 4, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. In response to your comments we offer the following information:

1. Fire apparatus access will be maintained on the construction site for the duration of the project.

2. The contractor will notify the Fire Communication Center of any interruption in the exiting fire hydrant system during the project.

3. Construction plans for the diesel fuel tank will be submitted to your office and to the Department of Planning and Permitting.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

POLICE DEPARTMENT

CITY AND COUNTY OF HONOLULU

801 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96813 - AREA CODE (808) 529-3111
http://www.honolulupd.org
www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

LEE D. DONOHUE
CHIEF

MICHAEL CARVALHO
ROBERT AU
DEPUTY CHIEFS

OUR REFERENCE CS-JNB/DL

August 21, 2000

Mr. Derek Mukai
R. M. Towill Corporation
420 Waiakamilo Street, 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: Public Review of Draft Environmental Assessment (EA) for Laie Wastewater Collection System Expansion, Phase I

Thank you for the opportunity to review and respond to the subject document.

Based on the consultant's representation, we do not anticipate an appreciable impact on traffic patterns or calls for police service in the area as a result of this project.

If there are any questions, please call Ms. Carol Sodetani at 529-3658.

Sincerely,

LEE D. DONOHUE
Chief of Police

By
EUGENE UEMURA
Assistant Chief
Support Services Bureau

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Lee Donohue, Chief
Police Department
City & County of Honolulu
801 S. Beretania Street
Honolulu, HI 96813

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Chief Donohue:

Thank you for your letter dated August 21, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge that you do not anticipate any appreciable impact on traffic patterns or calls for police service in the area as a result of this project.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

Scott W.H. Seu, P.E.
Manager
Environmental Department

August 8, 2000

Mr. Derek Mukai
R.M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Dear Mr. Mukai:

Subject: **Laie Wastewater Collection System Expansion, Phase I**

Thank you for the opportunity to comment on your July 2000 Preliminary Draft EA for the Laie Wastewater Collection System Expansion, Phase I, proposed by the City and County of Honolulu, Department of Design and Construction. We have reviewed the subject document and have the following comments:

Pg. 3-10, Section 3.3.5 (Electrical and Communication Systems – Anticipated Impacts and Mitigative Measures)

The statement "The HECO system has adequate service capacity to meet the projected power requirements of the proposed project" is incorrect. HECO's 11.5 kv electrical distribution overhead lines in the Laie area is loaded near its capacity limit. A significant load increase by this project or other customers in the area may require the development of a new electrical distribution substation in Laie to serve the new loads. A new substation may take up to two years to acquire the land, design and construct. The estimated completion date of July 2001 for the proposed project as noted in Section 2.4.1 may not be feasible.

Our point of contact for this project, and the originator of these comments, is Francis Hirakami (543-7536) senior customer engineer. I suggest your staff and consultants deal directly with Francis to coordinate HECO's continuing input on this project.

Sincerely,

for Scott Seu

cc: F. Hirakami

OEQC

ECS, INC.
615 Piikoi Street, Suite 207
Honolulu, Hawaii 96814
(808) 591-8181 Fax: (808) 591-9098

TELECON RECORD

Date/Time : August 11, 2000 / 2:05 pm

Between : Russell Yoshida, HECo

And : VKM

Project : Laie Wastewater Collection System Expansion, Phase I (Pump Station)

ECS No. : 060-051

Subject : Availability of HECo power

Upon review of the HECo correspondence dated 8-10-00 from Scott Seu from HECo and discussions within HECo on their ability to supply power to the pump station, it was confirmed by Russell that there is enough power to support the pump station. There is no determination as to whether the future phases of the Laie Wastewater Collection System Expansion can be supported since there is no data on what those loads would consist of.

Russell noted that he had prepared the HECo Service Proposal document and put it in the mail yesterday.

Signed: _____

Copies to:

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Scott Seu
Hawaiian Electric Company
P. O. Box 2750
Honolulu, HI 96740

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Seu:

Thank you for your letter dated August 8, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. Based on subsequent correspondence between Mr. Russell Yoshida of HECo and ECS, Inc., subconsultants on the project, we understand that there is sufficient power to support the proposed pump station. Plans for future phases of development will be submitted to your office for review and approval.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

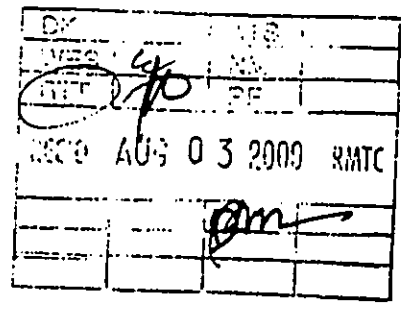
Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

GTE Hawaiian Tel
Beyond the call

GTE Hawaiian Telephone Company Incorporated
P.O. Box 2200 • Honolulu, HI 96841 • 808 546-4511

August 1, 2000



R. M. Towill Corporation
420 Waiakamilo Street, Suite 411
Honolulu, Hawaii 96817

Attention: Mr. Derek Mukai

Subject: Draft Environmental Assessment (EA) for Laie Wastewater Collection System Expansion, Phase I, Laie, Oahu, Hawaii

Dear Sir:

Thank you for the opportunity to review the above subject Draft Environmental Assessment. We do not foresee any conflicts with the telephone facilities in the area. If the new pump station requires telephone lines, then please forward the detail construction plans to our office for review.

Should you have any questions, please call Garret Hayashi at 840-1438.

Sincerely,

Wayne L. Cabral
Section Manager
Access Design & Construction

cc: Planning
File (Laie)

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Mr. Wayne L. Cabral
Access Design & Construction
GTE Hawaiian Tel
1177 Bishop Street
Honolulu, HI 96813

SUBJECT: Environmental Assessment for the Proposed Laie Wastewater Collection System Expansion, Phase I

Dear Mr. Cabral:

Thank you for your letter dated August 1, 2000 responding to requests for comments on the Draft EA for the proposed Laie Wastewater Collection System Expansion. We acknowledge that you do not foresee any conflicts with the telephone facilities in the project area. If the new pump station requires telephone lines, construction plans will be submitted to your office for review.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

Ua Mau Ke Ea O Ka `Aina I Ka Pono

Hawai`i's Own Environmental & Community Action Group
Protecting Our Fragile Natural and Cultural Resources
Through Research, Education, Advocacy, & Litigation

August 21, 2000

Department of Design and Construction
Infrastructure Design and Engineering
City and County of Honolulu
650 South King Street
Honolulu, Hawai`i 96813
Fax#: 523-4567

Leighton W. K. Lum, Ph.D., P.E.
R. M. Towill Corporation
420 Waiakamilo Road
Suite 411
Honolulu, Hawai`i 96817
Fax#: 842-1937

Office of Environmental Quality Control
State Office Tower
235 South Beretania Street, Suite 702
Honolulu, Hawai`i 96813
Fax#: 586-4186

Re: Preliminary Draft Environmental Assessment for
La`ie Wastewater Collection System Expansion, Phase I

Aloha!

Life of the Land appreciates this opportunity to comment on this Preliminary Draft Environmental Assessment for the La`ie Wastewater Collection Expansion, Phase 1.

We agree that it is important to put more houses on the sewer system and decrease the number of antiquated cesspools and septic systems, which threaten our precious water resources.

