DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
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87/EIS-10(BWM)

March 7, 1988

Marvin T. Miura, Ph. D, Director
Office of Environmental Quality Control
State of Hawaii
Kekuanaoa Building, Room 104
465 South King Street
Honolulu, Hawaii 96813

Dear Dr. Miura:

Final Environmental Impact Statement (EIS)
West Loch Golf Course and Shoreline Park (March 1988)
City and County of Honolulu
Department of Parks and Recreation
Tax Map Keys:

Golf Course:	9-1-17-Por. 6
	9-1-20-Por. 4
	-19
	9-1-21-15
	-Por. 16
	-Por. 17
	-21
	-Por. 25
	9-1-22-Por. 2
	-Por. 4
	-Por. 5
	-06, 07, 08, 09, 10, 11
	-Por. 13
Shoreline Park:	9-1-17-Por. 4
	-Por. 9
	-14
	-Por. 18

We are notifying you that the above is an acceptable EIS document, pursuant to Chapter 343, HRS, and Title 11, Administrative Rules, Department of Health, Chapter 200, Environmental Impact Statement Rules.

The Acceptance Report identifies three unresolved issues which were not specifically noted in the EIS. These issues are:

(1) whether the filling of the wetlands can proceed with an Army Corps of Engineers nationwide authorization;

(2) whether the construction of the water features for the golf course will compensate for the loss of wetland habitat from the fillings; and

(3) how the project site will be "selectively" monitored by a qualified archaeologist during initial grubbing activity and/or vegetation clearing, and how mitigation will be accomplished for the entire site.

A copy of our Acceptance Report is attached. If you have any questions, please contact Bennett Mark of our staff at 527-5038.

Very truly yours,

JOHN P. WHALEN
Director of Land Utilization

JPW:sl
1675B

attach.

cc: Hiram Kamaka, DPR

DEPARTMENT OF LAND UTILIZATION
87/EIS-10(BWM)

March 7, 1988

ACCEPTANCE REPORT: WEST LOCH GOLF COURSE AND SHORELINE PARK
CHAPTER 343, HRS
FINAL ENVIRONMENTAL IMPACT STATEMENT (EIS)
HONOULIULI, EWA, OAHU
CITY AND COUNTY OF HONOLULU
DEPARTMENT OF PARKS AND RECREATION
TAX MAP KEYS:

GOLF COURSE:	9-1-17-POR. 6
	9-1-20-POR. 4
	-19
	9-1-21-15
	-POR. 16
	-POR. 17
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	9-1-22-POR. 2
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	-POR. 5
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	-POR. 13
SHORELINE PARK:	9-1-17-POR. 4
	-POR. 9
	-14
	-POR. 18

A. BACKGROUND

The City and County of Honolulu, Department of Parks and Recreation (DPR) is proposing to develop a 197-acre, 18-hole municipal golf course and a 39-acre linear shoreline park in the West Loch area of Ewa.

The proposed 18-hole public golf course and shoreline park are located approximately 17 miles west of the primary urban center of Honolulu on the Ewa Plain at Honouliuli. The linear shoreline park fronts the West Loch of Pearl Harbor. The golf course is divided by the Ft. Weaver bypass road, and will be connected by a golf cart underpass at the existing highway bridge. The proposed developments are located between the Ewa community, located to the south west, and the Waipahu community, located to the north east.

Although not part of this EIS document, Increment I and Increment II of the proposed West Loch Estates affordable and elderly housing project straddle this area proposed for a golf course/shoreline park. These increments of the adjacent housing proposal are to provide a total of 1,500 residential units. Increment I proposed to be on the Waipahu side of the proposed golf course and shoreline park, is to consist of 600 single-family units; Increment II proposed to be on the Ewa side of the golf course is to consist of 900 residential units, of which 150 will be allocated for elderly multi-family units.

The 39-acre site for the proposed shoreline park is owned entirely by the James Campbell Estate. Most of the 197-acre site for the golf course is owned by the James Campbell Estate and a number of smaller parcel owners. Negotiations between the landowners and the City and County of Honolulu are currently underway and neither agreement to purchase nor the terms of such an agreement have yet been finalized. The City may proceed with the project by utilizing its power of eminent domain and acquiring the properties through condemnation.

The project area consists largely of gently sloping lands, most of which are presently under sugarcane cultivation by Oahu Sugar Company. Abandoned cane fields covered by weedy species occupy the northern portion of the project area. Pasture lands are found in the middle portion of the property. Wetlands, composed of mangrove swamp and cattail-bulrush marsh, occur along the West Loch boundary. While the wetlands do not contain any species of botanical significance, they do provide habitat for a number of endangered Hawaiian waterbirds. The adjacent Honouliuli Wildlife Sanctuary, located to the south of the project area, provides suitable habitat for endangered waterbirds; this wildlife sanctuary will be retained and so will not be affected by this project.

The golf course is proposed to be an 18-hole championship course owned and operated by the City and County of Honolulu. Other facilities will include a clubhouse, maintenance facilities, a driving range, and a turf farm. The golf course will be divided into two parts by Ft. Weaver Road. Eight of the eighteen holes will be located makai of Ft. Weaver Road with the remaining holes on the mauka side. Golfers will be able to cross the course via an underpass at the Ft. Weaver Road bridge. Lands proposed for the golf course makai of Ft. Weaver

Road are wholly within the flood hazard areas of Honouliuli Stream, and consist of soils that have both a high water table and poor drainage. Fill material will be imported to provide a growing medium for plant material. Honouliuli Stream will be cleared of weeds and overgrown wild cane plants; culverts will be installed where fairways cross the stream.

The fishponds located toward the makai end of the proposed golf course project site will be used as water features for the golf course. Mangroves will be removed in areas where they have encroached into the fishponds. The four ponds located toward the southern end of the site will be cleared and islands constructed within them to provide safe nesting areas protected from wild animals for the migratory waterbirds. An 11,400-square foot clubhouse/ cart storage building will consist of two stories with amenities located on the top floor, and cart storage on the bottom floor. Showers, lockers, and a manager's office will also be included in the clubhouse. The parking lot located adjacent to the clubhouse will be accessible via the entry road from the proposed West Loch Estates Increment I residential subdivision, located to the north of the project. Two buildings totaling 10,080 square feet will be located on the mauka side of the golf course site at Asing Park. The storage building will be 6,800 square feet and the maintenance building will be 3,280 square feet. The maintenance building will include bathrooms, office space, and room for equipment storage, and will be owned and operated by the City and County of Honolulu. A 1.5-acre turf farm will also be developed to provide a supply of material for repair and maintenance of the tees, greens, and fairways, and for use as a plant nursery.

The 39-acre linear park will be maintained by the City and County of Honolulu and will provide public access to the shoreline along the West Loch of Pearl Harbor. The park will be grassed and landscaped. Park furniture, a comfort station, jogging and bike paths, and interpretative displays will be included in the park. Existing piers that extend into West Loch will be restored. By prior agreement with the U. S. Navy, no boating or swimming will be allowed, and signs prohibiting such activity will be posted along the shore.

Existing fish ponds within the shoreline area will be cleared and maintained as one of the park's features. These ponds are intended to enhance the habitats for waterbirds in the West Loch area.

A 300-foot-wide buffer zone will be provided to help screen out any possible light and noise from park users or residents of the proposed southern increment of West Loch Estates, in order to protect the birds in the Honouliuli Wildlife Sanctuary. In the interest of further protecting these birds, a portion of the meandering shoreline pathway for pedestrians and bicyclers will be located away from the wildlife sanctuary, along the inland edge of the buffer zone. Since Chevron's fuel lines and HECO's 46 KV high tension power line run within the OR&L Railroad right-of-way along the shoreline, the pedestrian walkways will also provide access for Chevron USA and Hawaiian Electric Company maintenance trucks as well as for City park maintenance vehicles.

B. PROCEDURE

1. An EIS Preparation Notice (EISPN) was published in the "Office of Environmental Quality Control (OEQC) Bulletin" of September 23, 1987, under the Register of Chapter 343, HRS Documents. This bulletin was distributed to Federal, State, and City and County agencies, as well as interested community groups. Simultaneously, the DPR requested comments on the proposal directly from twenty-nine (29) Federal, State, City and County, and private agencies.

2. The deadline for comments from consulted parties and requests to be a consulted party was set for October 23, 1987. Twenty (20) parties made replies to the EISPN. The DPR made responses to all substantive comments, and included these in the Final EIS.

3. On December 30, 1987, the DPR submitted the Draft EIS to the OEQC and the DLU pursuant to the requirements of Chapter 343, HRS.

4. The announcement of the availability of the Draft EIS was published in the January 8, 1988 "OEQC Bulletin." The deadline for public review was set for February 22, 1988.

5. Twenty-three (23) parties commented on the Draft EIS before the deadline. The U. S. Department of the Navy and the City Department of Transportation Services (DTS) submitted comments after the deadline. The DPR made point-by-point responses to all substantive comments submitted before the deadline, and to the Navy Department's comments even though they were submitted after the deadline. The DPR's responses are included in the Final EIS. No response was made to DTS's comments.

6. The Final EIS was submitted to the DLU on March 7, 1988.

In conclusion, the DLU finds that the applicant has complied with the EIS procedures in accordance with Chapter 200 of Title 11, Environmental Impact Statement Rules, Sub-Chapter 7, Section 11-200-20, 21, and 22.

C. EIS CONTENT

The Final EIS consists of a single volume, containing the EIS, the comments, and ten appendixes. The latter include: (1) "Botanical Survey - West Loch Estates;" (2) "Terrestrial Vertebrate Animals of the West Loch Estates;" (3) "Traffic Noise Impact Study for the Proposed West Loch Estates;" (4) "Air Quality Impact Report - West Loch Estates;" (5) "Environmental Aspects of Storm Water Runoff - West Loch Estates;" (6) "Baseline Marine Surveys, Pearl Harbor, Oahu, Hawaii;" (7) "Traffic Impact Assessment Report for the Proposed West Loch Estates Subdivision;" (8) "Socio-Economic Impact Assessment for Proposed West Loch Estates Subdivision;" (9) "Proposed West Loch Estates Impact on Agriculture;" and (10) "Archaeological Reconnaissance Survey For Environmental Impact Statement, West Loch Estates - Golf Course and Parks."

The Final EIS includes additions, revisions, and clarifications. These principally include the following items:

1. Section 1. Introduction and Project Summary

   a. Page 1-3, which was missing from the DEIS was added; this page included a portion of "1.3 Project Location" and "1.4 Project Overview."

b. Section 1.4.2, the "Golf Course Plan" was revised so that:

(1) the reference to the use of the golf course water hazards as retention basins for flood waters and runoff from West Loch Estates was deleted;

(2) a section was added to note that Honouliuli Stream would be lined in specific areas to prevent extensive erosion;

(3) the description of the proposed buildings was revised so that two (rather than one indicated in the DEIS) maintenance buildings would be utilized; and

(4) the description of the clubhouse was expanded to include additional floor space and to include an additional function as a golf cart storage building.

c. Section 1.5, "Project Timetable and Phasing," was revised so that reference to the phasing of the work on the golf course, first in the mauka and then in the makai increments, was deleted.

d. Section 1.6.2, "Long Term Impacts," was revised as follows:

(1) Part E, "Hydrology" was modified so that (a) the allusion that the golf course would serve as a holding basin and potentially <u>enhance</u> recharge was deleted, (b) the implication that the impact of phosphorous loading would be <u>significantly</u> reduced by the golf course serving as a holding basin was deleted, and (c) the estimate that the increase in runoff was approximately 16 percent greater for the 100-year, 24-hour storm was added;

(2) Part F, "Marine Biology" was revised so that the sections which were repeated verbatim in Section 6.12 "Marine Biology: West Loch" were deleted; and

(3) Part G, "Historic/Cultural Sites," was revised so that the section describing the methodology used for assessment and recommending

general mitigation treatment, the significance criteria for eligibility for inclusion in the State and National Register of Historic Places, and the criteria for establishing the various levels of significance was deleted and moved to Section 6-6, "Archaeology."

2. <u>Section 2 - Proposed Project Description</u>

a. Part 2.2, "Golf Course Plan," was revised as follows:

(1) the statement that the fill material used on the golf course would stabilize that soil was deleted;

(2) the statement that the entire golf course would be inundated during a 100-year storm was revised to indicate that fill material would be used to raise the tees and greens above the 100-year flood level;

(3) the statement that the retention ponds to be constructed would reduce runoff impacts to West Loch and provide capacity for runoff from the abutting West Loch housing project was deleted;

(4) a statement was added indicating that culverts will be used for the golf cart crossings over Honouliuli Stream, and that in some areas a substantial lining of Honouliuli Stream will be required to prevent erosion; and

(5) the notation that improvements to certain sections of Honouliuli Stream mauka of Ft. Weaver Road to protect against the flooding of nearby residents was deleted.

b. Part 2.7, "Drainage," was revised so that the section indicating that the golf course drainage system would provide the necessary capacity to effectively retain and settle runoff from the residential area, golf course, and mauka drainage areas prior to discharge into West Loch was deleted. Also deleted was the stated expectation that the golf course drainage system would minimize the effects of increased runoff.

3. Section 3, Affected Environment

   a. Part 3.1.4, "Flood Plain," was revised as follows:

      (1) the description of Flood Zone X was corrected;

      (2) a description of Flood Zone AE was added;

      (3) the description of the design capacity of the Honouliuli floodway's maximum volume was deleted; and

      (4) the narrative describing the fill requirements for the golf course, the source of fill, and their effect on flood elevations and boundaries was deleted.

   b. Figure 3-3, "wetlands" was revised to show the locations of the fishponds.

   c. Part 3.1.10, "Surface Water Hydrology," was revised as follows:

      (1) the conclusion that additional water recharge at the golf course would be enhanced by the holding basins retaining excess storm runoff was deleted; and

      (2) the statement that a portion of the suspended solids and nutrient content would settle in the holding basins prior to discharge into West Loch was deleted.

   d. Part 3.1.11, "Marine Biology," was revised by deleting the sections which appeared verbatim in Section 6.12 "Marine Biology: West Loch".

   e. Part 3.1.12, "Historic and Archaeological Resources," was revised as follows:

      Figure 3-4 was revised to show the extent of Site No. 3324.

4. Section 6, Anticipated Impacts and Mitigation Measures

   a. Part 6.6, "Archaeology" was revised as follows:

(1) a discussion of the specific mitigation measures for five sites was deleted; and

(2) a new section was added which contained text moved from Section 1.6.2, "Long Term Impacts," Part G, "Historic/Cultural Sites"; portions of Part G were repeated in this new section. This new section contains specific assessments and mitigation measures for seven archaeological sites.

b. Part 6.8, "Air Quality" was revised by the deletion of the section describing the location of the air quality monitoring stations, the specific history of the stations, computer modelling estimates, and the results of a single event sample.

c. Part 6.10, "Hydrology" was revised by the deletion of the statement that the golf course holding basin would be expected to settle a portion of the suspended solids and nutrient content of the storm water runoff prior to discharge into West Loch.

d. Part 6.11, "Flood Plain Conditions," was revised to delete:

(1) the section stating that the stream within the golf course would be channelized; and

(2) the section stating that the golf course would be graded to direct runoff to drainage channels to minimize runoff into adjacent residential areas.

c. Part 6.13, "Traffic," was revised to delete:

(1) the details of the methodology used for estimating traffic volume forecasts;

(2) the projection that the intersections of Ft. Weaver Road with Increment I and II of the West Loch Estates housing would be over capacity by 1991, and that critical traffic flows would be expected in the afternoon peak hour; and

(3) the section with specific recommendations on turning lanes for Ft. Weaver Road.

5. Section 7, Relationship to Plans, Policies, and Controls

   Figure 7-2 was revised to indicate the Residential Development Plan designation of Increment II of the West Loch Housing project.

The Final EIS responded to other substantive comments by letter, but did not reflect these changes in the text. These included:

1. Information that the water from Well EP2 may have a chloride concentration higher than acceptable for irrigation, and that mixing with potable water might be necessary.

2. A statement regarding the unavailability of Oahu Sugar Company's historical records of the agriculture yields of the former cane lands proposed for the golf course and shoreline park.

3. A clarification that no portion of the project area will be located within any fishpond area which might qualify to be designated as part of the State Land Use Conservation District.

4. A description that the proposed retention ponds in the golf course would minimize siltation from average (10-year) storms but not for more severe (100-year) storms, and an acknowledgement that mangrove removal will not take place until the ponds were constructed.

5. An acknowledgement that the proposed cesspools in the golf course will be in a "pass zone" where disposal of wastewaters is permitted.

6. Information that the golf course parking area will not be initially lighted, but that electrical stubs would be installed to facilitate future lighting fixture installation.

7. Acknowledgement that a full archaeological/historical mitigation plan is in the process of being developed.

The Final EIS did not respond to the following concerns which are not considered to be "significant environmental points" as defined in Chapter 200 of Title 11, Environmental Impact Statement Rules, Sub-Chapter 7, at Section 11-200-18. The following concerns need not be addressed in the Final EIS for it to be acceptable:

1. The parking provisions for the golf course and shoreline park.

2. The design of the golf cart road underpass at Ft. Weaver Road.

3. How the transfer of Oahu Sugar Company's EP2 Well (preserved use of 0.5 million gallons per day) to the City for irrigation of the project will impact Oahu Sugar Company's operations.

4. The plans showing the location and extent of restoration of the piers along the West Loch shoreline.

5. An accurate description of the nature and extent (acreage) of the designated wetlands to be affected.

The EIS fulfills the content requirements for a Final EIS in accordance with Chapter 200 of Title 11, Environmental Impact Statement Rules, Sub-Chapter 7, at Section 11-200-18. Unresolved issues are noted in Section E below.

D. RESPONSES TO COMMENTS

The DPR made point-by-point responses to all significant environmental points raised before the deadline. These are reproduced in Section 13 of the Final EIS. The EIS therefore fulfills the public review requirement in accordance with Chapter 200 of Title 11, Environmental Impact Statement Rules, Sub-Chapter 7, at Section 11-200-22. Comments from the U. S. Navy received after the deadline and DPR's response are included in Section 13 of the Final EIS.

The DTS comment letter, also received after the deadline, was not responded to; the DTS comment letter is appended to this report.

E. UNRESOLVED ISSUES

The following were identified as Unresolved Issues in Section 10 of the EIS:

1. The application to the City Planning Commission for Special Use Permits to allow portions of the golf course to be developed on lands with Land Study Bureau Overall Productivity Ratings of "A" and "B" in the State Land Use Agricultural District. (The Final EIS incorrectly notes the State Land Use Commission as the approving body. The City Planning Commission has the authority to approve applications for Special Use Permits of 15 acres or less.)

2. Site Acquisition.

3. City Council Approval.

We note the following unresolved issues:

1. The determination of whether the filling of the wetlands can proceed with an Army Corps of Engineers nationwide authorization.

2. Whether the construction of the water features for the golf course will compensate for the loss of wetland habitat from the fillings.

3. How the project site will be "selectively" monitored by a qualified archaeologist during initial grubbing activity and/or vegetation clearing, and how mitigation will be accomplished for the entire project.

F. DETERMINATION

The Final EIS is determined to be ACCEPTABLE under the procedure established in Chapter 343, HRS.

APPROVED John P. Whalen

JOHN P. WHALEN
Director of Land Utilization

FINAL

WEST LOCH GOLF COURSE & SHORELINE PARK

ENVIRONMENTAL IMPACT STATEMENT

CITY AND COUNTY OF HONOLULU · STATE OF HAWAII

City and County of Honolulu

Department of Parks and Recreation

March 1988

ENVIRONMENTAL IMPACT STATEMENT

FOR

WEST LOCH GOLF COURSE AND SHORELINE PARK

West Loch, Ewa, Oahu, Hawaii

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU

This document is prepared pursuant to Chapter 343, HRS.

PROPOSING AGENCY: Department of Parks and Recreation

RESPONSIBLE OFFICIAL: Hiram Kamaka, Director   3-2-88 Date

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APPENDIX C - Traffic Noise Impact Study, Y. Ebisu & Associates
APPENDIX D - Air Quality Impact Report, J.W. Morrow
APPENDIX E - Environmental Aspects of Storm Water Runoff, G.L. Dugan, Ph.D
APPENDIX F - Baseline Marine Surveys, William A. Brewer & Associates
APPENDIX G - Traffic Impact Assessment Report, Pacific Planning & Engng
APPENDIX H - Socio-Economic Impact Assessment, Community Resources, Inc.
APPENDIX I - Impact on Agriculture, Decision Analysts Hawaii
APPENDIX J - Archaeology Study, Paul Rosendahl & Associates

SECTION 1
INTRODUCTION AND PROJECT SUMMARY

1.1 INTRODUCTION

The City and County of Honolulu, Department of Parks and Recreation (DPR) is proposing to develop a 197-acre, 18-hole municipal golf course and a 39-acre linear shoreline park in the West Loch area of Ewa. These two facilities are being proposed to meet the recreational needs of a growing leeward Oahu population.

Currently, the City and County operates four municipal golf courses: Ala Wai, Ted Makalena, Pali, and Kahuku. The Department of Parks and Recreation manages these golf courses. The Department of Parks and Recreation guidelines call for one golf course for every 100,000 residents. Within the Leeward area, there is only one such course. With the projected population growth in the leeward part of the island, the City has determined that it would be desirable to provide a second public golf course for residents of that area of Oahu.

With the increase in population in the Ewa District, the demands being placed on existing park facilities are beginning to show. The Department of Parks and Recreation guidelines call for eight acres of park land for every 1,000 residents. Based on Oahu's current estimated population of 814,500 persons, approximately 6,516 acres of park land are required. The Department of Parks and Recreation currently has only 4,200 acres of island-based park land. Thus, according to these standards, the need for additional island-based park land is already substantial.

Shoreline access is a major objective of the proposed park. Within the leeward area between Waipahu and Ewa Beach, there are few points with open public access to the water. This proposed action contemplates the dedication of a significant portion of land to achieve this objective.

1.2 PURPOSE

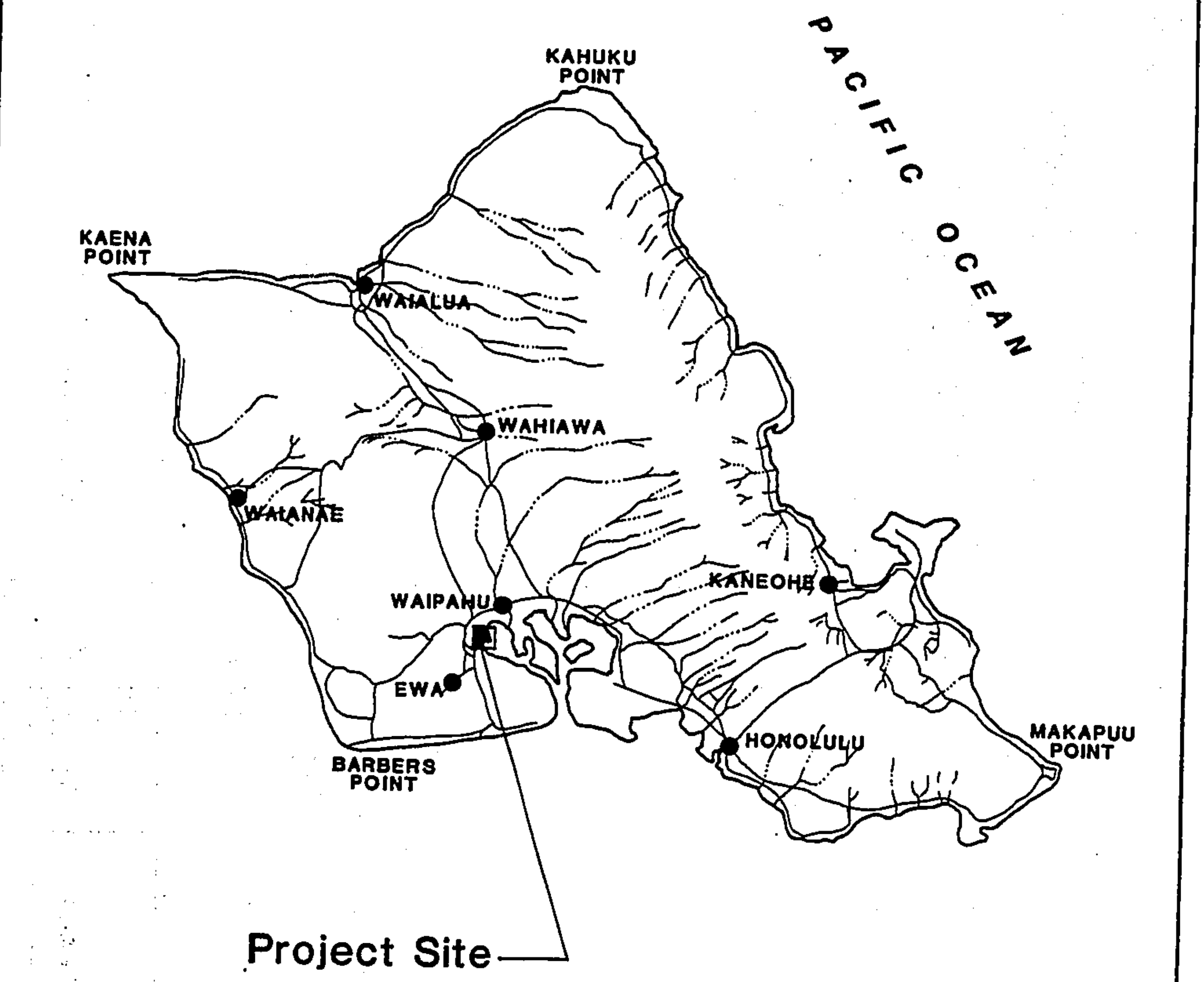
This Environmental Impact Statement is prepared pursuant to Chapter 343, Hawaii Revised Statutes, and the Rules and Regulations of the Office of Environmental Quality Control. The expenditure of public funds for the project triggers the applicability of this chapter.

1.3 PROJECT LOCATION

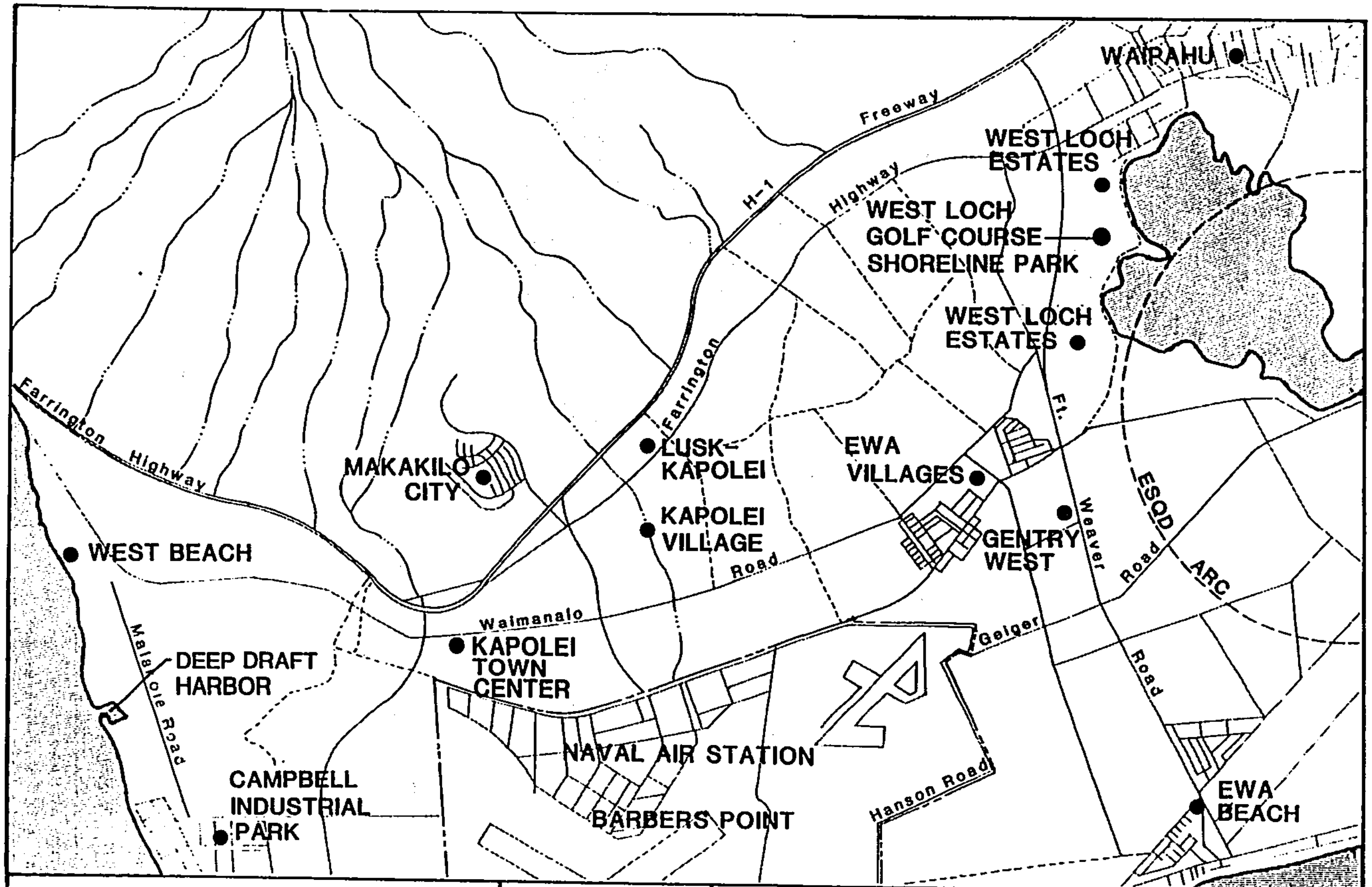
The proposed 18-hole public golf course and shoreline park are located approximately 17 miles west of the primary urban center of Honolulu on the Ewa Plain at Honouliuli. The project location is shown in Figure 1-1. The linear shoreline park fronts the West Loch of Pearl Harbor. The golf course is divided by the Ft. Weaver bypass road, and will be connected by a golf cart underpass at the existing highway bridge. The Ewa and Waipahu communities are located adjacent to the proposed development (Figure 1-2).

The land parcels affected by the proposed project are listed by owner, Tax Map Key, and acreage below:

Development	TMK	Owner	Acreage
Golf Course	9-1-17-por. 6	Campbell Estate	197
	9-1-20-por. 4 -19	and Various	
	9-1-21-15 -por. 16 -por. 17 -21 -por. 25		
	9-1-22-por. 2 -por. 4 -por. 5 -06,07,08, 09,10,11 -por. 13		
Shoreline Park	9-1-17-por. 4 -por. 9 -14 -por. 18	Campbell Estate	39



WEST LOCH **GOLF COURSE & SHORELINE PARK**		Figure 1-1
City and County of Honolulu Department of Parks and Recreation	R.M. TOWILL CORPORATION	**Location Map**



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

N
0 4500'

R.M. TOWILL CORPORATION

Figure 1-2

EXISTING/PLANNED DEVELOPMENTS

The project acreage is less than that specified above as only portions of several parcels are being utilized.

The site is comprised of extensively modified lands, which in recent times have been primarily utilized for sugarcane cultivation and pasture lands. In general, most of the area consists of fallowed cane land with poorly maintained dirt roads and drainage ditches. Ground elevation is relatively low with the highest point at approximately 25 feet where the golf course clubhouse is to be located.

The golf course is proposed to be located within the 100-year flood limits of the Honouliuli Stream. The existing stream course will, to the extent possible, be maintained as an enhancement to the golf course without affecting the drainage characteristics of the area.

Several fishponds, including the Apokeo fishpond, exist within the shoreline zone of the makai portion of the golf course. They will be retained as golf course features, and improved to allow use by waterbirds which inhabit this area of West Loch.

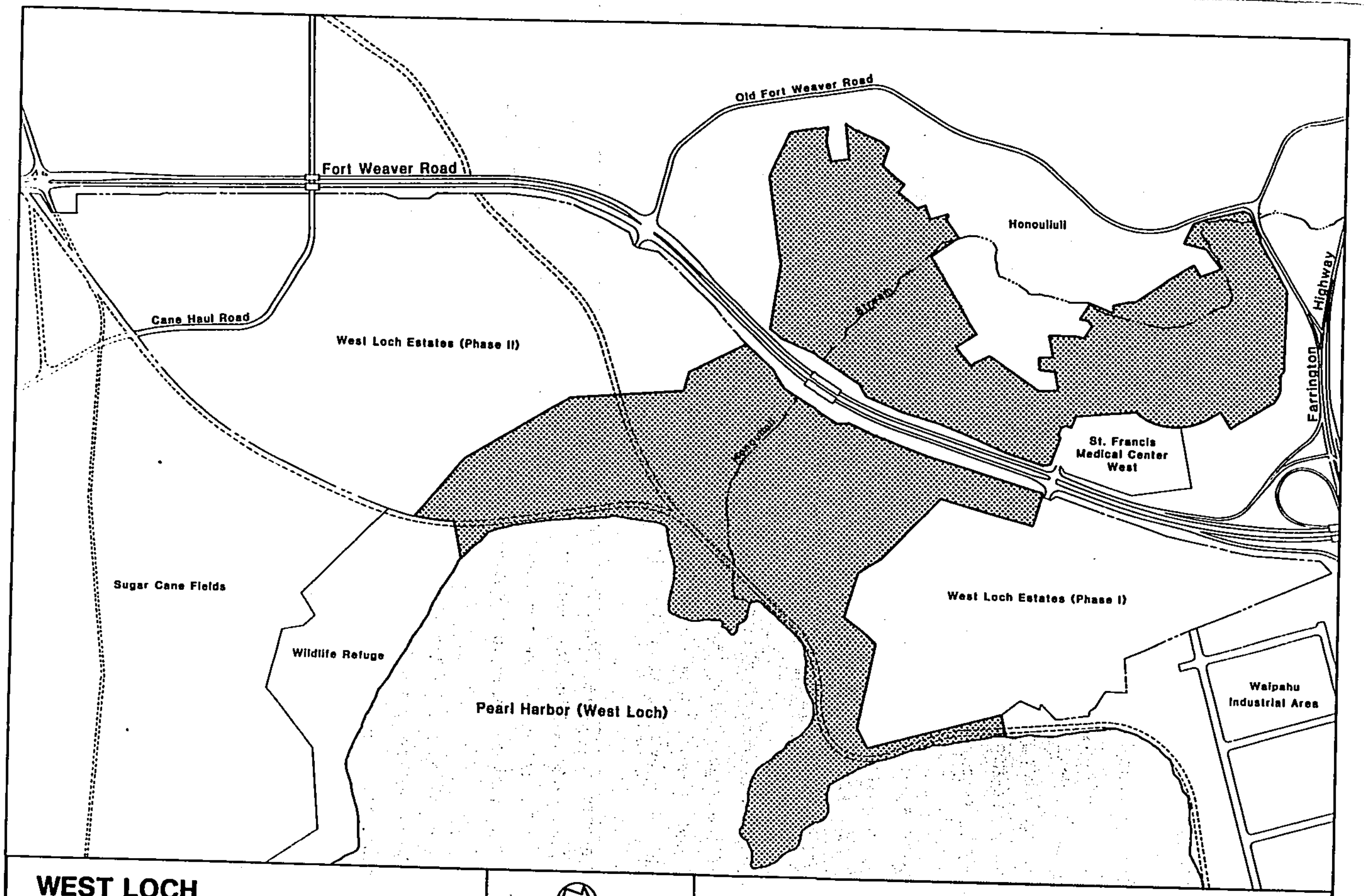
The proposed 39-acre shoreline park will be located within a 120 to 200-foot setback from the edge of West Loch. By prior agreement with the Navy, no boating or other water related activities will be allowed, and warning signs to deter such activity will be posted along the water's edge.

Existing fishponds within the shoreline zone will be retained as one of the park's features and will be improved to allow use by waterbirds which inhabit that area of West Loch.

1.4 PROPOSED ACTION AND ALTERNATIVES

1.4.1 Project Overview

The Master Plan consists of an 18-hole municipal golf course and 39-acre shoreline park. The golf course will be located within the 100-year flood plain of Honouliuli Stream and serve to retain some of the flood water (see Figure 1-3).