76 North King Street * Suite 203 * Honolulu, Hawai`i 96817 * phone/fax: 533-3454/533-0993 *
lifeoftheland@hotmail.com

In reviewing the document, it was unclear to us who the landowners outside the project area are. We know there are kuleana landowners in the La'ie area and we wonder how this project will impact those who farm kalo in lo'i. We would appreciate maps with more detail of the surrounding community as well as identification of the farmers and the crops they grow. This information would help our assessment of the impacts of this proposed project.

Were the surrounding landowners consulted on this project? Were community meetings held to explain the project and gather input from the community? When and where were they held and how was the public notified of such meetings?

Will this project enable further development of this area? The Tuesday August 15, 2000 article in the Honolulu Advertiser entitled "Sewer project planned in La'ie" stated that " in the 1980's HRI planned to build 400 homes, but lack of sewer services has kept construction on hold." If this project is approved, are you planning to build these homes? Is this anticipated development part of the Ko'olauloa *Sustainable* Communities Plan? Where would this new subdivision be?

Section 8 - Determination - (11) states that the sewer collection system will also be below the water table, so polyethylene chloride (PVC) will be used for the pipe material to minimize infiltration and inflow. Do you mean "polyvinyl chloride (PVC)?

We are also concerned with a collection system, which is below the water table. Are there other collection systems in Hawai'i which are below the water table? If so, where are they and how have they performed?

Mahalo for including Life of the Land as a consulted party on this proposed project. Please continue to keep us informed.

Sincerely,

Kat Brady
Assistant Executive Director

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 6, 2000

Ms. Kat Brady
Assistant Executive Director
Life of the Land
76 N. King Street, Suite 203
Honolulu, HI 96817

SUBJECT: Draft Environmental Assessment (EA) for the Proposed La'ie Wastewater Collection System Expansion, Phase 1

Dear Ms. Brady:

Thank you for your letter dated August 21, 2000 regarding the Draft EA for the proposed Lai'e Wastewater Collection System. In response to your comments (*in italic*), we offer the following information:

1. *...It is unclear to us who the landowners outside the project area are. We know there are kuleana landowners in the area and we wonder how this project will impact those who farm kalo in lo'i. We would appreciate maps with more detail of the surrounding community as well as identification of the farmers and the crops they grow.*

Proposed Phase I activities occur entirely on Brigham Young University campus property or within the privately-owned Naniloa Loop right-of-way. There are several small land-locked Kuleana parcels in the vicinity of the proposed pump station. These Kuleana parcels are identified by the following TMK numbers:

TMK	Property Owner	Area (sq. ft.)
5-5-05: 2 5-5-05: 13	Mamie Smith, Trustee	27,878 10,890
5-5-05: 3	Marvin T. Guerrero	27,443
5-5-05: 14	Kealoha Meheula, deceased	9,148
5-5-05: 32 5-5-05: 33	Zion Securities Corporation	62,683 31,189

Although small-scale, garden cultivation occurs on some of these parcels, none of the lots are farmed intensively and none are used for lo'i kalo. Brigham Young University grows papaya trees, and bananas on lands upslope of the project site. Lands west of the pump station are unimproved and not cultivated. Other private agricultural parcels, including Kuleana plots, would not be affected by the project due to their distance away and intervening topography.

The proposed project will not negatively impact agricultural activities in the area. The proposed sewer system will, in fact, benefit the environment by replacing the aging and leaking septic systems and cesspools currently being used with new and more reliable collection and treatment technology.

2. *Were the surrounding land owners consulted on this project? Were community meetings held to explain the project and gather input from the community? When and where were they held and how was the public notified of such meetings?*

Land owners surrounding the project area were not actively consulted on this project. However, the project has been publicized in the Lai'e community over the past year and a half. The local paper *Kaleo o Ko'olauloa* published articles about the project on July 8, 1999 and on August 17, 2000. Additionally, Mr. Daniel T. Ditto, President and CEO of Hawaii Reserves Inc., made presentations on the sewer project at Board and general membership meetings of the Lai'e Community Association.

As part of the normal environmental review process, the Draft EA for the project was published in the July 23, 2000 OEQC Environmental Notice for the 30-day public comment period commencing July 23, 2000. Notice of the comment period was also published in the July 24, 2000 Honolulu Advertiser (page B-3).

3. *Will this project enable further development of this area? If this project is approved, are you planning to build these homes? Is this anticipated development part of the Ko'olauloa Sustainable Communities Plan? Where would this new subdivision be?*

With regard to possible future development, the overall La'ie Sewer Project is planned to meet existing wastewater service needs and to support the removal of aging and leaking cesspools from service. System improvements are designed to carry capacity above existing demand levels in order to accommodate the possibility of future development in La'ie, as planned in the *Ko'olauloa Sustainable Communities Plan* (KSCP).

Although it is described within the overall framework of the La'ie Sewer Project, the proposed project (Phase 1) remains a stand-alone project independent of future development. Phase 1 is being developed to replace the existing sewer main servicing the BYU-H campus and the Polynesian Cultural Center (PCC). After nearly 30 years of use, the existing sewer lines are displaying signs of deterioration and are in need of upgrading. Phase 1 will not expand sewer service and will not increase effluent disposal from the La'ie Water Reclamation Facility. Phase 1 does not involve a commitment to larger actions. Phase 1 improvements will enable additional development within the framework of the KSCP.

If Phase 2 is undertaken in the future, it will provide the benefit of replacing over 700 cesspool and septic systems, most of which are aged and deteriorating, with a modern sewer collection and reclamation system. Instead of raw sewage being released into the ground, sewage and wastewater would be collected and treated to high enough levels for reuse for irrigation. If Phase 2 proceeds, it

will be undertaken in compliance with Chapter 343 HAR environmental impact assessment and public review requirements.

4. *Section 8 - Determination - (11) states that...polyethylene chloride (PVC) will be used for pipe material...Do you mean "polyvinyl chloride (PVC)"?*

"Polyethylene chloride" is incorrect. Section 8 is corrected to read "polyvinyl chloride (PVC)".

5. *Are there other collection systems in Hawaii which are below the water table? If so, where are they and how have they performed?*

Many areas in the State have wastewater collection systems below the water table, including Kapaa and Wailua on Kauai, and Waikiki on Oahu. A low-pressure sewer system, using technology similar to the proposed project, was installed beneath the water table in the Mapunapuna industrial subdivision in 1998. The system was designed by Fukunaga & Associates and constructed by Trenchless Engineering Corporation. The Mapunapuna system has performed well since its installation.

Should you have questions or require additional information, please do not hesitate to contact Mr. Kyle Yukumoto or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL

Hui Malama 'Aina 'O Lai'e
PO Box 607
Lai'e, HI 96762
(808) 293-5333

August 22, 2000

Comment to Laie Wastewater Collection System Expansion, Phase 1 Environmental Assessment.

HUI MALAMA 'AINA 'O LAI'E

My name is Dawn K. Wasson. President of the Board of Hui Malama 'Aina 'O Lai'e. We are a group of Kuleana landowners in the Lai'e area and have been in existence since 1974. It is in this capacity that I, along with Craig Rasmussen, the consultant for HMAL, submit these comments to the proposed expansion of the Lai'e sewage treatment system.

CONTEXT

In Western society it is common to take an individualistic approach to communication. We separate out individual projects or events and remain unconcerned with the broader context of the project or event.

ZSC/HRI has prepared an Environmental Assessment that looks narrowly at their project, but does not consider the broader implications of approving the expansion of the sewer system in Laie. ZSC/HRI has intentionally left out of the discussion an entire class of landowners, Kuleana landowners, and has relegated most of the Kuleana landowners to "future" access to the sewer system, whenever that may be, even though these landowners are the longest residents of the ahupua'a of Laie . . . even longer than Zion Securities itself.