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

R.M. TOWILL CORPORATION

Figure 1-3

1.4.2 Golf Course Plan

The golf course is proposed to be an 18-hole Championship Course. Other facilities will include: clubhouse, maintenance facilities, driving range, and turf farm.

A. Golf Course

The golf course will be divided into two parts by Ft. Weaver Road. Eight of the eighteen holes will be located makai of Ft. Weaver with the remaining on the mauka side. Golfers will be able to access both halves of the course via a cart path under the Ft. Weaver Road bridge.

Lands proposed for the golf course makai of Ft. Weaver consist of poorly drained soils with a high water table and are wholly within the 100-year and 500-year flooding zones of Honouliuli Stream. In order to improve the site for the golf course, fill material will be imported to stabilize the soft soils and provide a growing zone for plant material.

The existing Honouliuli Stream course will not be significantly altered except for a few bridge culvert cart crossings. The existing stream will be cleared of weeds and overgrown wild cane plants, and lined as required in specific areas to prevent extensive erosion.

B. Maintenance Facility and Turf Farm

Two buildings totaling 10,080 square feet (s.f.) will be located on the mauka side of the golf course site at Asing Park. One will be a storage building of 6,800 and the other will be a "butler" type maintenance building with bathroom, shower and office. This butler building will be 3,280 s.f. and City and County owned and operated.

C. Clubhouse

The golf course clubhouse/cart storage building will have approximately 11,400 square feet of floor area. It will consist of two stories with amenities located on the upper floor, and cart storage on the bottom floor. Clubhouse amenities will include a snackbar and outdoor dining to maximize the views out toward the golf course and West Loch. The building will be situated on the edge of a 25-foot high escarpment which will command views of the golf course driving range and the first and eighteenth holes. Showers, lockers, and a manager's office will also be included in the clubhouse. The parking lot located adjacent to the clubhouse will be accessible via the entry road of the proposed West Loch Estates' northern Increment I residential subdivision.

1.4.3 Shoreline Park

The major objective of the 39-acre linear park is to provide public open space along the shoreline. This park will feature passive recreational facilities such as jogging and bike paths, as well as benches, landscaping, and interpretive displays, along the shore. Another feature of the park is the peninsula that juts out into West Loch. This land will be grassed and landscaped. Park furniture and a comfort station will be provided at this site. Park users will be able to enjoy the panoramic views over the water as this shoreline park boasts unobstructed views of Waikiki and Diamond Head.

Protection of the birds in the adjacent wildlife sanctuary will be assured by a 300-foot wide buffer zone setback which will help screen out any possible light and noise from park users or residents of the proposed southern increment of West Loch Estates. In the interest of further protecting the birds, a portion of the meandering shoreline pathway for pedestrians and bicyclers will be directed away from the wildlife sanctuary, along the inland edge of the 200 to 300-foot buffer zone.

The park will be maintained by a City and County staff of five persons. Pedestrian walkways will provide access for park maintenance vehicles and for Chevron USA and Hawaiian Electric Company maintenance trucks as Chevron's fuel lines and HECo's 46 KV high tension power line run within the OR&L railroad right-of-way along the shoreline.

Existing piers that extend into West Loch will be restored. By prior agreement with the U.S. Navy, no boating or swimming will be allowed, and signs prohibiting such activity will be posted along the shore. Existing fishponds within the shoreline zone will be cleared and maintained as one of the park's features. These will enhance the habitats for waterbirds in the West Loch area.

1.4.4 <u>Project Alternatives</u>

The project site was selected because it offered two advantages to the community as a whole: it would help to fill a shortage of municipal golf courses on this island while simultaneously making productive use of the makai flood plain for the Honouliuli district of the Ewa region. Furthermore, the municipal golf course and shoreline park enhance the marketability of the surrounding 1,500-unit residential community proposed by the Department of Housing and Community Development.

Alternative sites and configurations for a municipal golf course have been considered within the City and County's designated second urban center but these alternatives would involve higher development costs.

The "no project" alternative must generally assume continued agricultural use consistent with the present State Land Use designation and zoning of the property. The golf course site has been fallowed by the Oahu Sugar Company for several years. Under these circumstances, the "no project" alternative is likely to leave the site without productive use and result in it becoming an eyesore or a blight to the area due to the dumping of trash and junk. This would be a detriment to the owner of the site, adjacent properties, and the community as a whole.

1.5 PROJECT TIMETABLE AND PHASING

The project will be phased in two increments over a 12-month period with start of construction beginning spring 1988.

The development budget, which is provided for budget planning purposes only, is approximately $8.3 million and $1.4 million for the golf course and shoreline park, respectively. These figures are preliminary and subject to change; anticipated costs listed are approximate and do not reflect confirmed estimates.

1.6 IMPACTS AND MITIGATING MEASURES

Impacts of the project can be viewed in the short and long term. Short term impacts generally result from construction related activities. Consequently, these impacts should last no longer than the duration of the construction.

Long term impacts, beneficial and adverse, result from the implementation and operation of the proposed project. Beneficial and adverse impacts, and those which cannot be mitigated, are summarized in this section.

1.6.1 Short Term Impacts

Short term impacts associated with this project are primarily construction related. Noise from construction activities such as trucks, trailers, earth moving equipment and construction crews, will increase during development of the golf course and park. During construction of the facilities, air pollutant emissions will be generated due to grading and general dust-generating construction activities. These impacts can be mitigated through adherence to State and County rules and regulations.

1.6.2 Long Term Impacts

Long term impacts associated with this project include:

A. Traffic

The proposed project will contribute to the overall increase in traffic volume on the major thoroughfares that traverse the area.

A traffic impact analysis conducted by Pacific Planning and Engineering indicates that at project build out (year 1990) the increase in vehicular traffic will be minimal and can be mitigated through design and measures intended to increase the flow of traffic at key intersections.

B. Air Quality

The increase in traffic in the area will be a source of carbon monoxide. An air quality impact analysis conducted by J. W. Morrow indicates that impacts on air quality can be mitigated through design measures intended to encourage the use of mass-transit and multiple ridership of private vehicles.

There is a potential fugitive dust problem during construction due to the relatively low rainfall in the area and the moderate silt content of the soil. This will be especially true during the drier, windier summer months. Strict application of dust control measures will be needed in order to avoid complaints of existing residents and possible violations of State Air Pollution Control Rules.

C. Noise

The increase in traffic will also be a source of additional noise in the area. Impacts and mitigative measures were studied and presented by Y. Ebisu and Associates. Such increases in noise resulting from traffic would have impacts on West Loch Estates residences and mitigating measures are recommended in the form of sound attenuation walls and berms along Ft. Weaver Road or the use of sound attenuating windows for two-story homes.

D. Social Impacts

The development of the golf course and shoreline park will result in the displacement of a number of residents and businesses.

Most of the affected parties are on month-to-month leases. The City and County will provide relocation assistance to those residents and businesses that request such assistance.

E. Hydrology

Estimated stormwater runoff and constituent changes due to the proposed golf course, shoreline park and the adjacent West Loch Estates housing development project indicate that the stormwater runoff volume for the 2-year, 1-hour duration storm under post-development conditions is about 3.5 times greater than predeveloped (1987) conditions, however, as this difference reduces down to approximately 16 percent greater for the 100-year, 24-hour storm.

The calculated increased runoff from the project area correspondingly indicates less groundwater recharge within the project site.

Water quality constituents of general concern include biocides and heavy metals. Typically, the biocides in general use tend to break down more readily compared to the more long lasting types that were used in the past; consequently, except for agricultural runoff, the types and concentrations are usually considered insignificant.

Heavy metals increase as a result of urbanization. However, for a basis of comparison only lead and iron, by a slight margin, actually exceed the primary (Dept. of Health, 1981) and secondary (U.S. Environmental Protection Agency, 1979) drinking water standards, respectively. Because new automobiles have switched to unleaded gasoline since the mid 1970's, lead concentration in residential stormwater runoff would be decreasing.

The proposed golf course water features will help settle a portion of the suspended solids, heavy metals and nutrient content of the stormwater runoff prior to discharge into West Loch.

F. Marine Biology

Despite a history of long term and generally manmade abuse, upper West Loch remains an area of apparent high biological productivity, as witnessed by the extant biomass of desirable and less desirable fish, crustaceans and shell fish. Upper West Loch also remains as one of the least studied areas within the greater Pearl Harbor Basin, a fact that is in part the result of privately owned lands, limited shoreline access (dictated by the circumferential mangrove stands), and absence of U.S. Navy facilities.

With the exception of minor construction induced, short term siltation and sedimentation resulting from mauka grading activities, impacts to estuarine biota in the upper West Loch basin are expected to be inconsequential. The relatively flat topography of the project site should insure that even these minor impacts can be mitigated through judicious use of various erosion control measures, particularly along the Honouliuli Stream and within the surrounding watershed. The prevailing flat coastal plain, numerous ponds, and dense mangrove stands which border the shoreline would appear to provide for silt and sediment containment under the most severe weather conditions.

A change in land use from the existing mauka cane lands to housing and a golf course complex would likely reduce silt and sediment deposition at the mouth of Honouliuli Stream. Existing high stormwater runoff and associated sedimentation may in part be responsible for the aggressive advancement of the mangrove vegetation in the former Matsuyama Fishpond (mouth of Honouliuli

Stream). Given G. Dugan's stormwater runoff calculations (see "Hydrology" impacts section), as well as the estuarine character of upper West Loch, the increased runoff values are not expected to produce any adverse effects to resident biota.

Removal of shoreline mangroves is not expected to produce any significant adverse impacts other than a short term rise in turbidity levels, minor habitat losses, and the loss or dislocation of an inshore fauna of low species diversity (Brewer, 1987). Rhizophora mangle is an exotic species originally introduced into Hawaii from Florida in 1902 to reduce shoreline erosion on Molokai's reef flats (Walsh, 1967). This species (and three other species imported from the Philippines in 1922) has subsequently invaded sheltered bays, estuaries, coastal and anchialine ponds statewide, often displacing indigenous vegetation (Walsh, 1967; Maciolek and Broch, 1974).

Unlike other insular areas in the Pacific where mangroves are indigenous, Hawaiian mangrove swamps do not appear to harbor any distinctive floral or faunal assemblages, nor do they appear to constitute important nursery grounds for indigenous marine or brackish water fauna (Walsh, 1967). Removal of mangrove stands may improve water quality in localized areas by enhancing water circulation and flushing (Brewer, 1987).

Urbanization and the corresponding increased population density associated with the proposed West Loch community, combined with expanded opportunities for shoreline recreation in the Honouliuli region would offer the potential for greater utilization of anticipated park facilities in the upper West Loch basin.

G. <u>Historic/Cultural Sites</u>

An evaluation of the archaeological study findings has concluded that there are no remains that should be classified in the "must preserve" category (see Appendix J). Additional data recovery at several sites is recommended as appropriate. This data recovery is proposed to be accomplished during the construction period. One site has been recommended for some level of interpretive development. Further, a written cultural resource management plan for mitigation work will be developed and submitted to the Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) prior to any work commencing. All mitigation work (data recovery and interpretive development) will be coordinated with DLNR-HSS.

Based on the findings of the combined reconnaissance survey field work, the cultural remains identified within the West Loch Estates Golf Course and Parks project area appear to range, for the most part, from limited to substantial significance in terms of potential information content. Four of the identified sites (Sites 3318, 3320, 3322, 3324) were determined to be significant for their information content only; appropriate mitigation for these four sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. The site-specific scope and scale of data collection and recovery work would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

Two of the identified sites (Sites 3319 and 3321) were determined to be significant both for their information content and for their cultural value because of the presence of one or more human burials. With regard to their scientific research value (information content), appropriate mitigation for these two sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. With regard to their cultural value, appropriate mitigation would involve either continued in-place protection (preservation "as is"), or disinterment of skeletal remains according to current State Health Department regulations and procedures.

One site (Site 3323) was determined to be significant both for its information content, and as an example of a site type. Appropriate mitigation for this site would involve further data collection (including historical documentary and local informant research) and continued preservation with some level of interpretive development. As with the other six sites for which further work has been recommended, the site-specific scope and scale of data collection work, as well as appropriate plans for interpretation, would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

Finally, it is recommended that a qualified archaeologist selectively monitor initial grubbing activity and/or vegetation clearing within the project area. The general significance assessments and recommended general treatments presented here are based on the findings of the combined surface and subsurface reconnaissance survey field work, which involved relatively limited subsurface testing. Therefore, these evaluations and recommendations are given with the general qualification that during any development activity involving the modification of the land surface, there is always the possibility, however remote, that previously unknown or unexpected subsurface cultural features, deposits, or burials might be encountered. In such a situation, immediate archaeological consultation should be sought.

1.7 RELATIONSHIP TO PLANS AND POLICIES

The proposed project, in accordance with Chapter 343, HRS, relating to Environmental Impact Statements (EIS), constitutes an agency action requiring preparation of an EIS. This EIS will be subject to review and acceptance by the Department of Land Utilization.

As indicated by the State Land Use Map, most of the project site is designated for agriculture with the peninsula of the shoreline park designated for urban usage.

The site is also designated for both agriculture and residential use on the Ewa Development Plan Land Use Map.

The site is zoned AG-1 with a small portion of the golf course zoned for R-5 use.

The project generally conforms with the State Plan, the State Functional Plans and the City and County of Honolulu General Plan, and is expected to conform with/and fulfill the policies and objectives outlined by these plans.

1.8 SUMMARY OF UNRESOLVED ISSUES

1.8.1 Land Use Approval

The majority of the land area within the project site is currently designated for agriculture use by the State Land Use Commission. A petition for a Special Use Permit will be filed with the Planning Commission (City and County of Honolulu) to allow the golf course use. Until this petition is filed and approval granted, the project site will remain in an agricultural use.

1.8.2 Site Acquisition

Most of the project site is owned by the James Campbell Estate, however, a number of smaller parcel owners will also be affected. Negotiations between the landowners and the City and County of Honolulu are currently underway and neither agreement to purchase nor the terms of such agreement have yet been finalized. The City may proceed with the project by utilizing its power of eminent domain and acquiring the property through condemnation.

1.8.3 City Council Approval

The West Loch Golf Course and Shoreline Park project is subject to the review and approval of the City Council of the City and County of Honolulu. That body must authorize the condemnation and appropriate funds for construction before the project can proceed.

SECTION 2
PROPOSED PROJECT DESCRIPTION

2.1 PROJECT RATIONALE

The City and County of Honolulu currently operates four municipal golf courses: Ala Wai, Ted Makalena, Pali and Kahuku. The Department of Parks and Recreation manages these golf courses. The Dept. of Parks and Recreation guidelines call for one golf course for every 100,000 residents. Within the Ewa District, there is only one such course.

With regard to utilization rate, the national average for a public golf course is 75,000 rounds of play annually. On three of the four existing municipal golf courses the following are the current average rounds:

Course	Annual Average Play
Ala Wai	200,000 rounds/year
Ted Makalena	165,000 rounds/year
Pali	145,000 rounds/year

The projected population growth in the leeward part of the island has led the City and County to determine that it would be desirable to provide a second public golf course for residents of this area of Oahu.

With the increase in population in the Ewa District, the demands being placed on existing park facilities are beginning to show. The Department of Parks and Recreation sets a standard of eight acres of island based park land for every 1,000 residents. Based on Oahu's current estimated population of 814,500 persons, approximately 6,516 acres of park land are required. The Department of Parks and Recreation currently has only 4,200 acres of island based park land. Thus, according to these standards, the need for additional island based park land is already substantial.

Shoreline access is the major objective of the proposed park. Within the leeward area between Waipahu and Ewa Beach, there are very few areas with open public access to the water. This proposed action contemplates the dedication of a significant portion of land to achieve this objective.

2.2 GOLF COURSE PLAN

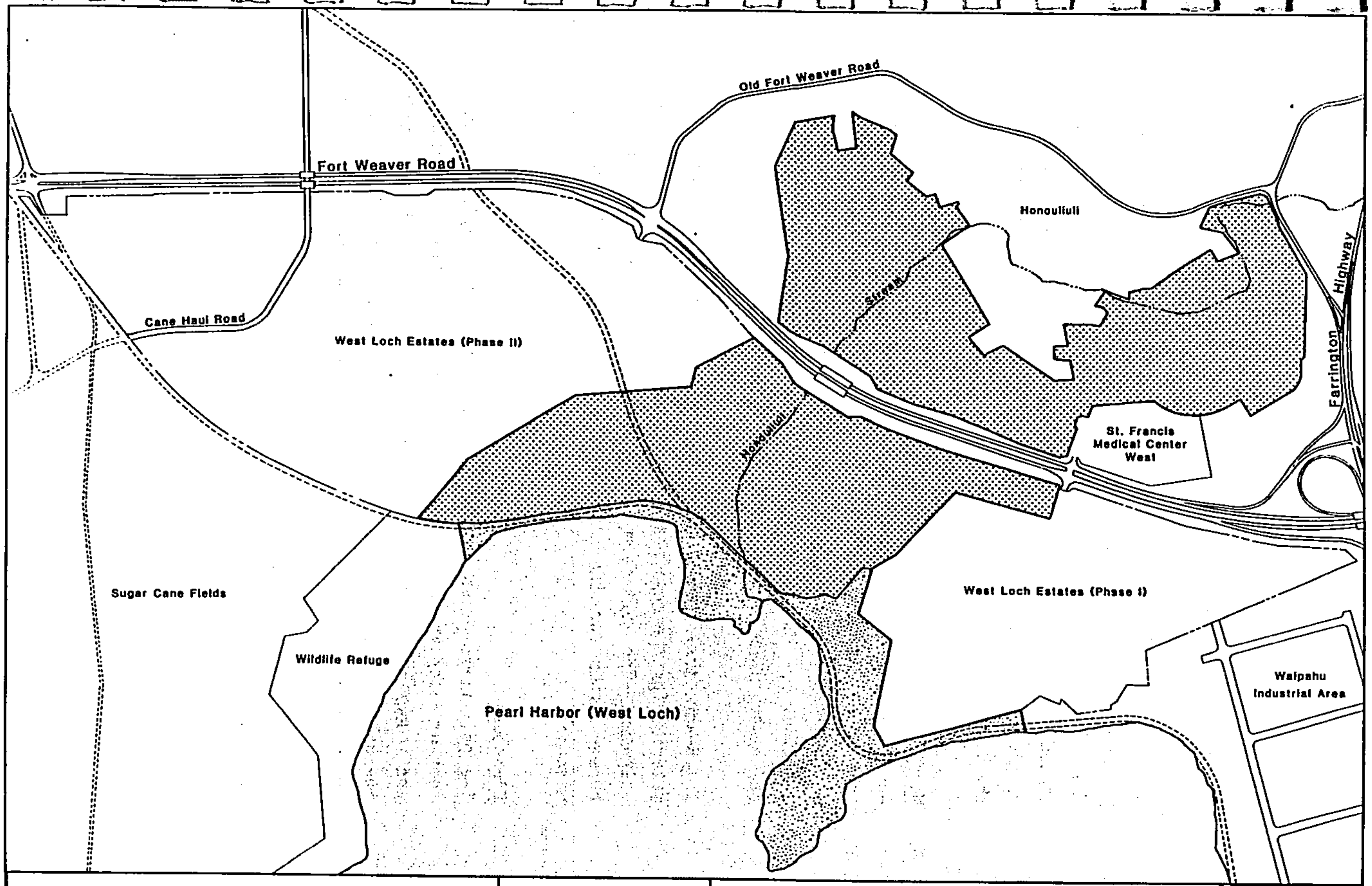
The project Master Plan encompasses approximately 215 acres and provides for a 197-acre, 18-hole municipal golf course and a 39-acre linear shoreline park (see Figure 2-1). The golf course is proposed as a championship par 72 facility. Major components of the golf course plan are described below.