I will structure my comment to this proposed plan in a way that addresses the entire impact of the proposal.

GENERAL CONCERNS

There are three main concerns I hope to address in my comment, and then will touch on some of the specific areas mentioned in the Environmental Assessment.

First is the systematic exclusion and marginalization of Native Hawaiians from the discussion. There were once over 100 Kuleana landowners in the ahupua'a of Laie. Today only a small percentage retain their ancestral lands. Zion Securities/ZSC/HRI was a major reason for Hawaiians being dispossessed of their lands in Laie.

Today, even though ZSC/HRI is fully aware of Kuleana landowners, where these lands are, and what rights these lands give to their holders, ZSC/HRI ignores their existence totally in terms of this proposal.

Secondly, Zion Securities, now ZSC/HRI, has engaged in a systematic campaign to stifle free speech in Laie. As part of the contract for purchasing land that they leased from ZSC/HRI, Mr. Edward Flood and Mr. Ralph Walters were being forced to ONLY support ZSC/HRI should they ever want regulatory approval for either their sewer or water systems.

This blatant violation of our principal of free speech is a concern, in that we now have no way of knowing how many people in Laie oppose the expansion of the sewer system, if they have been silenced by covenants in their deeds for their homes. This practice by ZSC/HRI is only one part of a systematic process of intimidation and scare tactics that ZSC/HRI aka the Mormon Church, uses when faced with opposition.

Further, we are concerned that the present treatment facility is not adequate for the increased usage proposed in the plan. ZSC/HRI fails to mention that there have been numerous spills or overflows since the system was upgraded in response to a consent decree many years ago. If the system cannot handle the 160 homes currently on the grid without periodic overflows, how is it going to handle over 700 homes? How many overflows will there be then? How will these spills impact the environment?

Some time ago, there was action by the City Council of Honolulu, at the urging of Councilwoman Donna Kim that mandated that ZSC/HRI provide service to all of old Laie PRIOR to any new development. The plan, as it stands, does not accomplish this mandate.

SYSTMATIC EXCLUSION OF HAWAIIANS

Kuleana lands are those lands given to the makaainana (commoners) during the Great Mahele of 1848. Many of Laie's

Kuleana landowners were actually given their lands by Kamehameha I prior to the Mahele and then subsequently filed for Kuleana status during the Mahele.

The terms of these Kuleana grants included certain rights not given to any other class of landholder. In part, these rights were the right to water, gathering, fishing and access to other lands for these purposes. These special rights were given in perpetuity. This is important because there are still Kuleana landowners in Laie and those lands will be effected by this proposed expansion of the sewage treatment plant. ZSC/HRI has made no attempt to contact Kuleana landowners for comment or consideration. We believe that this lack of regard for the rights of Kuleana Landowners by ZSC/HRI amounts to discrimination against an entire class of people. Further, if the City enters into an agreement with ZSC/HRI without fully resolving these issues, the City will be just as guilty of discrimination.

ZSC/HRI knows of the existence of these Kuleana lands in many ways. Some Kuleana landowners are afforded a special rate with ZSC/HRI's water company. ZSC/HRI has been ordered, in the past, to restore boundaries that ZSC/HRI had removed, to a Kuleana parcel as well as many other ways where the discussion of Kuleana lands has arisen. Kuleana lands are also clearly marked on the tax key maps, distinguished by their Land Commission Award and Royal Patent numbers.

Further evidence of ZSC/HRI's knowledge of Kuleana lands can be found in Land Commission records from 1970 when BYUH was asking for an expansion of the sewage system. At that hearing, during questioning by the Land Commissioners, Mr. Wes White testified that he had shaded Kuleana lands of Kaio, Nahulu and others, so that they did not appear on the maps he had submitted in support of his application. It also came out at that hearing that ZSC/HRI was using Kuleana lands without permission, running pipes for the sewer system across the Kuleana lands without asking, or compensating the landowners. After this information came to light, President Cameron of BYUH met with the 25 members of the Kaio family and eventually had to return their land to them resurveyed and with proper access. This was the first victory of Kuleana landowners against ZSC/HRI.

ZSC/HRI has engaged in a pattern and practice of on the one hand ignoring Kuleana landowners, and on the other engaging in a plan to dispossess or deny Native Hawaiians their rights to those lands. Zion Securities has used adverse

possession and multiple claims, as well as tax schemes to accomplish this goal. Since ZSC/HRI is an entity wholly owned by the Mormon Church, ZSC/HRI has also used threats of excommunication, disfellowship, revocation of temple privileges, removal from church positions as well as the threat of cancellation of land leases if Church members opposed ZSC/HRI.

The boundaries of the proposed project seem to show a desire by ZSC/HRI to exclude Kuleana landowners. On both the Lai'ekawai and Lai'emalo'o sides of Lai'e, as well as just mauka of the project boundaries there are Kuleana lands just outside of the boundaries of the proposed phases. A simple expansion of the scope of the project by a few hundred feet on either side of Lai'e would include the majority of Kuleana landowners in the first two phases of the project.

As mentioned above there were, at one time, over 100 Kuleana landowners in the ahupua'a. Currently there is Kuleana parcel at or near the proposed new BYUH pumping site. It was a common practice to have burial sites on Kuleana lands. In support of its claim that there are no significant historical or archeological sites on the land in question, ZSC/HRI has used a 1991 archeological study that does not specifically look at the lands to be used. Also, nowhere do I find oral testimony from Kupuna from the families that have/had Kuleana lands in that area as to any burial or other historically significant sites in the area. ZSC/HRI may say that there have been studies of the area and nothing of significance was discovered. This was a tactic used in another case, where BYUH professor William Wallace denied the existence of the entire scope of the Nioi Heiau until further investigation proved otherwise.

In the past there has been testimony from cane field workers that the area in question was kapu. There is further oral testimony that flowers were brought to the site and placed on graves located there.

ZSC/HRI should be forced to fully investigate the proposed site for any burial, cultural or historically significant sites.

LAND CONVENANTS

In a letter dated May 21, 1993, Mr. Lucky Fonoimoana writes to Mr. Edward Flood and Mr. Ralph Walters in regard to their

desire to purchase land that they leased from ZSC/HRI, then Zion Securities.

Attached to the letter were the terms of the sale. Section 3 (i) states in part "You will be required by your deed to cooperate with Zions and NOT TO OPPOSE its efforts. . ." (emphasis added). It goes on in the same section to say in relation to Zions future right to dedicate either the sewer or water system to the City & County of Honolulu that "you will be required by your deed to cooperate with Zions and not to oppose the dedication."

The existence of this letter raises grave concerns as to the accuracy of any testimony, favorable to ZSC/HRI, from landholders or lessee's in Laie in that they too have this covenant burdening their land as well. The existence of this restrictive, and perhaps illegal, covenant certainly makes clear why there would be a lack of opposition from the Laie Community, to any plan that ZSC/HRI puts forward in that most of the land was either purchased or leased from ZSC/HRI/Zion Securities.

CURRENT STATE OF THE FACILITY

There have been numerous reports from residents who live in the general area of the current sewage treatment plant of spills and overflows. Understandably, in light of the previous section, these Laie residents have been reluctant to be identified by name or address for fear of retribution by ZSC/HRI.