A. Golf Course

The golf course will be divided into two parts by Fort Weaver Road. Eight of the eighteen holes will be located makai of Fort Weaver with the remaining located mauka of Fort Weaver. Golfers will be able to access both parts of the course via a cart path under Ft. Weaver Road.

Lands proposed for the golf course consist of poorly drained soils, have a high water table, and are wholly within the 100-year and 500-year flood plain of Honouliuli Stream. Fill material will be used to create a growing (root) zone for plant material. It is anticipated that the remainder of the golf course (including the cart paths) will be inundated during such a flood.

The existing Honouliuli Stream course will not be altered except in areas where the stream will cross a fairway. In these areas, culverts will be placed for golf cart crossings. The stream course will be a grass-lined channel, except in areas where a more substantial lining is required to prevent erosion.



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

N

400' 0' 400' 800'
SCALE IN FEET

R.M. TOWILL CORPORATION

Figure 2-1
Project Land Uses

Golf Course   Shoreline Park

Fishponds that are currently located towards the makai end of the project site will be used as water features of the golf course. The four ponds located towards the southern end of the site will be cleared and islands constructed within them to provide nesting sites for waterbirds that migrate into the area. The islands constructed within the ponds will provide a safe sanctuary for nesting away from wild cats, dogs and mongoose. The design and construction of these islands will be coordinated with the U.S. Fish and Wildlife Service.

B. Maintenance Facility and Turf Farm

An 8,400 square foot "butler" type maintenance building will be constructed to house maintenance equipment and supplies. It is anticipated that the golf course will provide employment for 15 individuals. The building will include office space, storage, and restroom/locker facilities for the workers.

A 1.5-acre turf farm will be developed to provide a supply of material for the repair and maintenance of the tees, greens and fairways. The turf farm will also be used by the City as a nursery site for the cultivation of various landscaping materials.

C. Clubhouse

The golf course clubhouse will have approximately 6,400 square feet of floor area. Clubhouse amenities will include a snackbar and indoor and outdoor dining areas to maximize the views towards the golf course and West Loch. The building will be situated on the edge of a 25-foot high bluff looking down at the golf course driving range and the first and eighteenth holes. Showers, lockers, and a pro shop will also be included in the clubhouse. The parking lot located adjacent to the clubhouse will be accessible via the entry road of the proposed West Loch Estates' northern Increment I residential subdivision.

D. <u>Other Facilities</u>

A lighted driving range and putting green will also be provided as part of the golf course complex.

Protection of the birds in the wildlife sanctuary will be assured by a 300-foot wide buffer zone setback which will help screen out any possible light and noise from park users or residents of the proposed southern increment of West Loch Estates. In the interest of further protecting the birds, a portion of the shoreline pathway for pedestrians and bicyclers which will be meandering in nature, will be directed away from the wildlife sanctuary, along the inland edge of the 300-foot buffer zone.

2.3 SHORELINE PARK

The shoreline park will include two major sections. The first section includes the Hoaeae Peninsula (see Figure 2-1). This area will be developed as a passive recreation area. The second area includes the area along the old OR&L railroad right-of-way. This area will be developed as a linear park with jogging and bicycle paths.

A. <u>Peninsula Park Area</u>

The peninsula will be developed as a passive recreation area with picnicking areas and walking paths. No vehicular access will be allowed on the peninsula. The site will be cleared of all structures that currently exist along with most of the mangrove that line the peninsula. Shelters will be constructed on the peninsula for use by picnickers. The existing piers that are located along the water's edge will be repaired. By prior agreement with the Navy, no water activities will be allowed. The piers will be used as park features only.

A comfort station will be constructed in an area along the railroad right-of-way for park users.

B. Linear Park

A linear park will be developed along the shoreline to allow joggers and bikers access along the railroad right-of-way. The railroad right-of-way currently serves as an energy corridor for Chevron and Hawaiian Electric Company. An eight-inch oil line is located within the energy corridor along with a 46 KV powerline. The railroad right-of-way is 40 feet wide. A building setback of 40 feet from either side of the right-of-way has been established. There will be no structures constructed within the right-of-way or setback areas. The linear park will be landscaped to enhance the area. The jogging path will also serve as a maintenance road for the oil company and utility company.

The mangrove along the water's edge will be cleared to allow views across Pearl Harbor.

2.4 CIRCULATION SYSTEM

Access to the golf course will be via the entry road constructed for the first phase of the West Loch Estates housing project. From the entry road a driveway will be constructed to access the parking lot and clubhouse.

Access to the shoreline park will be from two locations: the first will be via the main loop road in the first increment of the housing project and the second will be from the second increment of the housing project. A parking area will be provided at the southeastern end of the first increment housing development to serve the park users.

2.5 WATER

Potable water demand for the clubhouse, comfort stations and drinking water fountains for the golf course and shoreline park is estimated to be 15,000 gallons per day. The Board of Water Supply will supply the potable water required by the project from its existing system. The new Waipio Heights Wells III, presently under construction, will technically provide the water for this additional demand. Storage will be provided by a new 228-foot reservoir to be constructed in the Waipahu-Honouliuli area. Utilization of non-potable water to fulfill the irrigation requirements of the project is also planned. An application has been filed with the State Department of Land and Natural Resources (DLNR) requesting transferral of Oahu Sugar Company's EP2 Well (Preserved Use of 0.5 mgd) to the City's Department of Parks and Recreation.

2.6 WASTEWATER

Anticipated sewage flow of 20,000 to 25,000 gallons per day (gpd) from the golf course clubhouse site will be accommodated by the City and County's Waipahu sewer system. This flow will be tied into the first housing increment sewer system. The first housing increment will connect with the Waipahu system and a 1,200-foot long, 12-inch relief sewer is planned to extend from the site to the Kunia Wastewater Pump Station. The line may be upgraded to a 15-inch trunk sewer if necessary. The Waipahu sewer system will have the necessary capacity with the specified improvements. The Honouliuli WWTP currently has the capacity necessary to treat and dispose of the effluent generated by the project.

The comfort station on the golf course will be served by cesspools. The anticipated sewage production will be 800 to 1,000 gallons per day.

2.7 DRAINAGE

On-site drainage will be managed by a street drainage system consisting of underground drain lines, drain manholes, and intake boxes. Most of the runoff from the subdivision system will be discharged into the proposed municipal golf course drainage system where it will ultimately be conveyed to Pearl Harbor.

2.8 TELEPHONE AND ELECTRICITY

Telephone service to the project will be provided by Hawaiian Telephone Company, and electricity will be provided by Hawaiian Electric Company.

Two sets of electrical lines abut the project. An existing elevated line runs along Ft. Weaver Road, containing one 46 KV circuit and one 12 KV circuit. Another electrical line with two 46 KV circuits and one 12 KV circuit runs along the West Loch shoreline and the OR&L right-of-way. Electrical power for the site will come from either the Kahe or Waiau generating plants. It is anticipated that Hawaiian Electric will need a new transformer station at or near the project site. Definitive engineering design will be coordinated with the respective utility firms during the final off-site improvements planning.

Telephone service will be provided by existing switching stations which are located near Waikele Street and Renton Road. An underground telephone cable linking Hickam Air Force Base and Kunia also crosses the mauka portion of the project site.

2.9 PROJECT PHASING

The project will be constructed over a one-year construction period. Construction activities will begin in the mauka half of the project and then progress makai over the construction period.

2.9.1 Golf Course

Construction is expected to begin during the second quarter of 1988 in the mauka half of the project, and then progress makai over the construction period.

2.9.2 Shoreline Park

Shoreline Park construction is expected to commence in the third quarter of 1988 and be completed within a twelve-month period.

2.9.3 Development Costs

The development budget, which is provided for budget planning purposes only, is shown below. The cost estimates are based on 1987 dollars.

A. <u>Golf Course</u>

Earthwork	$2,373,000
Golf Course Features	1,666,000
Landscaping	1,657,000
Maintenance Structures	863,000
Clubhouse	1,500,000
Misc. (fencing, culverts)	247,000
TOTAL	$8,306,000

B. <u>Shoreline Park</u>

Trees, Ground Cover, Grass	$ 279,000
Irrigation	521,000
AC Walk 10' Wide	296,000
	$1,096,000
Structures (picnic tables, comfort sta.)	340,000
TOTAL	$1,436,000

SECTION 3
AFFECTED ENVIRONMENT

3.1 PHYSICAL ENVIRONMENT

3.1.1 Topography

The project site consists of gently sloping lowlands with grades ranging from 0 to 5 percent. Ground elevations within the project site range from sea level along the coastal areas to approximately 65 feet above sea level at the northern limits of the site and 40 feet above sea level at the southern limits.

3.1.2 Groundwater Hydrology

The proposed project site is located within the Pearl Harbor Ground Water Control Area (GWCA), which is regulated by the State Board of Land and Natural Resources (BLNR). In 1980, the BLNR certified the sustainable yield of the Pearl Harbor GWCA at 225 million gallons per day (mgd). In 1985, the BLNR established three subareas within the Pearl Harbor GWCA: the Koolau subarea; the Waianae subarea; and the coastal caprock subarea. The sustainable yield for the Koolau subarea was set at 200 mgd. The Waianae subarea included the Waianae basal aquifer and was determined to have a sustainable yield of 25 mgd. A sustainable yield for the coastal caprock subarea will be determined in the future for brackish water and seawater withdrawals. At present, the Koolau subarea has an unallocated water resource of 90,000 mgd and the Waianae subarea has an unallocated water resource of 5.96 mgd.

The project site is located within the coastal caprock subarea boundary of the Pearl Harbor GWCA.

3.1.3 Soil Types and Ratings

The project site contains a variety of soil types including silty clays, mottled clays, massive clays, coral deposits, as well as mixed soil types. Generally, permeability and runoff are slow, with only slight erosion hazards. Colors of the different soils include dark brown, dark reddish-brown, dark grayish-brown and very dark gray soils. The soils are neutral to slightly acid and workability of the soil is considered difficult.

Ratings for the different soil types are listed in the Land Study Bureau's (LSB) Detailed Land Classification. The classification system ranks soils in five overall productivity categories ranging from the best rank, "A" to the worst rank of "E" (see Figure 3-1). Factors involved in the ranking process were machine tillability, stoniness, texture, clay properties, drainage, rainfall, elevation and slope.

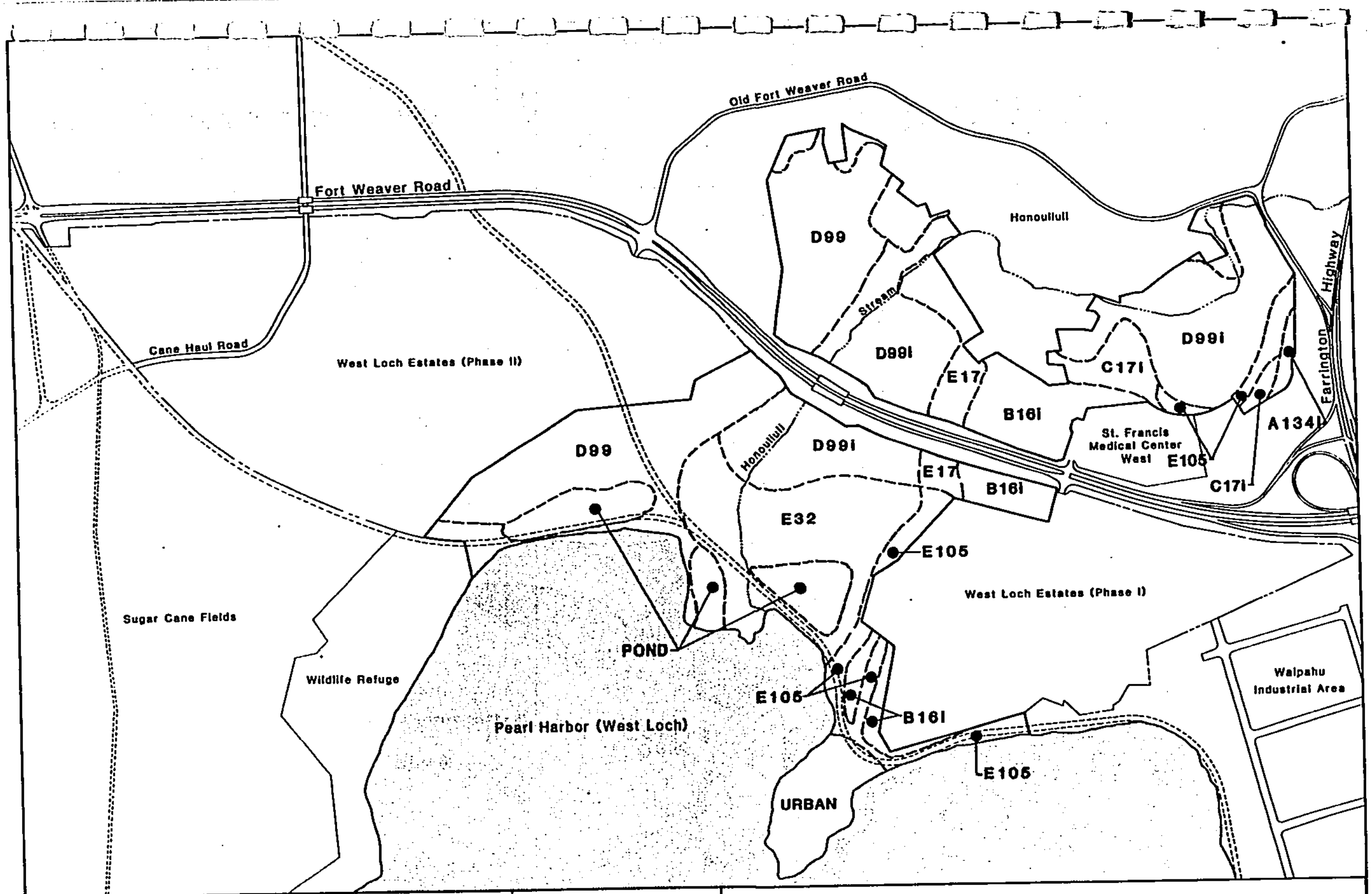
According to the Department of Agriculture, the project lands are largely classified "Prime" and "Other Important" according to the Agricultural Lands of Importance to the State of Hawaii (ALISH) system. (See Figure 3-2)

The following are brief descriptions of the soil types on the site and their LSB ratings:

A. <u>HxA (0 to 2 percent slope), HxB (2 to 6 percent slope), Honouliuli Series</u>

The Honouliuli soil series consists of well-drained soils on coastal plains in the Ewa area. These soils developed in alluvium derived from basic igneous material. They form in gently sloping elevations ranging from 15 to 125 feet above sea level. Average annual rainfall in these areas is approximately 18 to 30 inches per year and occurs mainly between the months of November and April. The mean annual soil temperature is 74°F. Honouliuli soils are geographically associated with Ewa, Lualualei, Mamala, and Waialua soils.

The HxA and HxB soil profile consists of dark reddish-brown, very sticky and very plastic clay throughout. The surface layer is about 15 inches thick. The subsoil and substratum have subangular blocky structures and many slickensides. The soils are neutral to mildly alkaline.