Their fear, however, does not reduce the severity of their claim. If the current system, operating at 1/3 capacity, according to ZSC/HRI, is experiencing spills and overflows periodically, what will happen when 600 additional houses are added to the system? Will there be spills "regularly"? It's of grave concern that the current troubles with the plant are not mentioned anywhere in the report.

CITY MANDATE

In the early 1990's the City Council passed a resolution mandating that prior to any new development in Laie, all of old Laie had to be added to the sewer system.

The plan, as stated, does not accomplish this mandate. Many of the oldest parts of Laie are slated for "future" addition to the system, with no time frame given as to when "future" is.

COST

There is no mention in the plan as to the cost of being hooked-up to the sewer system. How are Lai'e residents supposed to make an accurate determination to the value of participating in the sewage system if they are not fully aware of the costs. The ability to make such a decision is further complicated by a lack of data as to the volume of sewage that PCC and BYUH sends to the treatment facility. Are Lai'e residents being asked to subsidize these large wholly church owned entities? It is impossible to answer that question with the information provided.

It is also curious that ZSC/HRI wants to keep the portion of the system that PCC and BYUH use private, even after turning over control of the system to the City & County.

AIR QUALITY

Hawaii Reserves, Inc. (ZSC/HRI) glosses over the impact that increased usage of the treatment plant will have on air quality in the Laie area. Not only do they not talk about current odor problems, but they do not specifically address how they intend to abate the odor problem in the future.

Currently, consistent with the prevailing wind patterns, students in the dormitories at BYU-Hawaii Campus (BYUH) are inundated with the stench from the current sewage treatment plant. With increased usage of the plant, one can only assume that the odor problem will increase as well.

ZSC/HRI does say "However, as a precautionary measure, a new odor control system will be provided. The new odor control systems will provide adequate treatment and minimize long-term impacts on air quality." They do not say, however, how this will be accomplished.

Air quality is also an issue when the expanded sewage treatment system is looked at in an expanded way. As ZSC/HRI needs this plant expansion in order to proceed with already proposed development in Laie, what will the impact of the additional cars be on air quality. The current report is silent on this issue.

ECONOMY

The report seems to intimate that the sewage treatment expansion will be a panacea to the economy of Laie.

Although it is not mentioned in the report, the main reason the expansion of the system is necessary is to accommodate the proposed new housing that ZSC/HRI would like to build in Laie. ZSC/HRI knows that permission to build these new homes is contingent on adding all of old Lai'e to the sewer system as mandated by the City & County of Honolulu.

With 400 new homes will come at least 600 new adults. There are not 600 new jobs being created in the Laie area for these new residents thereby increasing the unemployment rate in the area. A larger labor pool is also a deterrent to higher wages, and therefore will put economic pressure on those who currently hold jobs in the area by allowing employers the ability to hold the line, or even decrease wages.

ZSC/HRI says "Construction activities will stimulate jobs and generate revenue in the community". While it is true that the construction jobs will be added, it will only be for a short time -- 5 months according to ZSC/HRI's schedule for Phase I. There are no guarantees by ZSC/HRI that Laie residents will be hired for the construction work, and therefore any economic benefit could fall to other communities. ZSC/HRI is also known to hire LDS companies from Utah for their larger construction projects. As there is no mention of an intent by ZSC/HRI to use Hawaii labor it can be inferred that a Utah company will be used, thus creating an economic drain on the area as wages and profits are funneled back to the mainland.

TRAFFIC

Again, ZSC/HRI only talks about the impact to traffic in the narrow sense of building the proposed expansion of the sewer system, but since this new system is needed for their proposed development one must look at the impact on traffic created by the addition of 400 new homes in the area.

Currently, when there is an accident on Kamehameha Highway traffic in both directions can be at a standstill for hours. Additional traffic, due to increased population, will certainly increase the number of accidents and create and adverse impact on current Laie residents. Commute times for those who are not fortunate enough to be able to work in their community will increase as well.

RECOMMENDATIONS

That ZSC/HRI be forced to disclose hookup costs to individual landowners in Lai'e, especially Kuleana Landowners.

That Kuleana landowners be given access to all information necessary to determine whether Kuleana landowner rights have been violated.

That Kuleana landowners parcels are always identified on all maps submitted in support of proposals, projects, applications, reports or any other document dealing with land in the Lai'e ahupua'a.

That Kuleana landowners indicated on tax map key No. 5-5-08 and 5-5-05 be included in Phase I of the project.

That based on the flat fee for water afforded some Kuleana landowners, that all Kuleana landowners be afforded a nominal flat fee for sewer service.

That the Native Tenant Rights guaranteed to Kuleana landowners, provided in a deed to George Nebecker and Francis Hammond, representatives of the Mormon Church in 1865, be respected and honored.

That as a matter of policy, that Kuleana landowners be specifically consulted during the planning of any public works project in Lai'e.

That ZSC/HRI release all covenants from the lease or sale of land that prohibits the interest holder from opposing ZSC/HRI. That ZSC/HRI inform and encourage all such interest holder to testify.

That ZSC/HRI provide the community at large with detailed reports of all spills and overflows, as well as a detailed plan as to how they intend to remedy this issue PRIOR to adding any more users to the system.

That ZSC/HRI and the City & County agree in an enforceable way, to being sued for any violation of pertinent laws or regulations.

That ZSC/HRI be asked to further study in more detail, the effects of adding the addition users on the air quality, traffic and economy of Lai'e.

That ZSC/HRI release the specific plan for odor control.

Sincerely,

Dawn K. Wasson
President

Craig R. Rasmussen
Consultant

Memo/Submittal to:
R.M. Towill (Mr. Jim Neirmann)-- Fax: 842-1937; OEQC (Mr. Leslie Segundo)—Fax: 586-4186

Subject: Laie Wastewater Collection System Expansion, Phase 1: Draft EA

From: Dawn K. Wasson

The following submissions are made by way of clarification of what I submitted on August 22, 2000:

1. To the extent that resident kuleana landowners in Old Laie are omitted from the sewer hook up plans proposed, the draft EA is both deficient and defective. Kuleana landowners who are part of Old Laie must be connected up to the proposed new collection system for the 'environmental' reasons which are canvassed in the Draft EA *and because this was mandated by the City Council several years ago.*

2. A Draft EA is an instrument of disclosure. This Draft EA is riddled with inadequate disclosure. For example, no hook up costs are specified although this information has been repeatedly sought from Hawaii Reserves. It is very possible that many households may opt, for reasons of cost, not to hook up to the proposed new system. How will the applicants enforce their hookup promises/plans? And if many households refuse to hook up the so called 'environmental' reasons for the new system are defeated. In my view hook up costs must be disclosed as part of the disclosure requirements of any Draft EA.

3. To the extent that the Draft EA does not contextually address the existing STP and the related disposal system (the Drainfield and the surface water discharge area) and the Federal Consent Decree out of which this emerged and in which it is rooted, there is a further disclosure problem. The Drainfield and the Surface water disposal system must be a part of the 'scaffolding' on which the new collection system is constructed—they are all systemically connected and they all must be revisited.

4. Clearly as the very title of the Draft EA indicates: "..., Phase 1 (emphasis added) the new collection system is part of a larger collection system. *This is a segmented*

application, first one shoe is dropped then the other ones will be dropped later. After Phase 1 there will be Phase 2, then Phase 3, then Phase 4 and associated modifications. Cumulative impacts, particularly on the disposal systems, will not be addressed and in this sense this Draft EA is fatally flawed. Impacts of increased discharges into the drainfield and thence into the SMA area and into nearshore waters is not addressed in the Draft EA. The same for surface discharges over what is a potable aquifer (soil types and conditions, rainfall amounts and other climatic factors must be taken into account). None of this is addressed in the Draft EA.

5. This sewage system has a long history of not working: pumps fail with apparent regularity, drinking water is found to be contaminated (as recently as only two months ago), drinking water drawn from groundwater sources is heavily chlorinated. Here you have a history of other problems as well: in 1990 and several years before and after that the Federal Clean Water Act and the attendant NPDES permits were violated by the applicants. These are applicants, who, because of their track record, are not to be trusted and therefore their statements of disclosure must be examined with great care and with careful scrutiny. [Towill and OEQC should note that HRI promised more than five years ago to do a restoration plan for Nioi heiau and that has still not been done.] Towill's work in the Draft EA and the foregoing areas is sloppy; disclosure is much less than adequate.

The foregoing issues alone are a sufficient basis to *deny a finding of no significant impact and to require the applicants to proceed to a full Environmental Impact Statement.*

But there are other issues too and they are set out here in summary:

a. p.2-1: note the term: waste water will be 'reused primarily for irrigation'—specification needed here as part of disclosure. Some of this water goes into the Drainfield. Details needed. Disclosure highly inadequate.

b. p. 2-2: segmentation is confirmed in the limited details provided here.

c. p. 2-2: Population growth at 'average of 2%'—this figure must be looked at in the light of BYU-H enrollments and increased visitor numbers for PCC—all of which have sewage disposal implications. Will applicants specify in writing caps on BYU-H and PCC visitor level? If not, we have yet another disclosure issue here.

d. p. 2-1: Dedication to the City: disclosure details must be provided.

e. p. 3-2: This hydrology section is in 'shorthand'. Disclosure inadequate.

f. p. 3-3: Hawaiian hunting, gathering and PASH protected rights are not addressed.

The flora and fauna studies are between 7 and 10 years old. They ought to, must be redone.

g. p. 3-3, 4: The water quality analysis/statements are unsupported by any evidence and are in fact, in my view, designed to mislead. They are yet another attempt to falsify history.

h. 3-6: Nioi Heiau not addressed.

i. pp. 3-7 through 3-10; I have several problems with all of these sections covered, in part, in the section that precedes this.

j. p. 3-10 (3.3.3 and 3.3.4): These sections suffer from pronounced inadequate disclosure.

k. p. 3-11: Fire hydrant system is inadequately addressed. There is a report of this in City files. Inadequate disclosure.

l. Applicants should be made to disclose nature and extent of discussions with City about providing water from groundwater sources in La'ie. Here again we have inadequate disclosure.

m. p. 4-3: Whereas it might be that none of the "proposed activities for the development of the pump station and force main, and collection system (Phase1) will involve landds within the SMA" (4.7) you will notice that *no mention is made of the effect of the disposal system (the drainfield in particular) on the SMA area. Yet another example of inadequate disclosure.*

n. p. 5-1. The range of alternatives is inadequate and amounts to inadequate disclosure. I am seeking additional professional advice on this issue.

o. Federal Clean Water Act 604 (b) issues are not addressed in this section (p. 6-1).

p. Applicants have known for 10 years that Hui Malama 'Aina O La'ie and the Hawai'I - La'ieikwai Association have had, and continue to have, a serious interest in waste water and sewage issues in La'ie. Both these organizations are well known to the applicants because they have been involved in extensive litigation with them and their predecessor (Zions Securities) in Clean Water Act and Consent Decree enforcement issues. OEQC will note (p. 7-2) that applicant did not send a copy of the Draft EA to either of these organizations nor did they consult with them.

q. Section 8: Many of the conclusionary statements set out here are fatally flawed. I wish to discuss these with OEQC as soon as possible. By inference some of these matters are addressed in this memo.

The bottom line is this: Applicants ask for a Finding of No Significant Impact (FONSI) for this project. ***This should be denied. The applicants should be ordered to proceed to an full Environmental Impact Statement and thus to make all of the full disclosures of the impact of this project, including cumulative impacts over time, on the environment.***

Please contact the undersigned as soon as possible to discuss this matter further.

Please note that I reserve the right to elaborate further on all of my representations either in person or through delegated representatives as a result of discussions I hope we can have as soon as possible. Mahalo.

Dawn K. Wasson
President, Hui Malama 'Aina O La'ie

P.O. Box 607
La'ie, Hawai'I 96762

Phone & Fax: 293-5533

420 Waiakamilo Road
Suite 411
Honolulu Hawaii 96817-4941
Telephone 808 842 1133
Fax 808 842 1937
eMail rmtowill@hawaii.rr.com

R. M. TOWILL CORPORATION
SINCE 1930

Planning
Engineering
Environmental Services
Photogrammetry
Surveying
Construction Management

December 5, 2000

Ms. Dawn Wasson, President
Hui Malama 'Aina 'O La'ie
P.O. Box 607
La'ie, Hawaii 96762

Subject: Draft Environmental Assessment (EA) for the Proposed La'ie Wastewater Collection System Expansion, Phase 1

Dear Ms. Wasson:

Thank you for your letter dated August 22, 2000 and your supplemental letter received in our office on September 18, 2000. This letter is in response to both of your submittals. As a preface, we have provided the following overview of Hawaii's environmental review process as a framework to our response.

Hawaii's environmental review process is established by Chapter 343, Hawaii Revised Statutes (HRS), and Title 11, Chapter 200, Hawaii Administrative Rules (HAR) of the Department of Health to ensure that systematic consideration is given to the environmental consequences of actions proposed within the State. The process ensures the right of the public to participate in reviewing projects that might result in environmental impacts to their communities.

In accordance with Chapter 343 HRS and 11-200 HAR, the subject Draft Environmental Assessment (EA) was prepared and published in the OEQC Environmental Notice on July 23, 2000. The Draft EA provides a detailed description of the proposed project, and an evaluation of environmental affects related to project activities. Copies of the Draft EA were made available at the public reference desks of the Kahuku Public Library and the State Library in Honolulu. The 30-day public comment period required by 11-200 HAR ended on August 22, 2000.

We have reviewed the letters received during the public review period and have provided responses to all of the comments pertaining to potential impacts from Phase 1 activities. Although Phase 1 is described within the context of the overall La'ie Sewer Project, it is a stand-alone project that provides a valuable service and environmental benefit *independent* of possible future improvements to the sewer system. All comment letters received during the public review period are included in the Final EA with our responses.

In response to your general comments, we offer the following information:

Kuleana

Nearby Kuleana Parcels

The Phase 1 project work will be done entirely on BYU-Hawaii land and along a portion of Naniloa Loop. There are a few small land-locked kuleana parcels in the vicinity of the proposed pump station, but none of them will be directly impacted by the project. Other kuleana plots are not affected by Phase 1 activities due to their distance away and intervening topography.

Archaeology

The State Historic Preservation Division (SHPD) has reviewed and commented on this EA. Project plans include employment of a qualified archaeologist who will monitor work activities according to a state-approved archaeological monitoring plan. SHPD has determined that, with implementation of an acceptable archaeological monitoring plan, proposed Phase 1 improvements to the La'ie Wastewater Collection System will have "no adverse effect" on significant historic sites.

Notice Requirements

Notice requirements for the EA process are established under Hawaii Revised Statutes, Chapter 343 Section 3, Public Records and Notices. Kuleana landowners are part of the public and receive the same public notices as others.