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

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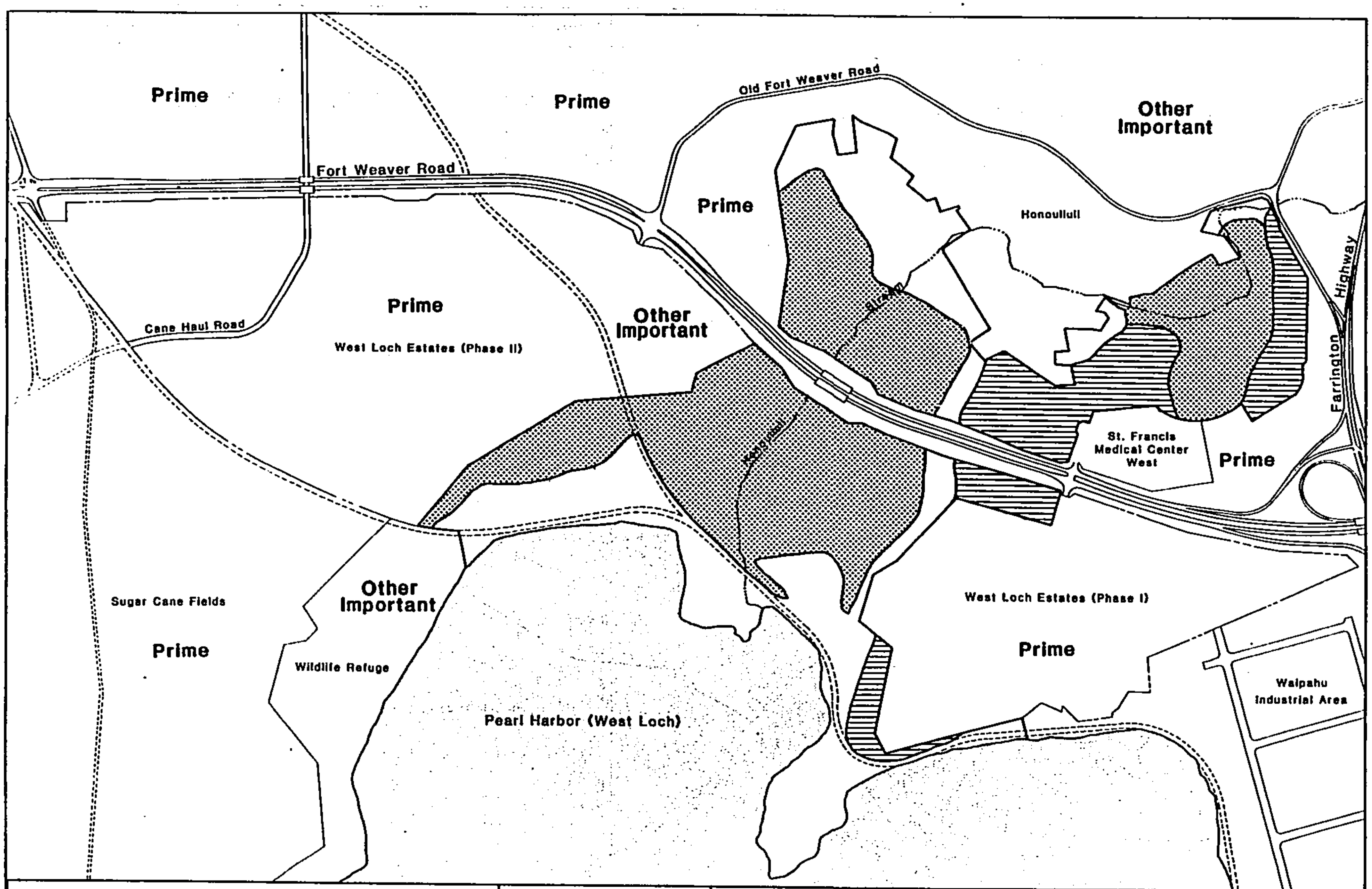
Figure 3-1
Detailed Land Classification
A134i . . . . E105 - Productivity Rating



WEST LOCH

GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

R.M. TOWILL CORPORATION

Figure 3-2
Agricultural Lands Important to the State of Hawaii (ALISH)

Permeability of these soils is moderately slow. Runoff is slow and the erosion hazard is no more than slight. These soils are principally used for sugarcane, truck crops, and pasture. Workability of the soil is considered slightly difficult due to the very sticky and plastic characteristics. The shrink-swell potential is high. The natural vegetation consists of kiawe, koa haole, fingergrass, bristly foxtail, and Bermuda grass. The LSB ratings for these soils are B16i and C17i.

B. <u>HeB (2 to 6 percent slope), Haleiwa Series</u>

The Haleiwa soil series consists of well-drained soils on fans and in drainageways along the coastal plains. They developed in alluvium derived from basic igneous material. They are nearly level to strongly sloping. Elevations range from sea level to 250 feet. Annual rainfall is 30 to 60 inches per year, most of which occurs in the months between November and April. The mean annual soil temperature is 73°F. Haleiwa soils are geographically associated with Waialua and Kawaihapai soils on the Island of Oahu.

A representative profile of the HeB soil type includes a 17-inch thick surface layer consisting of dark brown silty clay. The subsoil and substratum layers, which may reach a depth of more than 5 feet, are dark brown and dark yellowish-brown silty clay with a subangular blocky structure. The soil is neutral to slightly acid.

The HeB soil is characterized by slow runoff and slight erosion hazards. Uses of the soil include sugarcane, pineapple and truck crops. Natural vegetation occurring with this soil includes koa haole, lantana, guava, Christmasberry, Bermuda grass and fingergrass. The LSB rating for these soils are B16i and C17i.

C. <u>HLMG (30 to 90 percent slope), Helemano Series</u>

The Helemano soils are well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. They developed from alluvium and colluvium derived from basic igneous rock. Slope percentages are steep to extremely steep with elevations ranging from 500 to 1,200 feet above sea level. Average rainfall for these soils is 30 to 60 inches per year and soil temperatures average 72°F. Helemano soils are geographically associated with Lahaina, Leilehua, Manana, Molokai, and Wahiawa soils.

A representative profile of the HLMG soil type includes a dark reddish-brown surface layer approximately 10 inches thick. The subsoil, approximately 50 inches thick, is dark reddish-brown with a dark red silty clay that has a subangular blocky structure. The substratum is soft, highly weathered, basic rock. The soil is neutral in the surface layer and neutral to slightly acid in the subsoil.

Permeability of the soil is moderately rapid. Runoff is medium to very rapid, and the erosion hazard is severe to very severe. This soil is used for pasture, woodland, and wildlife habitat. natural vegetation occurring with this soil includes Bermuda grass, Christmasberry, eucalyptus, Formosa koa, guava, Japanese tea, Java plum, and koa haole. The LSB rating for this soil is E105.

D. <u>Kfb, Kaloko Series</u>

The Kaloko soil series consists of poorly drained soils on coastal plains. These soils developed in alluvium derived from basic igneous rock and deposited over marly lagoon deposits. The soils are nearly level in slope with elevations ranging from sea level to 20 feet above sea level. Average rainfall for these soils is 20 to 25 inches per year and soil temperatures average 73°F. Kaloko soils are geographically associated with Keaau, Pearl Harbor and Waialua soils.

The Kfb soil type occurs in slight depressions on coastal plains. The surface layer of the soil is very dark, grey clay. The subsoil and substratum layers are massive clay and silty clay. The soil is neutral to slightly acid throughout.

Permeability of the soil is slow. Runoff is ponded to very slow, and the erosion hazard is none to slight. The natural vegetation consists of kiawe, klu, Bermuda grass, and annuals. This soil is typically used for pasture and sugarcane purposes. The LSB rating for this soil is B16i.

E. <u>KmaB (2 to 6 percent slope), KmbA (0 to 2 percent slope), Keaau Series</u>

This series consists of poorly drained soils on coastal plains. These soils developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level to gently sloping. Elevations of this soil range from 5 to 40 feet. Average rainfall is 20 to 35 inches per year with most of the rainfall occurring between the months of November and April. The mean annual soil temperature is 73°F. These soils are geographically associated with Kaloko, Mokuleia, and Pearl Harbor soils.

These soils have a representative profile consisting of a surface layer (about 15 inches thick) of very dark grayish-brown clay. The subsoil (about 19 inches thick) is very dark grayish-brown and dark born mottled clay that has a subangular and angular blocky structure. The substratum is white to very pale brown reef limestone or consolidated coral sand. The soil is mildly alkaline in the surface layer and subsoil and moderately alkaline in the sustratum.

KmaB soil is characterized by a sufficient amount of stones to hinder cultivation. Runoff is slow and the erosion hazard is slight. This soil is used for sugarcane and pasture.

KmbA soil is strongly affected by salts within the soil profile occurring where seepage water evaporates. Under natural conditions KmbA soil areas remain idle or are used for pasture. The LSB rating for these soils are E32, C17i and B16i.

F. Ph, Pearl Harbor

The Pearl Harbor soil series consists of very poorly drained soils on the nearly level coastal plains. These soils developed in alluvium overlying organic material. Elevations of the soil range from sea level to 5 feet above sea level. Average annual rainfall is 18 to 40 inches per year with an average soil temperature of 74°F. Pearl Harbor soils are geographically associated with Hanalei, Kaloko, and Keaau soils.

A profile of the Ph soil type includes a 12-inch thick surface layer of very dark gray mottled clay. The 19-inch subsoil is very dark gray and very dark grayish-brown mottled clay that has an angular and subangular blocky structure. The substratum is muck or peat. The soil is neutral in the surface layer and mildly to moderately alkaline in the subsoil.

Permeability of the soil is very slow and runoff is very slow to ponded. The erosion hazard is considered slight. While workability of the soil is difficult, the soil is used for taro, sugarcane and pasture. Natural vegetation occurring within this soil includes cattails, mangrove trees, California grass, and sedges. The LSB ratings for these soils are D99 and D99i.

G. WzA (0 to 2 percent slope), WzC (6 to 12 percent slope), Waipahu Series

The Waipahu soil series consists of well-drained soils on marine terraces. These soils developed in old alluvium derived from igneous rock and are nearly level to moderately sloping. Elevations range from sea level to 125 feet above sea level. Average rainfall is 25 to 35 inches per year, mostly occurring between the months of November and April. The average soil temperature is 75°F. Waipahu soils are geographically associated with Hanalei, Honouliuli, and Waialua soils.

A representative profile of these soils consists of a 12-inch thick, dark grayish-brown, silty clay with a prismatic structure that is very sticky and very plastic in the lower part. The substratum is alluvial clay. The soils are slightly acid in the surface and subsoil layers.

Permeability of the WzA soil type is moderately slow and runoff is slow with an erosion hazard of none to slight. This soil is used for sugarcane and homesites.

The WzC soil type has a medium runoff and a moderate erosion hazard. This soil is also used for sugarcane and homesites. The LSB ratings for these soils are B16i and C17i.

3.1.4 Flood Plain

It should be noted that according to the Flood Insurance Study for the City and County of Honolulu, the project parcels are located in the following designated zones:

A. Zone A

Zone A is a special flood hazard area inundated by the 100-year flood, determined by approximate methods; no base flood elevations determined for the site.

Zone AE

Same as Zone A, except determined by detailed methods; base flood elevations determined.

B. Zone X

Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with a drainage area less than 1 square mile; and areas protected by levee from the 100-year flood. Zone X has been also designated as areas outside he 500-year flood.

C. Zone D

Zone D represents unstudied areas under the Federal Insurance Administration study and is an area of undetermined but possible flood hazards. No information on potential flood hazards has been identified for this area.

The majority of the proposed golf course is located in the Honouliuli Flood Plain separating the two residential phases of the proposed West Loch Estates. The mauka portion of the golf course west of Ft. Weaver Road is fallowed sugarcane land with attendant weeds and some brush. The majority of the golf course is located in the flood plain, classified as Zone AE in terms of flood hazard, as identified by the Federal Insurance Administration Flood Insurance Rate Map (National Flood Insurance Program). This implies that the land could be inundated by the 100-year flood. Areas close to the streambed are designated as the floodway, which is the area for the passage of the 100-year flood.

The remainder of the golf course and the shoreline park are classified as Zones X and D which respectively denotes areas of minimal flooding and areas of undetermined, but possible flood hazard (City and County of Honolulu, 1980). The golf course will be designed in accordance with general provisions of the City and County's Land Use Ordinance, which calls for no adverse effects (i.e., rise in flood water level) to the 100-year flood elevations.

The project site is located in a relatively dry area with median annual rainfall of approximately 23 inches. The site is underlaid by the water restricting caprock.

3.1.5 Climate

The climate of the project area is constant and relatively dry, with prevailing tradewinds coming out of the northeast. Wind data gathered from Naval Air Station, Barbers Point (located southwest of the project site) reveals the dominant wind regime is the northeast tradewinds which blow 85 percent of the time at an average of 9 knots per hour.

Temperatures in the Ewa Plain area range from 72 to 80°F. Climate data (1986) taken from Honolulu International Airport (located southeast of the project site) reveals the average temperature for the warmest month is 81°F. The average temperature for the coolest month is 72.6°F. Extreme temperatures were recorded at 94°F as the highest temperature and 53°F as the lowest temperature.

The Ewa Plain experiences light rainfall amounts of approximately 23 inches per year. Most of this rainfall occurs between the months of November and April.

3.1.6 Flora

A botanical survey for the project site was conducted during July 1987 by Char & Associates. The report is attached as Appendix A and is summarized below.

The project area consists largely of gently sloping lands, most of which are presently under sugarcane cultivation by Oahu Sugar Company.

Abandoned cane fields covered by weedy species occupy the northern portion of the project area. Scattered patches of scrub vegetation are generally found along the perimeter boundaries of the cane fields. Pasture lands are found in the middle portion of the property and wetlands, composed of mangrove swamp and cattail-bulrush marsh, occur along the West Loch boundary.

The vegetation on the proposed West Loch Estates Development is dominated by introduced (or alien) species. Of a total of 164 plant species inventoried, 86.6 percent or 142 species are introduced; 16 are indigenous, i.e., native to the islands and elsewhere; 1 is endemic, i.e., native only to the islands; and 5 are of early Polynesian introduction. There is little of botanical interest on the project site. The native species are found in similar environmental habitats throughout the islands. Some plants, such as the koali (Ipomoea cairica), koali-'awania (Ipomoea indica), 'uhaloa (Waltheria indica), and hoary abutilon (Abutilon incanum) are considered rather "weedy" natives which do well in open, more or less disturbed areas. None of the native species are considered rare, threatened or endangered.

While the wetlands do not contain any species of botanical significance, they do provide habitat for a number of endangered Hawaiian waterbirds. The cattail-bulrush marsh around the Apokeo Fishponds is especially valuable as wetland habitat (see Figure 3-3).

3.1.7 Wildlife

A study of wildlife within the project site and vicinity was conducted during August 1987 by Andrew J. Berger. The study is attached as Appendix B and is summarized below.

The terrestrial vertebrate study indicated that the project area had been drastically disturbed for more than 100 years and there was no evidence of an endemic ecosystem in the vicinity of the project area. Amphibians and reptiles are found throughout the islands; however, all have been introduced and none are threatened or endangered species.

Many of the endemic birds, which are unique to the Hawaiian Islands are classified as endangered or threatened species and a Fish and Wildlife Service (FWS) refuge is situated adjacent to Increment II.

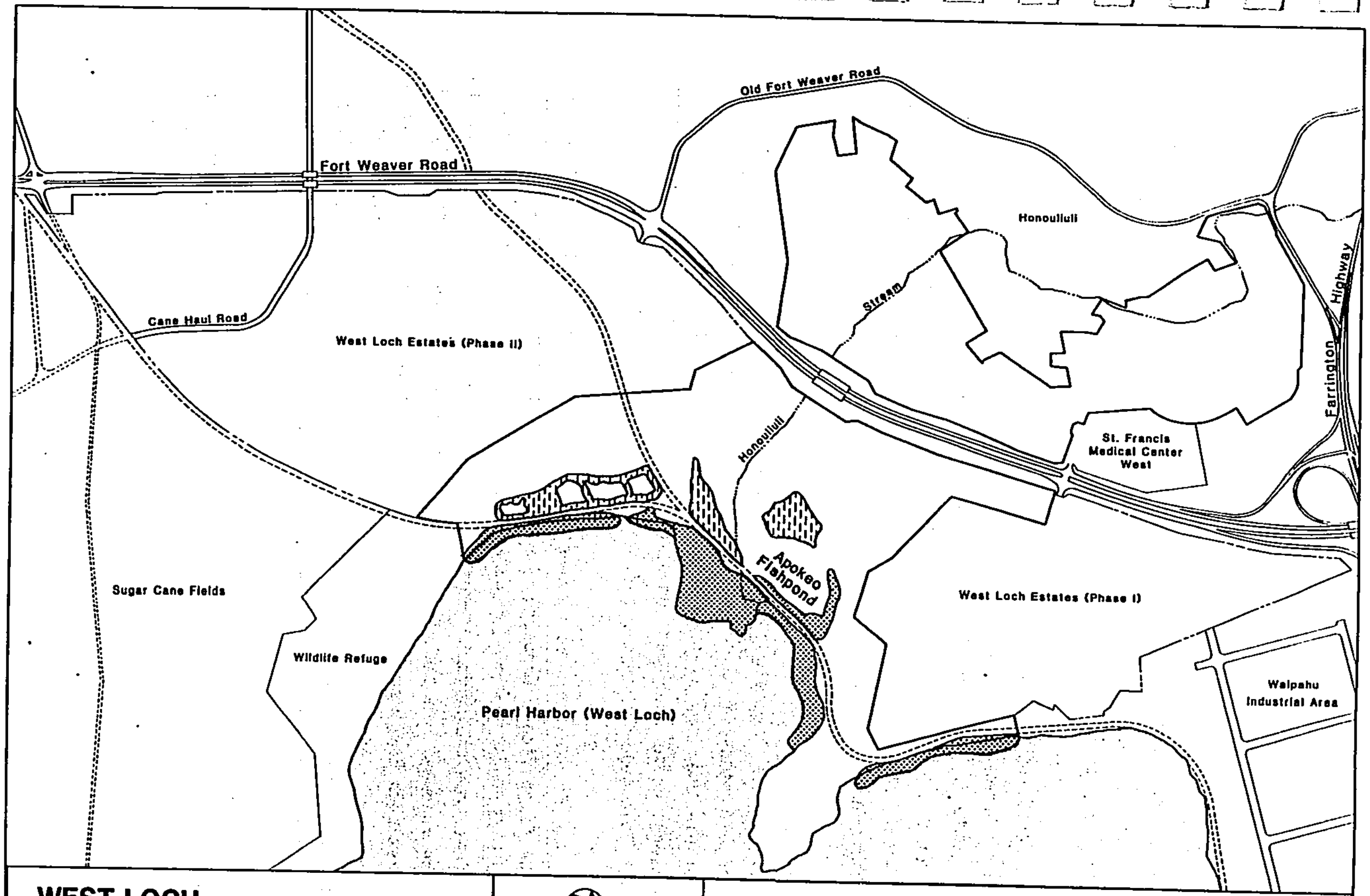


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Figure 3-3

Wetlands

Indigenous birds, which occur naturally in Hawaii and in other parts of the world, are found in the project area. These primarily consist of black-crowned night herons and migratory winter residents such as the golden plover. No indigenous nesting seabirds are found in the vicinity of the project site.

Introduced birds are also found throughout the project site; however, none are considered threatened or endangered species. Introduced mammals are also likely to be found on the project site. None are considered to be threatened or endangered and most have been proven to be detrimental to man, his buildings, products, agricultural crops and/or to native forests and their animal life.