In accordance with Chapter 343 HRS, the Draft EA for the project was published in the July 23, 2000, OEQC Environmental Notice for the 30-day public comment period commencing July 23, 2000. Notice of the comment period was published in the July 24, 2000 Honolulu Advertiser (page B-3).

Additionally, the project has been publicized in the La'ie community over the past year and a half. The local paper *Kaleo o Ko'olauloa* published articles about the project on July 8, 1999 and on August 17, 2000. Additionally, Mr. Daniel T. Ditto, President and CEO of Hawaii Reserves Inc. (HRI), and other HRI representatives, have made presentations on the sewer project at Board and general membership meetings of the La'ie Community Association.

Improvement District Boundary

The issue of the improvement district boundary excluding kuleana parcels (second letter, item 1) is beyond the scope of the Phase 1 project and of this EA. However, we would like to provide the following general information about improvement districts that we hope is helpful to you.

Improvement district boundaries are determined based on densities, public access points for sewer lines, cost-benefit analysis, and zoning, among other criterion. Generally, landowners that do not meet these requirements cannot be included in an improvement district. The kuleana parcels located on TMK: 5-5-04, 05, 06 and 08 do not meet the criteria set out above, and thus were not included within the district boundaries depicted in the future Phase 2 service area.

We appreciate the question you raise about the district boundary line. In our review of the district boundaries, we found a mistake in the northern boundary, as shown in Figure 1.1-2 of the EA for Phase 1. Currently, the proposed northern boundary takes in the Cackle Fresh Store on Kamehemeha Highway, the cluster of homes immediately behind and adjacent to the Store, and the City Corporation Yard. The district does not include any portion of land mauka of these lots. The incorrect northern boundary in Figure 1.1-2 was due to an oversight on our part and will be revised for the final EA.

Covenants that Run with the Land

This issue is beyond the scope of this EA. However, to our knowledge, HRI and their predecessor Zion Securities, Inc. have generally provided substantial discounts to residents in the sale of their fee interest in residential lots. Covenants and restrictions in deeds and leases are negotiated at the time of sale, which involves an exchange of consideration, and covenants are common in land transactions.

Though these covenants are legally binding, HRI and the City are committed to facilitate and solicit community input throughout the sewer improvement district process. It is believed that the benefits of the La'ie Sewer Project will generate a degree of community support that will attenuate the need for adversarial enforcement of these covenants. The project will be a boon to public health and safety, the environment and to property owners, whose property values will likely rise as a result of these new infrastructure improvements.

Current State of the La'ie Water Reclamation Facility

Since the La'ie Water Reclamation Facility (LWRF) expansion was completed in 1997 there have been no spill or overflow incidents at the facility. The LWRF continues to function effectively. There have been spills along various points of the existing collection system due to pipe failures. Existing pump stations have not experienced any operational problems, but the main gravity and force main is over thirty years old. Hence the need for a new collection system. The Phase 1 project will replace the existing collection system with a new gravity collector, pump station and force main. These upgrades will greatly improve system reliability and will benefit environmental conditions by eliminating or substantially reducing the potential for leaks or spills from aging sewer lines.

With respect to item 3 in your second letter (received September 18, 2000) regarding the existing sewage treatment facility and drainfield, we have confirmed that the current wastewater system in La'ie, including the full capacity of the LWRF and disposal system, are approved and permitted by required city and state agencies. The proposed Phase 1 improvements are in compliance with existing LWRF permits.

Your comments (second letter, item 5) further inferred that failing wastewater pump stations recently caused drinking water contamination. We have confirmed that there have been no pump station failures and that the recent contamination reading was from a sample taken from a large, isolated private property owner's distribution system and was likely due to the system not being in

Dawn Wasson's letters.
- HR1/251 covenants
- current La'ie reclam-
- City mandate
- Hook up cost

-resulting in regulations and decrees invested with the authority of the whole assembly.
-COUNCIL

use for a pe ibution system there have been no po up re-testing. Additionally, the Department of Health recently tested La'ie's drinking water at the well source and found no contamination reading. We have seen no information that would demonstrate any en surface water and

C
Tl
wa
or
en
am

x legally convened
x members of hierarchy not
x purpose of carrying out Judicial/doctrinal
x by means of deliberation
x resulting in regulations/decrees invested with authority

ekyeve
ekyeve

o this EA review pro : your comment
1, which adopted the idment. The
Wastewater Treatme pliance with
ealth period before an ment Plan
nat requirement has

Hook-up Cost for Residents (second letter, item 2)
Improvements proposed under Phase 1 do not include residential
costs are outside of the scope of this EA. The question of what re the
collection system is a subject of the sewer improvement district pr
mechanism for Phase 2 of the project.

NCCB
Meeting of bishops

Air quality
Odor emission rates must be kept below the exempt amounts esta re
Rules, Chapter 11-60, "Air Pollution Control". The Department o tes
when an application is made to obtain an air pollution permit for t

Odor will be controlled through the use of a carbon filtration system installed at the pump station. Wastewater entering the pump station will be collected in a sealed, lined, wet-well into which two pumps and two air filtration units will be constructed. One of the air filtration units will remain in continuous operation, the other will serve as a back-up system.

The air filtration units use an exhaust fan to draw air out of the air space in the wet-well and through an activated carbon filter that traps and absorbs odorous compounds before venting to the outside air through a dispersion stack. Activated carbon absorbs a variety of organic and inorganic compounds including hydrogen sulfide (H_2S), the most common odorous gas found in wastewater collection and treatment systems. This information will be included in the Final EA.

Economy
As stated in the EA, projected increases in resident and visitor populations will create new economic opportunities, as well as place greater demands on existing infrastructure. The proposed project will replace the aging collection system to meet existing service needs and is designed to accommodate additional needs in anticipation of future demands. Phase 1 improvements will not have a significant impact on the local economy. Economic impacts from the proposed project will result from construction jobs, services, and procurements in the form of construction supplies and equipment.

use for a period of time. The private distribution system was flushed, is back in use, and there have been no positive readings from the follow up re-testing. Additionally, the Department of Health recently tested La'ie's drinking water at the well source and found no contamination reading. We have seen no information that would demonstrate any measurable connection between surface water and ground water.

City Mandate
This issue is not directly related to this EA review process. However, we believe that your comment was referring to Ordinance 92-141, which adopted the 1992 Development Plan amendment. The ordinance requires that the La'ie Wastewater Treatment facility be brought into compliance with environmental laws for a two-month period before any areas included in the Development Plan amendment could be rezoned. That requirement has been satisfied.

Hook-up Cost for Residents (second letter, item 2)
Improvements proposed under Phase 1 do not include residential sewer connections. Hook-up costs are outside of the scope of this EA. The question of what residents will pay to hook-up to the collection system is a subject of the sewer improvement district process, which is the funding mechanism for Phase 2 of the project.

Air quality
Odor emission rates must be kept below the exempt amounts established in Hawaii Administrative Rules, Chapter 11-60, "Air Pollution Control". The Department of Health will verify emission rates when an application is made to obtain an air pollution permit for the project.

Odor will be controlled through the use of a carbon filtration system installed at the pump station. Wastewater entering the pump station will be collected in a sealed, lined, wet-well into which two pumps and two air filtration units will be constructed. One of the air filtration units will remain in continuous operation, the other will serve as a back-up system.

The air filtration units use an exhaust fan to draw air out of the air space in the wet-well and through an activated carbon filter that traps and absorbs odorous compounds before venting to the outside air through a dispersion stack. Activated carbon absorbs a variety of organic and inorganic compounds including hydrogen sulfide (H_2S), the most common odorous gas found in wastewater collection and treatment systems. This information will be included in the Final EA.

Economy
As stated in the EA, projected increases in resident and visitor populations will create new economic opportunities, as well as place greater demands on existing infrastructure. The proposed project will replace the aging collection system to meet existing service needs and is designed to accommodate additional needs in anticipation of future demands. Phase 1 improvements will not have a significant impact on the local economy. Economic impacts from the proposed project will result from construction jobs, services, and procurements in the form of construction supplies and equipment.

Traffic
The project will result in only minor traffic impacts related to construction activities. Traffic impacts due to future growth are beyond the scope of this EA. From their review of this EA, the State Department of Transportation, City and County Department of Transportation Services and the Honolulu Police Department determined that the Phase 1 project would not result in impacts to roadway facilities or traffic patterns.

Cumulative Impacts (second letter, item 4)
Cumulative impacts result from a series of projects that individually do not generate significant adverse effects, but collectively add up to a significant negative impact on the environment. The La'ie Sewer Project, though broken down into two distinct phases, does not add up to a large, negative impact on the environment. In fact, both Phase 1 and Phase 2 of the La'ie Sewer Project, whether considered individually or jointly, will provide a benefit to the environment by upgrading and integrating the aged sewer system with a new wastewater collection and reclamation system that treats effluent to reusable (R1) quality reuse water.

With regard to possible future growth, the La'ie Sewer Project is proposed to meet existing wastewater service needs and to support the withdrawal of aging and leaking cesspools from service. The system is designed to carry capacity above existing levels in order to accommodate the possibility of future projected needs in La'ie, as planned in the *Ko'olauloa Sustainable Communities Plan* (KSCP).

Although it is described within the overall framework of the La'ie Sewer Project, Phase 1 remains a stand-alone project independent of the future of Phase 2. Phase 1 is being developed to replace the existing sewer main. After nearly 30 years of use, the existing sewer lines are displaying signs of deterioration and are in need of upgrading. Phase 1 will not expand sewer service and will not increase effluent disposal from the LWRF.

If Phase 2 is undertaken in the future, it will provide the benefit of replacing over 500 cesspool and septic systems, the majority of which are aged and deteriorating, with a modern sewer collection system. Instead of untreated, raw sewage being released into the ground, sewage and wastewater would be collected and treated to high enough levels for reuse for irrigation. Phase 2 is intended to be funded through the establishment of a sewer improvement district, a public process that is administered by the City Council and subject to its approval. Phase 2 will be undertaken in compliance with Chapter 343 HRS environmental impact and public review requirements.

Recommendations
In response to the recommendations listed on pages 8-9 of your letter dated August 28, 2000 (*in italics below*), we offer the following in response:

1. *That ZSC/HRI be forced to disclose hookup costs to individual landowners in La'ie, especially kuleana landowners.*

Sewer connection fees have not yet been determined. As previously stated, connection fees will be determined during Phase 2 of the project through the establishment of a sewer improvement district (SID). The SID is a City government funding mechanism for public improvements that assesses each property owner a fair portion of the benefits they derive from the service provided. The SID process is governed by City ordinance.

2. *That Kuleana land owners be given access to all information necessary to determine whether Kuleana landowner rights have been violated.*

Kuleana land owners, like all residents of Hawaii, are protected in their rights of access to public records and information. HRI has never sought to, and is not in a position to deny Kuleana land owners access to public information or legal process.

3. *That Kuleana landowners parcels are always identified on all maps submitted in support of proposals, projects, applications, reports or any other document dealing with land in the La'ie ahupua'a.*

Maps submitted in support of documents dealing with the project area will identify all privately-owned lots when warranted by the proposed action.

4. *That Kuleana landowners indicated on tax map key No. 5-5-08 and 5-5-05 be included in Phase 1 of the project.*

Phase 1 improvements include installation of a trunk sewer line, pump station, and force main. Improvements do not include service connection to residential parcels. Service connections to residential parcels will be handled during Phase 2 through the sewer improvement district process governed by the City Council.

5. *That based on flat fee for water afforded some Kuleana landowners, that all kuleana landowners be afforded a flat fee for sewer service.*

As previously stated, sewer service fees will be determined in accordance with City ordinances. Fees will be applied fairly and consistently for all landowners.

6. *That Native Tenant Rights guaranteed to Kuleana Landowners, provided in a deed to George Nebecker and Francis Hammond, representatives of the Mormon Church in 1865, be respected and honored.*

This issue is outside of the scope of this environmental assessment.

7. *That as a matter of policy, that Kuleana landowners be specifically consulted during the planning of any public works project in La'ie.*

All residents of La'ie, including Kuleana landowners, have the opportunity to participate in plan review through the environmental assessment public comment process. When warranted, public

works projects in the community are presented to the La'ie Community Association and discussed at regularly scheduled Neighborhood Board meetings and, in some cases, at specially held public hearings. The public can also participate in City Council hearings on proposed projects.

8. That ZSC/HRI release all covenants from the lease or sale of land that prohibits the interest holder from opposing ZSC/HRI. That ZSC/HRI inform and encourage all such interest holder to testify.

The issue of covenants attached to land leases or sales between HRI and private individuals is beyond the scope of this environmental assessment. However, we would like to emphasize that lease and sale transactions are freely entered agreements with clearly defined rights and responsibilities accepted by all participating parties.

9. That ZSC/HRI provide the community at large with detailed reports of all spills and overflows, as well as a detailed plan as to how they intend to remedy this issue PRIOR to adding any more users to the system.

By law, HRI must report all facility spills and overflows to the State Department of Health, Clean Water Branch. The Department of Health maintains a log of all wastewater spills and enforcement measures taken. The log is public record. To date, no spills have occurred at the La'ie Water Reclamation Facility (LWRF).

The LWRF maintains a spill response plan that includes measures for facility shut down, spill containment, emergency services contact (ambulance, fire, police), public notification, and reporting to the Department of Health.

10. That ZSC/HRI and the City & County agree in an enforceable way, to being sued for any violation of pertinent laws or regulations.

HRI and the City & County of Honolulu are subject to State and Federal law. No agreement with HRI or the City is required to bring suit against either party.

11. That ZSC/HRI be asked to further study, in more detail, the effects of adding the addition users on the air quality, traffic and economy of La'ie.

The Environmental Assessment prepared for this project addresses project impacts to air quality, traffic, the economy of La'ie, and other concerns. The City and County of Honolulu, Department of Design and Construction and HRI maintain that the mitigation measures proposed in the EA are sufficient to minimize or prevent significant adverse impacts to the environment and economy of La'ie. Based on this assessment, the DDC has issued a Finding of No Significant Impact for this project.

12. That ZSC/HRI releases the specific plan for odor control.

As previously described, odor will be controlled through the use of an activated carbon filtration system installed at the pump station. Emission rates from the odor control system will be kept below the exempt amounts established in HAR, Chapter 11-60, "Air Pollution Control". The Department of Health will verify emission rates when an application is made to obtain an air pollution permit for the project.