3.1.8 Noise

Existing noise levels within the project site and vicinity have been subject to study by the U.S. Navy as part of the Air Installations Compatible Use Zone (AICUZ) program for NASBP (U.S. Navy 1984). An additional noise study was conducted by Y. Ebisu & Associates during August 1987. This study is summarized below and is attached as Appendix C.

Along the Ft. Weaver Road right-of-way, existing traffic noise levels are in the "Significant Exposure, Normally Unacceptable" category. Existing setback distances to the 65 Ldn contour line are estimated at 235 feet and 128 feet from the centerline of the roadway at the north and south sections of the roadway. In the vicinity of the proposed residential subdivisions of West Loch Estates, which are located on the Diamond Head (east) side of the roadway, existing traffic noise levels are in the "Significant exposure, Normally Unacceptable" category (approximately 67 to 73 Ldn) along the first row of proposed lots which will front the highway.

In the vicinity of the Renton Road intersection, existing residences of Fernandez Village are in the "Moderate Exposure, Acceptable" category due to the large setback distances (240+ feet) from the centerline of Ft. Weaver Road, and due to the lower vehicle speeds near the signaled intersection. To the north, the existing Hale'O Ulu School on the west side of Ft. Weaver Road is exposed to traffic noise levels of 65 to 70 Ldn, which are considered "Unacceptable" for naturally ventilated schools. Existing quonset huts on the project site and south of the Honouliuli Stream Bridge are in the "Significant Exposure, Normally Unacceptable" category (approximately 65 to 70 Ldn). These existing structures will be removed under the proposed project development plan.

Along the existing cane haul road which runs through the southern portion (Increment II) of the project, cane haul trucks are the dominant noise sources during the harvesting season, which occurs on a 2.5-year cycle.

During a peak harvesting day of 24-hour operation, cane haul truck noise levels could exceed 65 Ldn within a 190-foot setback distance from the haul road's centerline. However, average Ldn values for the 190-day harvest season or for the 365-day annual period do not exceed 65 Ldn at setback distances of 80 feet, and cane haul truck noise levels are in the "Moderate Exposure, Acceptable" category at the proposed residential lots along the haul road.

The West Loch project site is located outside the Barbers Point Naval Air Station and Honolulu International Airport Ldn 55 noise contours. The potential impacts are considered negligible due to the sites' distance from aircraft flight patterns.

3.1.9 Air Quality

An Air Quality analysis for the project site was conducted during September 1987 by J.W. Morrow. The study is attached as Appendix D and is summarized below.

The two nearest State Department of Health air monitoring stations to the project area are located at the Campbell Industrial Park about 6 miles to the southwest and at Pearl City, some 4 miles to the northeast. Total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen dioxide

(NO_2) were all monitored on a 24-hour basis. Initially, the site was at the Barbers Point Lighthouse, but the proximity to the ocean resulted in very high TSP levels due to salt spray. The station was therefore moved to the Chevron Refinery site about 1.7 kilometers north of the lighthouse on March 17, 1972. In 1976, NO2 monitoring was ceased. On August 7, 1979, the monitoring station was moved to a rooftop location at the same Chevron site.

It should also be noted that total suspended particulate monitoring with a high-volume sampler was ceased at the site in October 1985. In November 1985, a new PM-10 sampler was installed. This instrument measures respirable particulate matter under 10 microns in aerodynamic diameter.

It is evident from existing data that both the *National Ambient Air Quality* standards (NAAQS) and Hawaii Ambient Air Quality Standards (HAAQS) are being met at those monitoring sites.

Because the Campbell Industrial Park monitoring station is situated relatively close to the elevated sources, i.e., the stacks, located at the industrial park, the data collected may not be representative of the highest ambient pollutant levels resulting from the various industrial sources at the park. Computer modeling done in conjunction with the City's resource recovery facility permitting indicated maximum SO_2 concentrations occurring some 1.0 to 1.5 kilometers north of the park in the flat terrain as well as on the hillsides also north of the park.

Unfortunately, there are no routine monitoring data for the primary automotive pollutant, i.e., carbon monoxide. The nearest CO monitoring site is at the Department of Health building in downtown Honolulu some 11 miles east-southeast of the project area. Because the area is presently at an early stage of development it can be surmised that present CO levels are also relatively low.

A spot sampling of carbon monoxide concentrations along Ft. Weaver Road was conducted during two recent AM peak hour traffic periods as part of the air impact analysis.

It should be noted that during the September 17, 1987 sampling the monitoring instrument was located upwind of the Ft. Weaver Road traffic due to the light northeasterly winds; thus, the low CO levels being measured were due to vehicles operating on the H-1 freeway upwind (northeast) of the sampling site.

During the September 22, 1987 sampling, on-site winds were very light and at times calm. During the calm periods, CO concentrations leveled off at about 1.0 - 1.5 mg/m³.

3.1.10 Surface Water Hydrology

Impacts on the project area's hydrology relative to the environment were studied by Gordon L. Dugan, Ph.D in October 1987. A summary of his findings is presented below with the complete study included in Appendix E.

A development project such as West Loch Estates generally produces alterations in surface water runoff as a result of modifying existing ground conditions. Interest in these runoff changes is generally a result of concern over two factors; public safety and environmental impact.

The calculated increased runoff from the project area indicates less groundwater recharge within the project site. It should be noted that runoff values (acre/feet/event) represent a volume of water and should not be confused with peak discharge rates which represent the maximum volume of stormwater runoff discharge per unit of time (e.g., cfs), which are required for engineering design purposes.

Increases in constituent loads could result from construction activities. The impact of construction activities will be minimized by adhering to strict erosion control measures as outlined in the City and County of Honolulu (1981) ordinance relating to grading, grubbing, and stockpiling.

Other water quality constituents of general concern include biocides and heavy metals. Typically, the biocides in general use tend to break down more readily in comparison to the more long lasting types that were used in the past; consequently, except for agricultural runoff the types and concentrations are usually considered insignificant.

Heavy metals increase as a result of urbanization. However, for the basis of comparison only lead and iron, by a slight margin, actually exceed the primary (Department of Health, 1981) and secondary (U.S. Environmental Protection Agency, 1979) drinking water standards, respectively. Because new automobiles have switched to unleaded gasoline since the mid 1970's, lead concentration in residential stormwater runoff would be expected to be decreasing.

The possible long term effect of any slight increase in heavy metals on biological life of West Loch waters is not presently well defined. However, a biological study of Pearl Harbor, conducted by the U.S. Navy in the 1970's concluded that the heavy metal burden in Pearl Harbor was below the level of concern and the major detriment to marine environment appeared to be silt (Evans et al., 1972). More detailed discussion is provided in another section, "Marine Biology," as part of a separate study. As noted in Table 6-2, the suspended solids load for all storm events are calculated to decrease significantly.

3.1.11 Marine Biology

A study to define baseline marine environmental conditions that occur in the vicinity of the proposed West Loch Estates community and golf course project and to describe the marine resources that could be affected by this development, was conducted by William A. Brewer & Associates in September 1987. A summary of findings are presented below with the complete study included in Appendix F.

The upper West Loch basin can be defined as a shallow estuarine ecosystem, dominated by a generally monotonous mudflat biological community and a less expansive, but more diverse epifaunal community. This estuarine ecosystem has been significantly altered by drainage from upland agricultural lands, domestic sewage and cane processing discharges, and urbanization. In 1968, following the establishment of water quality standards for the State, Pearl Harbor was designated as the highest priority pollution problem in Hawaii (FWPCA, 1969). Silt from terrigenous sources remains a major pollutant along all of the western side of upper West Loch.

Despite a history of long term and generally manmade abuse, upper West Loch remains an area of apparent high biological productivity, as witnessed by the extant biomass of desirable and less desirable fish, crustaceans and shellfish. Upper West Loch also remains as one of the least studied areas within the greater Pearl Harbor basin, a factor that is in part the result of privately owned lands, limited shoreline access (dictated by the circumferential mangrove stands), and absence of U.S. Navy facilities.

Upper West Loch appears to provide a small but significant sport and subsistence fishery for tilapia, various crustaceans, and oyster (the latter being harvested frequently, but contrary to Department of Health, and Department of Land and Natural Resources regulations). The basin also appears to constitute a major spawning area and nursery for several important commercial and sport fishes, and a pupping area for at least one species of shark.

The fish and benthic invertebrate population found within upper West Loch are those that are generally found in association with any shallow estuarine or mudflat habitat within the state. These species are adapted to changing salinities, high ambient turbidity levels, and unconsolidated bottom sediments. Any short term or long term increase in turbidity levels resulting from increased silt and sediment loading or resuspension of existing bottom sediments would not be expected to affect most represented estuarine species, but may be expected to exert a continuing stress to oysters as well as other filter-feeding organisms. The type of stress characterizes the predevelopment (1987) conditions and would continue to occur with or without the proposed project.

With respect to water quality, temperatures ranged from 28.0°C to 30.5°C. Salinities ranged from 18.3 ppt at a low tide station to 29.4 ppt at a high tide offshore station, compared to normal oceanic salinity for offshore Hawaiian waters which average approximately 35 ppt. These data indicate the influence of both subsurface and surface freshwater discharges on water quality within the upper West Loch basin. Dissolved oxygen values demonstrated similar variability and ranged from 4.05 ppm in murky inshore waters at the nearshore station to 6.25 ppm at the offshore station during high tide. Fecal coliform levels ranging from 4-1,100 MPN were reported from water column sampling of the same area (DLNR, 1971).

Silt and sediment laden runoff resulting from upland agricultural practices and urbanization appear to be exerting the singlemost adverse environmental influence within the upper West Loch. At least three perennial and intermittent streams (Waikele, Honouliuli, and Kapakahi) are apparently responsible for silt and sediment deposition. These carry significant runoff from lands under sugarcane and pineapple cultivation, and until relatively recently the Waikele Stream received an average of nearly 4.0 million gallons per day (mgd) of partially treated sewage (FWPCA, 1969).

The introduced American mangrove (Rhizophora mangle), which lines most of West Loch, may be contributing to sediment buildup because of their dense proproot systems which tend to trap and settle suspended silt and sediments which might otherwise be flushed out of the loch. Several studies conducted between 1963 and 1973 in the upper West Loch indicated that oyster beds provide a baseline which suggests that the rate of mangrove encroachment in the loch is proceeding at an unprecedented rate (Sparks, 1963; DLNR, 1971; Kawamoto & Sakuda, 1973).

Rhizophora mangle is an exotic species originally introduced into Hawaii from Florida in 1902 to reduce shoreline erosion on Molokai's reef flats (Walsh, 1967). This species (and three other species imported from the Philippines in 1922) has subsequently invaded sheltered bays, estuaries, coastal and anchialine ponds statewide, often displacing indigenous vegetation (Walsh, 1967; Maciolek and Broch, 1974).

Sparks' (1963) photographic record reveals an open, generally mangrove-free shoreline in the Honouliuli region. Kawamoto and Sakuda (1973) provided a map which indicates that the Matsuyama Fishpond was once a major open water pond. Mangroves now constitute a nearly solid coastal barrier averaging approximately 40 meters wide around most the Honouliuli sector of upper West Loch. The former Matsuyama Fishpond, which once extended approximately 150 meters seaward into West Loch, is now a solid 150-meter wide mangrove swamp.

3.1.12 Historic and Archaeological Resources

Archaeological resources within the project area were studied by Paul H. Rosendahl, Ph.D., Inc. (PHRI). The findings of their combined surface and subsurface reconnaissance survey are documented in Appendix J. The study of the project area included the determination of the presence or absence of archaeological remains within the project boundaries. This on-site field investigation included field surveys, shallow subsurface testing by hand tools, and deep subsurface testing by machine auger and backhoe trenching to determine the existence and extent of cultural remains. From the subsurface testing, sample materials were collected for radiocarbon and volcanic glass dating, and for pollen analysis. In addition to field work, the investigators studied historic records to assist in the identification and interpretation of archaeological remains. The field team also interviewed local informants for additional information.

Seven (7) sites were identified during the field studies; all appeared worthy of some degree of further investigation. These sites are summarized below (see Figure 3-4).

A. Site 3318 - Historic Artifact Concentration (Hoaeae Point)
This site apparently contains no extensive historic or prehistoric deposits. The site is of special concern because of previous information (written and informant) on the presence of early historic period habitation on Hoaeae Point. Occupation by

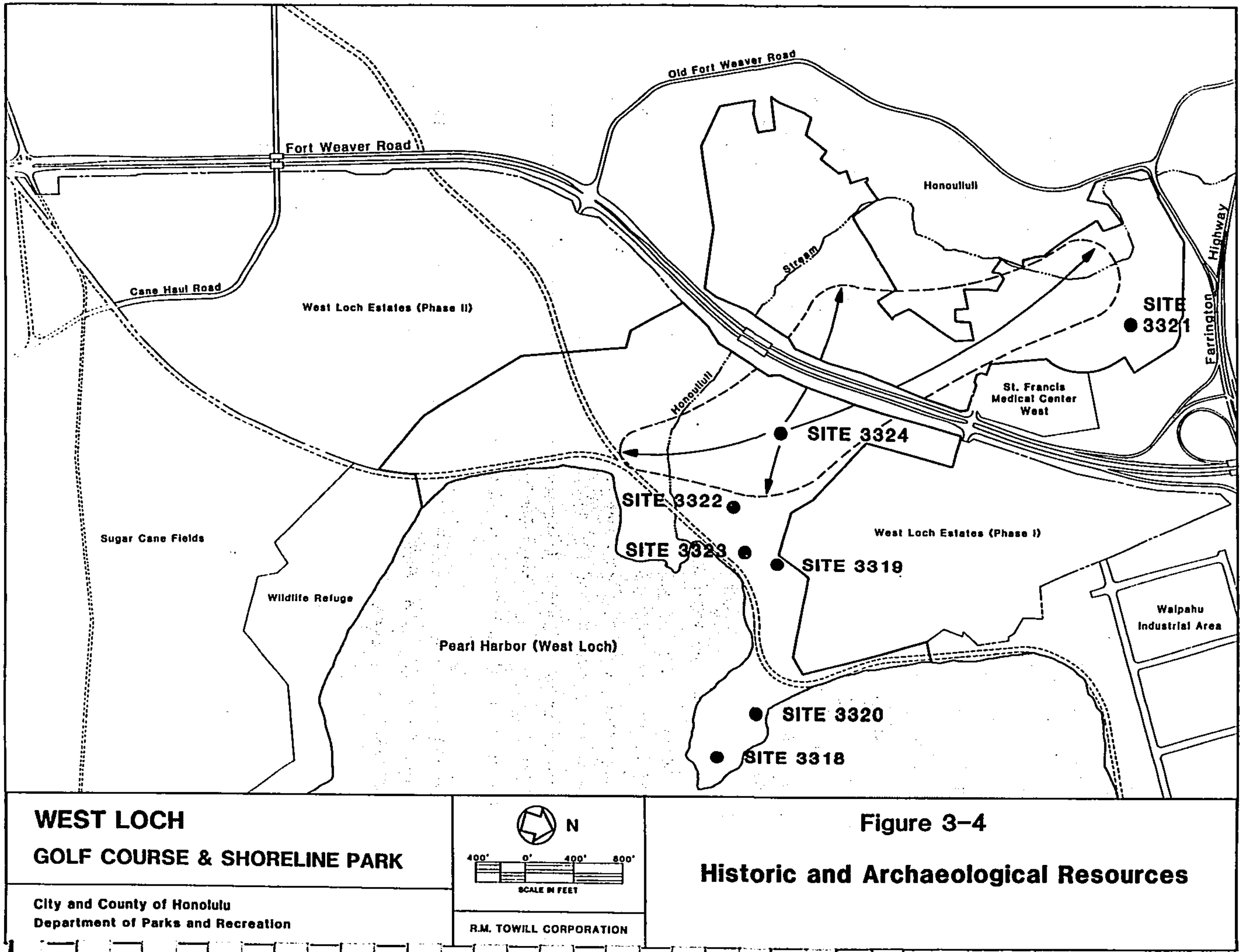

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Figure 3-4

Historic and Archaeological Resources

the military during WWII and later by lessees, however, appears for the most part to have removed or destroyed the historic evidence.

B. Site 3319 - Habitation Deposit and Possible Cemetery (Bluff above Site 3323)
This site does contain a remnant prehistoric cultural deposit. A historic period church and cemetery were said to have been situated there at one time. During site investigations, no definite remains of a church or cemetery were found. A single burial was discovered eroding out of the exposed bank above the OR&L Railroad right-of-way.

C. Site 3320 - Habitation Deposit (Hoaeae Point)
This site, located on an elevated area on Hoaeae Point, appears to be a primary (undisturbed) deposit. Both prehistoric and historic period artifacts were discovered. The site area appears to represent the only portion of Hoaeae Point not extensively altered or destroyed by WWII and subsequent occupation.

D. Site 3321 - Habitation Deposit
The site is a significant find in that the two levels of previous habitation have been found. Further, the site is significant in that inland habitation sites are usually not in such a well preserved state. An apparent stone wall, trash pits, post holes, fire pits, and at least one burial have been found at the site. The site is estimated to cover an area approximately 1.5 acres in maximum size. Radiocarbon dating for the lower occupation layer dates in the range of A.D. 540-850, with the upper layer dating to A.D. 1340-1640.

E. Site 3322 - Buried Fishpond
Based on old maps, the presence of a buried fishpond in the seaward portion of the project area was believed probable. Subsurface testing revealed deposits indicative of a buried

fishpond. Analyses of radiocarbon dating and pollen samples from these deposits have shown good potential for further investigation of the local prehistoric and historic period environmental setting.

F. Site 3323 - Historic Fishpond

Situated immediately seaward of the older buried fishpond, this fishpond was formed in the 1890's during the construction of the OR&L Railroad, when a section of the roadbed causeway enclosed a section of the existing coastal flats. Documentary research has suggested that this fishpond was intensively utilized up to fairly recent times.

G. Site 3324 - Buried Pondfield System

Based on documentary records, it is obvious that much of the project area was once an area of relatively dense habitation and cultivation. The extensive program of deep subsurface testing documented the presence of a buried pondfield system of both prehistoric and historic period age that underlies a large portion of the Honouliuli Stream flood plain. Radiocarbon dating samples from this extensive site complex suggest that portions of the complex may be quite old, and that the more inland portions of the complex are possibly younger than the more seaward portions.