With regards to items a through q in your letter received September 18, 2000, we offer the following response:

a. *p.2-1: note the term: waste water will be 'reused primarily for irrigation' specification needed here as part of disclosure. Some of this water goes into the Drainfield. Details needed. Disclosure highly inadequate.*

The current wastewater system in La'ie, including the full capacity of the LWRF, collection system and disposal and discharge system, are approved and permitted by all required city and state agencies. Phase 1 will not result in an increase in effluent to the LWRF. Requisite permits are on file at the State Department of Health. Additional details are beyond the scope of this EA.

b. *p. 2-2: segmentation is confirmed in the limited details provided here.*

Please see previous response above under the heading **Cumulative Impacts**.

c. *p. 2-2: Population growth at 'average of 2%' – this figure must be looked at in the light of BYU-H enrollments and increased visitor numbers for PCC – all of which have sewage disposal implications. Will applicants specify in writing caps on BYU-H and PCC visitor level? If not, we have yet another disclosure issue here.*

As stated previously, Phase 1 improvements are designed to replace a portion of the existing sewer collection system. Phase 1 improvements will not expand the sewer system service area. The proposed sewer lines and pump station have been designed within the limits of the peak design capacity of the LWRF. The LWRF is sized for a design average flow of 0.90 million gallons a day (mgd). Currently, the treatment facility handles a design average flow of approximately 0.30 mgd.

The 2% population growth figure was used as one assumption in establishing design flow rates for the LWRF. Design flows were developed in the "Laie Water Reclamation System Facility Plan" (August 1993) and resulted in the sizing of the LWRF for 0.90 mgd design average flow. The design year for the plant is 2012. The Final EA will be revised to clarify this issue.

d. *p. 2-1: Dedication to the City: disclosure details must be provided.*

The EA adequately discloses the intentions of HRI and the City with respect to the dedication. Further details of the dedication of the sewer system to the City are not yet finalized, thus cannot be provided.

e. p. 3-2: This hydrology section is in 'shorthand'. Disclosure inadequate.

The section on hydrology is adequate for assessing potential impacts. Proposed improvements will benefit the environment by upgrading the existing, deteriorating collection lines with a new, more reliable system. Construction activities and sewer system operations following construction will comply with all federal and state regulations and permits required by the Clean Water Act of 1977.

f. p. 3-3: Hawaiian hunting, gathering, and PASH protect rights are not addressed. The flora and fauna studies are between 7 and 10 years old. They ought to, must be redone.

The proposed project will not interrupt access to hunting areas. Additionally, due to the proximity of residential areas, the Temple View Apartments, and BYU-H campus, hunting is not permitted in the project area. The project site is dominated with common, introduced plant species not identified with traditional gathering practices. Clearing of the project site will not, at any rate, diminish the availability of these plant species as a resource. The project does not occur near the shoreline and does not interfere with access to shoreline resources.

The flora and fauna studies used in this EA accurately describe the current conditions of the project site with respect to potential impacts on plants and animals. Vegetation in the project area, dominated by California grass and other introduced species, is periodically trimmed. No endangered or endemic plant species and no plant species native to the Hawaiian Islands are known within the project site.

g. p.3-3,4: The water quality analysis/ statements are unsupported by any evidence and are in fact, in my view, designed to mislead. They are yet another attempt to falsify history.

We note your opinion concerning the objectivity of the information presented in this section. The water quality information is provided as a background description of the affected environment. Mitigation measures outlined in the EA, and enforced by the State Department of Health, Clean Water Branch through their NPDES permitting process, will ensure that no significant impacts to water quality will result from construction of this project.

h. 3-6: Nioi Heiau not addressed.

The State Historic Preservation Division (SHPD) reviewed the EA and identified the Nioi Heiau complex as being outside of the project area. SHPD has determined that the proposed project will have "no effect" on the Heiau. Their correspondence will be included in the Final EA.

i. pp. 3-7 through 3-10: I have several problems with all of these sections covered, in part, in the section that precedes this.

Your comment is noted. We stand behind the information and evaluation provided in these sections.

j. *p. 3-10 (3.3.3 and 3.3.4): These sections suffer from pronounced inadequate disclosure.*

Your comment is noted. We stand behind the information and evaluation provided in these sections.

k. *p. 3-11: Fire hydrant system is inadequately addressed. There is a report of this in City files. Inadequate disclosure.*

The City and County of Honolulu Fire Department reviewed the EA. In response to their comments, the contractor will be instructed to notify the Fire Communication Center of any interruption to the existing fire hydrant system during the project. This information will be included in the Final EA. The Fire Department raised no other issues regarding the fire hydrant system.

l. *Applicants should be made to disclose nature and extent of discussions with City about providing water from ground sources in La'ie. Here again we have inadequate disclosure.*

The proposed project involves improvements to the wastewater collection system. It does not involve the provision of ground water or water distribution systems. This issue is outside of the scope of this EA.

m. *p. 4-3: Whereas is <u>might</u> be that none of the "proposed activities for the development of the pump station and force main, and collection system (Phase 1) will involve lands within the SMA" (4.7) you will notice that <u>no mention is made of the effect of the disposal system (the drainfield in particular) on the SMA area. Yet another example of inadequate disclosure.</u>*

Discharge of treated effluent from the reclamation facility is approved and permitted by all required city and state agencies. The operation of proposed Phase 1 improvements is in compliance with existing LWRF permits.

n. *p. 5-1. The range of alternatives is inadequate and amounts to inadequate disclosure. I am seeking additional professional advice on this issue.*

Your comment is noted. The proposed design was chosen on the basis of cost, function, and reliability in comparison with the three alternatives (including the "No Action" alternative) described in Section 5. The preferred design represents the state of the art for the sewering conditions in Lai'e.

o. *Federal Clean Water Act 604 (b) issues are not addressed in this section (p. 6-1).*

Clean Water Act 604(b) pertains to federal funding allotted to states for nonpoint source water quality management planning. The proposed project is not using any federal or state funding, thus, the section you reference does not pertain to this project.

p. *Applicants have known for 10 years that Hui Malama 'Aina O La'ie and the Hawai'i La'ieikwai Association have had, and continue to have, a serious interest in waste water and sewage issues in La'ie....OEQC will note (p. 7-2) that applicant did not send a copy of the Draft EA to either of these organizations, nor did they consult with them.*

As previously stated, the Draft EA was made available for public review at the Kahuku Public Library and at the State Library in Honolulu. Availability of the document for review was publicized in the July 23, 2000 OEQC Environmental Notice and in the July 24, 2000 Honolulu Advertiser. Hui Malama 'Aina O La'ie and the Hawai'i La'ieikawai Association have had the opportunity to review and comment on the document through the public review process, in compliance with Chapter 343 HRS, and 11-200 HAR.

q. *Section 8: many of the conclusionary statements set out here are fatally flawed. I wish to discuss these with OEQC as soon as possible. By inference, some of these matters are addressed in this memo.*

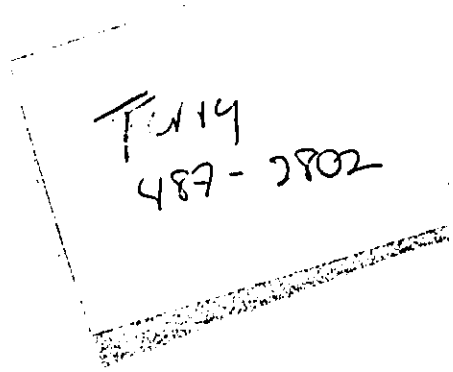
Your comment is noted. Section 8 of the Final EA will be revised to incorporate our responses to comments received during the public review period that are relevant to Phase I improvements.

Should you have questions or require additional information, please do not hesitate to contact me or Mr. Derek Mukai of R. M. Towill Corporation at 842-1133.

Very truly yours,

Leighton W. K. Lum, Ph.D., P.E.
Chief Environmental Engineer

JN:LL


T-N14
487-2802