3.1.13 Surrounding Land Uses

Existing Uses - The Ewa area encompasses the entire Ewa Plain which extends from Kunia Road in the northeast to Kahe Point in the west. Within this area lie scattered residential communities, a major industrial park, a major destination resort area, a wildlife refuge, two major military installations, and a portion of Oahu's largest sugar plantation (see Figure 3-5). The surrounding land uses that have major influence on the project site are described below.

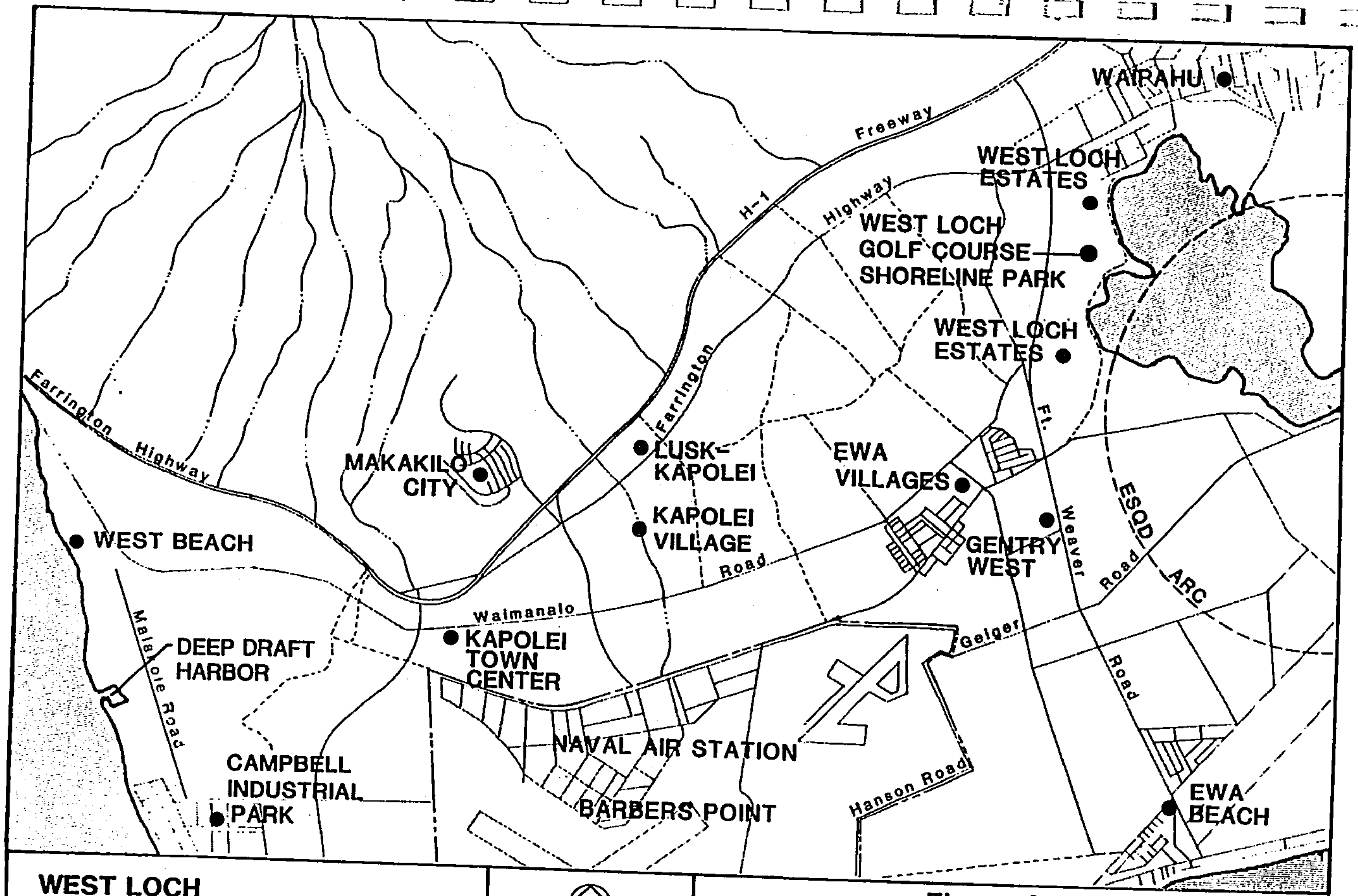

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Figure 3-5

EXISTING/PLANNED DEVELOPMENTS

A. Waipahu

Waipahu is located northeast of the project site at the northern tip of Pearl Harbor. In 1980, the Federal Census recorded the resident population of Waipahu at 29,139 persons.

Waipahu is an older community which was primarily founded by the location of Oahu Sugar Company's major sugar mill. Many immigrant groups were brought in to work in the sugar industry and many settled in Waipahu. As the sugar industry declined, the U.S. Navy operations in Pearl Harbor began to play a more prominent role in Waipahu. Waipahu's growth as an industrial and commercial center is tied in part to nearby defense activities.

B. Ewa Beach

Ewa Beach, an older residential community with a small commercial center is located south of the project site along the coastline. Homes in Ewa Beach are moderately priced, except for some oceanfront properties. The Ewa Beach community had 3,465 housing units and a population total of 14,500 residents in 1980.

C. Ewa Villages

Located southeast of the project site are a number of small plantation villages known collectively as the Ewa Villages. These communities are the Varona, Tenney, Renton, and Fernandez Villages. Their heritage goes back to the Ewa Plantation when it was an active sugar mill town. Most of the housing units within the Ewa Villages are very old and low priced. In 1985, 3,000 people lived in the villages.

D. James Campbell Industrial Park

The James Campbell Industrial Park, located southwest of the project site, includes 2,400 acres with 1,360 acres in current use and the remaining acreage reserved for future expansion. Uses within the Industrial Park include a mix of light industrial and heavy industrial activities. The Industrial Park employed approximately 2,500 people in 1985.

E. Naval Air Station, Barbers Point (NASBP)
Also located southwest of the project site is NASBP, which housed approximately 2,900 residents and employed 1,500 civilians in 1985. According to the NASBP master plan 1985, the mission of NASBP is to maintain and operate facilities and provide services and material support operations for aviation activities and units of the operating forces of the United States Navy. Aircraft operations of NASBP are conducted on a 24-hour basis and primarily consist of fixed wing propeller-driven aircraft with most flights occurring within the daylight hours.

F. Blast Hazard Zone
The proposed development is near the Explosive Safety Quantity Distance (ESQD) hazard zone that originates from the ammunition wharves at NAVMAG Lualualei, West Loch Branch. These explosive safety quantity distance arcs or "blast hazard zone" is a known constraint in the planning of the project. It is located approximately 200 feet from the project boundary at the closest point and will be buffered by a shoreline park and setback area related to the Fish and Wildlife Service bird refuge (see Figure 3-5).

3.1.14 Approved Uses

Within the Ewa Plain, there are three planned developments which have recently received government approvals. A brief description of these developments are presented below (see Figure 3-5).

A. Ko Olina
The Ko Olina planned residential/resort community is located on the western edge of the Ewa Plain, west of the James Campbell Industrial Park. The total area of the planned community includes approximately 642 acres. Major land uses of the planned

community include 5,200 housing units, 4,000 visitor units, a 500 slip marina, an 18-hole championship golf course, a Hawaiian cultural center, two shopping centers, and a number of restaurants.

B. Ewa Marina

The planned Ewa Marina consists of 727 acres of land and water area designed for water-oriented activities. The dominant element of the planned development is the 98-acre marina. Other elements of the plan include 4.5 miles of waterfront property to accommodate residential and commercial use, 4,850 units within 26 development areas, a retail shopping center, a golf course, restaurants, parks and a school.

C. Ewa by Gentry (Pearl Meadows)

Ewa by Gentry, previously known as Pearl Meadows is a planned residential development adjacent to the Ewa Villages. Development of the project is expected to create approximately 8,500 housing units consisting of single-family detached, single-family attached, townhomes, and apartment/condominum units with various densities.

SECTION 4
PUBLIC FACILITIES/SERVICES AND IMPACTS

4.1 TRANSPORTATION

A regional traffic impact study was conducted during September 1987 by Pacific Planning and Engineering. The study is attached as Appendix G and is summarized below.

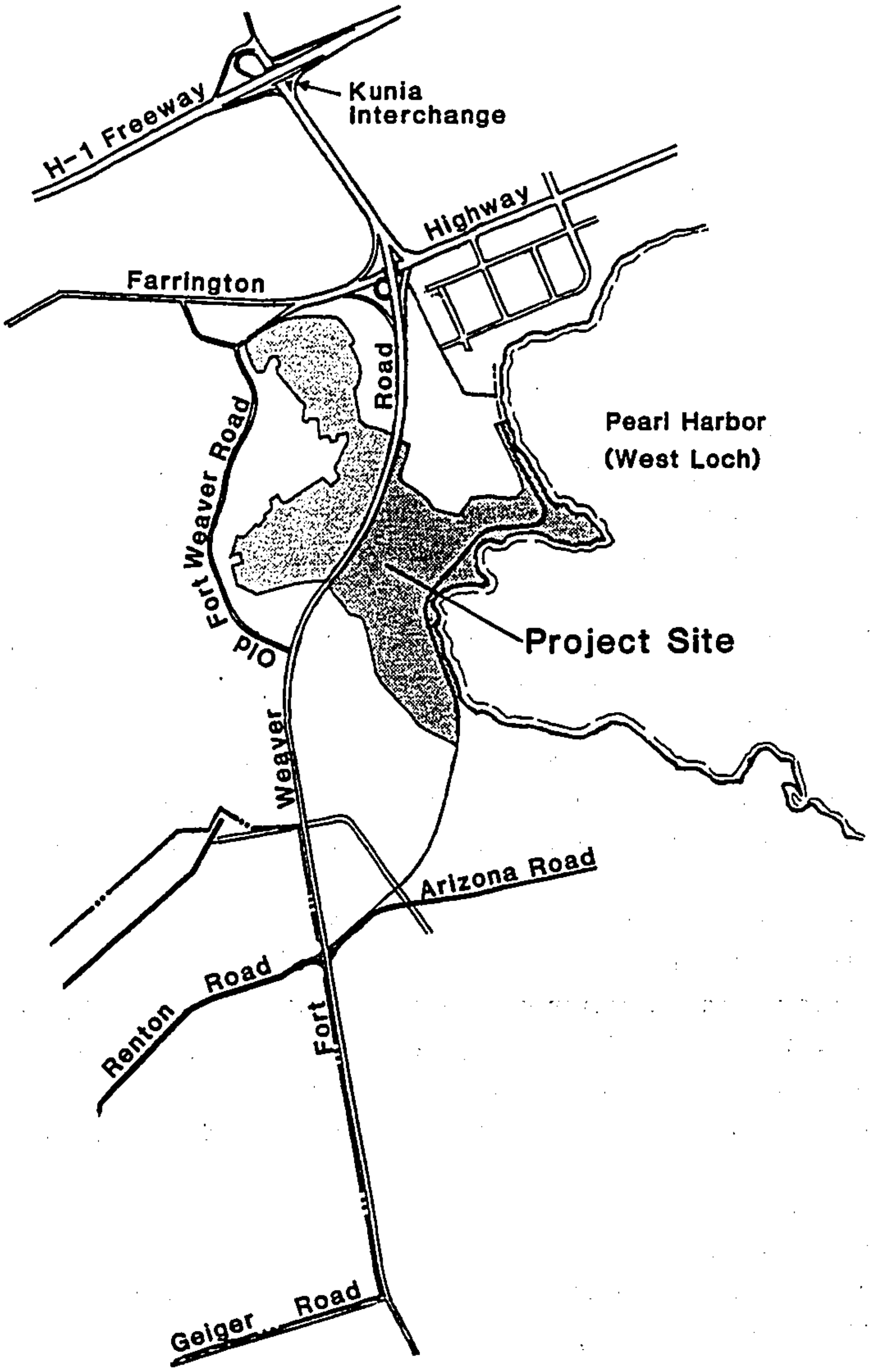
Ft. Weaver Road provides the primary access to the proposed development and serves as a major arterial roadway between H-1 Freeway and the existing Ewa Beach Community (Figure 4-1). The roadway is a four-lane divided highway with a wide grassed medial that provides roadway width for left turn storage lanes into the proposed golf course.

There are no sight distance or other physical roadway constraints which would result in unusual traffic safety concerns or conditions at the proposed intersections with Ft. Weaver Road. The speed limits are 35 and 45 miles per hour. There is a designated bikeway on the east side of the roadway. There are no private driveway access points. All access is controlled by the State Department of Transportation, Highways Division.

Intersection improvements for the St. Francis Hospital-West, presently under construction, will provide deceleration and left turn storage lanes for northbound Ft. Weaver Road traffic turning left into the hospital site. In addition, a traffic signal system was recommended at the intersection to improve egress during the afternoon peak hour. This intersection will be the principal access point for the golf course and shoreline park.

4.2 WATER

The project site is located within the Board of Water Supply's (BWS) Ewa District and the State's Pearl Harbor Ground Water Control Area. At present, the BWS has imposed restrictions on potable water connections in the Ft. Weaver Road-Ewa Beach area until planned water transmission improvements are completed and in place. The existing system is served by the Kunia Wells I (Total Preserved and Permitted Use of 6.00 mgd) and the



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

N
0 2500'

R.M. TOWILL CORPORATION

Figure 4-1

Traffic Access

Hoaeae Wells (Total Preserved Use of 6.61 mgd). The project's potable water demand of 15,000 gpd will be technically served by the Waipio Heights Wells III (Total Permitted Use of 0.85 mgd) currently under construction.

4.3 WASTEWATER

Wastewater from the Ewa Plain area is currently treated at the City and County's Honouliuli Wastewater Treatment Plan (WWTP) and disposed of via the Barbers Point Ocean Outfall. The capacity of the WWTP is 25 mgd. The current flow to the plant is 21 mgd. The Barbers Point Ocean Outfall has a capacity of 112 mgd, the projected peak flow for the year 2020. The County Division of Wastewater Management (DWM) is asking for funds to expand the plant capacity to 38 mgd by the year 1994 to accommodate proposed developments in Central and Leeward Oahu.

4.4 SOLID WASTE

The City's Department of Public Works, Division of Refuse Collection and Disposal provides solid waste collection and disposal for single-family residential areas. Non-residential and multi-family residential areas are serviced by private refuse collection companies. Solid waste is disposed of either at the Palailai Landfill or the Waipahu Incinerator.

The Division of Refuse Collection will provide collection services for the golf course and park provided refuse containers (3 c.y.) are accessible.

The Palailai Landfill is scheduled to close within the next few years and is not expected to provide refuse disposal capacity for the West Loch Golf Course project. The City and County of Honolulu is exploring new means and locations for disposal of solid wastes. A new landfill site at Waimanalo Gulch is being implemented. Also, a Garbage-to-Energy H-POWER facility, to be located in the James Campbell Industrial Park, is scheduled to become operational in late 1990.

4.5 POWER AND COMMUNICATIONS

The Ewa Plain area is serviced by the Hawaiian Electric Company for power generation and transmission facilities. Existing power facilities within the project area and vicinity include the Kahe and Waiau Power Plants.

Hawaiian Telephone Company maintains communication facilities of the project site and vicinity.

4.6 POLICE AND FIRE PROTECTION

Police service for the Ewa Plain area is provided by the Pearl City station, which is staffed by 161 officers who rotate on three different shifts. Three districts are patrolled by the Pearl City station: Waianae Coast; Waipahu/Ewa Beach; and Aiea/Pearl City.

Fire protection services for the project area and vicinity are provided by the Waipahu station, which houses one engine company (5 fire fighters), and one ladder company (6 fire fighters). Additional fire protection services are available from the Ewa Beach and Pearl City stations. A new engine company is planned for Ewa Tenney Village in 1991.

4.7 MEDICAL FACILITIES

Current medical facilities serving the project area and vicinity are provided by the Waipahu Clinic, staffed by 70 doctors, nurses, and aides. The Waipahu Clinic offers a variety of services including physical, occupational, speech therapy, public health nursing, children's health, Hansen's disease clincs, and complete mental health services. The nearest hospital/emergency services are provided by the Moanalua Kaiser Medical Center.

The new St. Francis Hospital-West is also planned for the immediate vicinity which should significantly increase health service capabilities in the region. The St. Francis Hospital-West facility, when completed, will include a comprehensive emergency and ambulatory care center, a full service hospital, a major medical office building, a medical education center, day care facilities, and a "wellness" center.

4.8 SCHOOLS

The State Department of Education has indicated that Ewa Elementary, Ilima Intermediate, and Campbell High, currently service the project area. The Department also indicated that Ilima Intermediate and Campbell High Schools are currently operating at capacity, therefore, additional budgeting will be required to expand the facilities at both of these schools. A new elementary school site of 6.1 acres is planned adjacent to the District Park in Increment II of the West Loch Estates Master Plan.

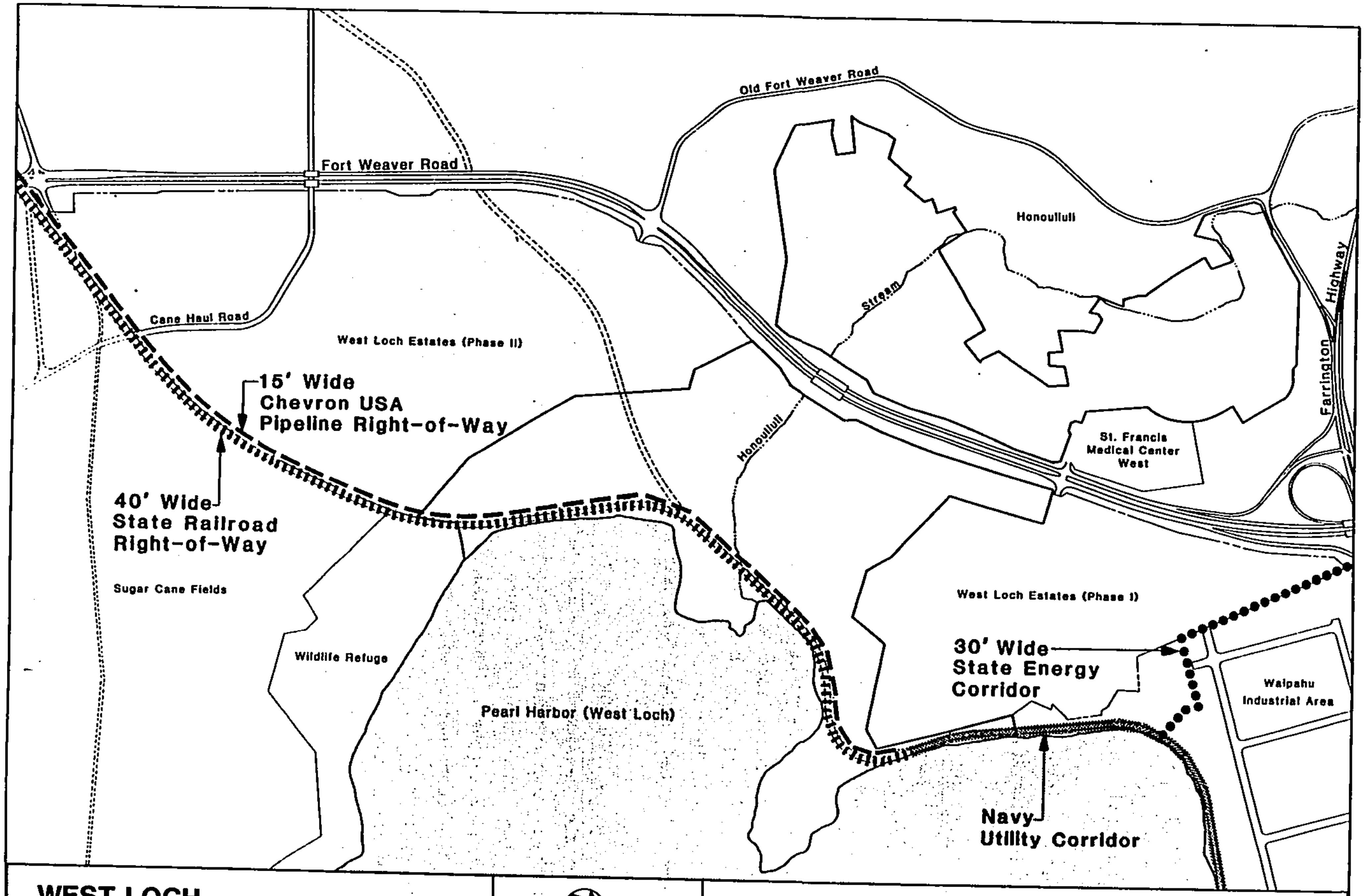
4.9 RECREATIONAL FACILITIES

Currently, there is only one existing recreation facility located within the immediate area. Asing Field consists of a medium-sized baseball field area and one basketball court.

From a regional perspective, recreational facilities are limited to small neighborhood parks located in nearby communities, as well as larger community parks located in Ewa Beach and Waipahu. Other existing facilities include beach parks located in Ewa Beach and NASBP, and golf courses located in NASBP and Waipahu.

4.10 ENERGY CORRIDOR

The State Department of Transportation has indicated that a small portion of the northern end of the West Loch Estates Increment I is located in the PRI energy corridor (see Figure 4-2). This corridor consists of fuel lines which link Campbell Industrial Park with Pearl Harbor. The City will maintain coordination with the State DOT in any actions affecting the energy corridor. A second energy corridor is located within the OR&L right-of-way and provides connection from Campbell Industrial Park to Nimitz Highway for Chevron USA (see Figure 4-2). There will be no impacts on either energy corridor from the proposed project.



WEST LOCH

GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

R.M. TOWILL CORPORATION

Figure 4-2

Railroad and Energy Corridors

SECTION 5

SOCIO-ECONOMIC ENVIRONMENT

5.1 SOCIO-ECONOMIC CONDITIONS

A socio-economic study was conducted for the proposed project by Community Resources, Inc., and is dated September 1987 (Appendix H). A summary of the demographics of the area is presented below.

Data presented are from the 1970 and 1980 U.S. Census. This time period was one of significant population growth in the study area. Ewa, which had 24,037 residents in 1970, grew by more than 50 percent to 36,234 in 1980. The population of the Waipahu census designated place (CDP) grew from 24,150 to 29,139.

The most recent estimate of population in the study area is for 1985. The City and County Department of General Planning (personal communication, Steve Young, planner, September 14, 1987) estimates the Ewa Development Plan Area population at 37,400 and the Waipahu CDP population at 29,400. If correct, these estimates suggest much slower study area population growth rates in the 1980's than in the 1970's, possibly due in part to the high interest rates and general slowdown in housing construction experienced during much of the early 1980's.

5.2 EWA

Ewa's largest civilian community is Ewa Beach, located a few miles south of the project site. With a 1980 population of 14,500, Ewa Beach is partially a military support community and partially a bedroom community of commuters to Honolulu. Proximate to Ewa Beach are the military housing areas of Iroquois Point (1980 population of 3,900) and Barbers Point Housing (1980 population of 1,400). In western Ewa, the major community is Makakilo (1980 population of 7,700, with ongoing construction and population growth).

Caucasians and Filipinos are the largest ethnic groups among Ewa's population. Almost half of the area's residents are Caucasian (44.5

percent) and almost one quarter are Filipino (24.8 percent); these shares are higher than the 33.1 percent and 12.8 percent shares, respectively, for all of Oahu.

The Ewa area has a relatively young population. Greater percentages of Ewa residents are under five years of age (10.7 percent) and between five and 17 years of age (27.8 percent), as opposed to Oahu as a whole (7.9 percent and 24.2 percent, respectively). The proportion of residents aged 65 years and older is especially low in Ewa. Senior citizens constitute 7.2 percent of Oahu's population, but only three percent of Ewa's. The youth of the Ewa population can be attributed in large part to the substantial numbers of military force members and dependents living there -- 18.5 percent of Ewa residents aged 16 years and above were in the armed forces in 1980, a figure well above the Oahu-wide average of 10.1 percent.

Ewa residents are somewhat more likely than all Oahu residents to have been born elsewhere in the United States; 36 percent were born outside of Hawaii, while 30.1 percent of total Oahu residents in 1980 were born elsewhere in the United States. Ewa's share of foreign-born residents was similar to Oahu's; thus, the percentage of Hawaii-born residents was lower than for the island as a whole.

As would be expected from data on place of birth and age, Ewa residents show greater mobility than the Oahu population as a whole. Relatively fewer Ewa than overall Oahu residents reported living in the same house or on the same island in 1980 as in 1975. The principal mobility difference was that Ewa residents were markedly more likely (26.1 percent) to have resided in a different state five years previously than were Oahu residents generally (18.4 percent).

The adult population of Ewa contains proportionately fewer highly-educated people than does Oahu as a whole. While a slightly lower proportion of Ewa residents completed eight or fewer years in school and the proportion of high school graduates is higher, the percentage who have completed four years of education beyond high school (12.6 percent) is considerably lower than for Oahu (21.7 percent).

5.3 WAIPAHU

The Waipahu CDP includes census tracts 87.01, 87.02, 89.01, and a portion of tract 88. Several of the more suburban-oriented neighborhoods -- such as Village Park, Waipio and Crestview/Ocean View -- are within the Waipahu Neighborhood Board area, but not within the census designated place of Waipahu.

Waipahu's ethnic characteristics indicate a substantially greater proportion of Filipinos than is the case for the island as a whole. This is consistent with the historic roots of Waipahu as a plantation community comprised heavily of immigrants. More than 40 percent of Waipahu residents (41.6 percent) reported Filipino ancestry, far greater than the 12.8 percent for the island as a whole. Each of Hawaii's other major ethnic groups show lower representation in Waipahu than for all of Oahu. Differences are most pronounced for Caucasians, who made up 33.1 percent of Oahu's population in 1980 but just 13.5 percent among Waipahu residents.

Waipahu has a relatively young population. Considerably higher proportions of Waipahu residents are less than five years of age (10.7 percent) than for the City and County (7.9 percent); Waipahu's median age of 24.5 years is much younger than all of Oahu's 28.1 years.

The population of Waipahu contains considerably larger numbers born in a foreign country than is the case for the entire island. More than one in every four Waipahu residents (27.9 percent) was born abroad, compared with 14.8 percent of all Oahu residents. Waipahu also has a slightly higher proportion of Hawaii-born residents (56.9 percent) than the county as a whole (55.1 percent), and only about half as many people who were born elsewhere in the United States (15.2 percent, compared with 30.1 percent for all of Oahu.)

Mobility patterns, measured by residence five years prior to the 1980 Census, are similar for Oahu and Waipahu residents. The chief differences, as suggested by differences in birthplace, are that greater proportions of Waipahu residents (9.3 percent) than of Oahu residents as a whole (6.6 percent) lived in a different country in 1975. Similarly, relatively fewer Waipahu residents (8.5 percent) reported having lived in a different state in 1975, compared with 18.4 percent for all of the island's population.

Education levels of Waipahu residents are somewhat lower than for Ewa or for all of Oahu. While 14.4 percent of Oahu's population aged 25 years and above completed eight school years or less, the similar statistic for Waipahu was 27.5 percent. Less than ten percent of Waipahu residents (8.7 percent) have four or more years of education beyond high school, compared with 21.7 percent for Oahu residents generally. Education levels rose for Waipahu, as for the island as a whole, between 1970 and 1980. The proportion of Waipahu's population with some education beyond high school almost doubled over the decade, moving from 13 percent to 23.6 percent.

5.4 HOUSING

Housing tenure in Ewa resembles the pattern for all of Oahu; 49.8 percent of dwelling units are owner-occupied. Crowded units, those occupied by more than 1.51 persons per room, are somewhat more common in Ewa, where 8.5 percent of all homes would be defined as crowed by this standard. This could be related to a larger-than-average family size in Ewa, (3.96 persons per household, compared with 3.15 for all of Oahu). While the 1980 median value of owner-occupied housing was lower than for the island as a whole, median monthly mortgage payments (at $514) were higher than the island-wide average of $494. This would suggest that Ewa homeowners had, in general, purchased their homes more recently than was the island-wide norm, a proposition supported by the fact that Ewa residents were more likely to be in-migrants to Hawaii than Oahu residents as a whole.

Waipahu's housing stock characteristics are similar to those of the entire county so far as tenure (owner vs. renter-occupied units) and availability of plumbing facilities are concerned. However, Waipahu contains a larger than average number of "crowded" dwelling units, where crowding is defined as 1.51 persons or more per room. The percentage of such units in Waipahu (13.8 percent) was almost twice the island-wide rate of 7.4 percent. More widespread crowding may be related to Waipahu's relatively large household size; average number of persons per household was 4.11 in 1980, compared with 3.15 for Oahu as a whole.

As of 1980, renters in Waipahu were slightly worse off in comparison to all island renters, while Waipahu homeowners were marginally better off than owners on the entire island. Median cash rent was $295 for Waipahu, and represented 15.7 percent of median family income. For Oahu as a whole, median cash rent was $279, representing 14.9 percent of median family income.

The median value of owner-occupied housing in Waipahu ($112,000) was lower than the island-wide median in 1980 ($130,400). However, Waipahu homeowners had lower median monthly mortgage payments ($420) compared to Oahu as a whole ($494). The Waipahu median constituted 22.3 percent of median family income, well below the island-wide average of 25.2 percent.

SECTION 6
ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1 BOTANICAL RESOURCES

A substantial portion of the project site and adjacent areas consist either of sugarcane land (some of which has been fallow for several years) or of a dense growth of introduced trees, shrubs, vines and grasses (especially along the West Loch shoreline). The conclusions found in a botanical report of the project by Winona Char and Associates (see Appendix A) are that because the area has been disturbed over a period of time, there are no rare or endangered plants or unique plant communities. Thus, there does not appear to be any problems relative to project impacts on plant resources.

A botanical survey map (Figure 3-3) delineating the various types of wetland vegetation on the project site indicates that approximately 9 acres of Typha-Scirpus (Cattail-bulrush) marsh land lies adjacent to the Brachiaria pastures. Approximately 4 acres of this marsh land will be filled and cleared for the proposed golf course. About 1 acre will be excavated to create a new water feature and to help improve drainage on the golf course. As a result of consultation with the U.S. Army Corps of Engineers, the proposed filling work will be processed under a Department of the Army Nation-Wide Permit due to the probability that the project will enhance the existing area for wildlife habitats.

A second area of potential impact is the 29.8-acre area of Brachiaria (California grass) pasture occurring in the Honouliuli Stream drainage area. Although this area continues to show positive indicators for wetland soils and vegetation, Ms. Char concluded (and the Corps of Engineers concurred) that the hydrology has been sufficiently altered by improvements to Ft. Weaver Road that it would at best be considered a marginal wetland.

Moreover, it appears that the remaining pasture is transitioning toward a greater predominance of upland characteristics as surrounding drainage alterations and development continue. Consequently, a Department of the

Army permit will not be required for placement of fill in the Brachiaria pasture. Ms. Char further concluded that the amount of area available for endangered waterbirds (i.e., open pond areas and vegetation along the margins of the golf course water hazards) would increase greatly, thereby enhancing this site aesthetically and biologically.

The shoreline area at which the mouth of the Honouliuli Stream meets the waters of West Loch is covered with a dense growth of introduced trees and shrubs; the most predominant being mangrove.

The objective is to clear the mangroves in order to increase views as well as to improve water circulation in West Loch near the shore. Clearing along the shoreline while selectively retaining some in specific locations will help prevent further land erosion.

Clearing of these mangroves will be done manually, and during the clearing process, silt screens will be used to effectively minimize siltation of nearshore waters.

6.2 WILDLIFE/TERRESTRIAL VERTEBRATES

According to a report on the wildlife of the West Loch/Waipio region by Dr. Andrew Berger (see Appendix B), among the endemic or native, endangered birds on Oahu, most are forest birds, and few of them actually exist on Oahu. For three of the four species of endangered Hawaiian waterbirds (i.e., the Koloa duck, Hawaiian gallinule, and the Hawaiian coot), Dr. Berger concludes that the Pearl Harbor region does not offer suitable food and safe nesting sites required, and therefore none of these are common to this area. This is due in part to the fact that these birds do not tend to nest in habitats adjacent to salt water.

In its present condition, Dr. Berger concludes, the area does not offer optimal habitation as far as endemic or native vegetation and its related animal life is concerned.

The Honouliuli and Waiawa National Wildlife Refuges are of special value to the endangered Hawaiian stilt. To ensure protection from potential runoff into the refuge, drainage from the proposed second phase of the residential development will be diverted from the wildlife refuge to the ponds along the shoreline. These ponds will function not only as water features on the golf course, but also as small retention basins for some of the surface water overflow through the flood plain.

Honouliuli Wildlife Sanctuary - Protection of the birds in the wildlife sanctuary will be ensured by a 300-foot wide buffer zone setback which will help screen out any possible light and noise from park users or residents of the proposed southern increment of West Loch Estates. A portion of the shoreline pathway for pedestrians and bicyclers, which will be meandering in nature, will be directed away from the wildlife sanctuary along the inland edge of the 300-foot buffer zone.

To prevent household pets (e.g., cats and dogs) from wandering into the wildlife sanctuary, a 6-foot high fence on the mauka side of the pedestrian path will be provided. Further, lighting for the residential subdivision will be positioned in such a way that the birds and other wildlife in the sanctuary will not be disturbed.

6.3 ENERGY CORRIDORS

A 40-foot wide OR&L right-of-way runs along the shoreline of the West Loch Estates, shoreline park and golf course project area. Hawaiian Electric Company has a high tension overhead 46KV power line within this right-of-way, and Chevron USA fuel lines run parallel to this easement. The shoreline park path will be paved to accommodate Chevron, Parks and Recreation, and Hawaiian Electric Company maintenance vehicles.

The City and County is considering in its long range transportation plans, a rapid transit route along this right-of-way. While present conditions and plans merely require a paved pathway for the park and access for other maintenance vehicles, the prospect of a fully operating mass transit system running along the West Loch shoreline presents a potential need to protect future residents from noise and other safety hazards. Thus, provisions for safety and noise abatement structures along the transit route will be considered in determining sufficient setback areas from the OR&L easement.

6.4 NOISE

Existing noise levels within the project site and vicinity have been subject to study by the U.S. Navy as part of the Air Installations Compatible Use Zone (AICUZ) program for NASBP (U.S. Navy, 1984). An additional noise study was conducted by Y. Ebisu & Associates during August 1987. The findings of this study are discussed below and are attached as Appendix C.

Along the Ft. Weaver Road right-of-way, existing traffic noise levels are in the "Significant Exposure, Normally Unacceptable" category. Existing setback distances to the 65 Ldn contour line are estimated at 235 feet and 128 feet from the centerline of the roadway at the north and south sections of the roadway. The golf course clubhouse is sited at a 25-foot elevation in the northern half of the Ft. Weaver Road bypass, thereby minimizing noise impacts from this right-of-way.

In the vicinity of the Renton Road intersection, existing residences of Fernandez Village are in the "Moderate Exposure, Acceptable" category due to the large setback distances (240+ feet) from the centerline of Ft. Weaver Road, and due to the lower vehicle speeds near the signaled intersection. To the north, the existing Hale O Ulu School on the west side of Ft. Weaver Road is exposed to traffic noise levels of 65 to 70 Ldn, which are considered "Unacceptable" for naturally ventilated schools. Existing quonset huts on the proposed golf course site and south of the Honouliuli Stream bridge are in the "Significant Exposure, Normally Unacceptable" category (approximately 65 to 70 Ldn). These existing structures will be removed under the proposed development plan.

Noise and dust impacts from continued cane haul truck activities will thus be mitigated by an 80-foot setback along with heavy landscaping on both sides of the cane haul road, as recommended by Y. Ebisu and Associates.

The project site is located outside the Barbers Point Naval Air Station and Honolulu International Airport 55 Ldn noise contours. The potential impacts are considered negligible due to the site's distance from aircraft flight patterns.

6.5 DISPLACEMENT AND RELOCATION

Approximately 30 families who are on a month-to-month lease with Campbell Estate on the Hoaeae Peninsula will be requiring relocation assistance as the 39-acre shoreline park is planned to begin construction in the fall of 1988.

A household survey was sent and direct contact was made with these families to determine their incomes and the extent of potential assistance needed by each household from the City.

These households will receive relocation assistance from the City and County of Honolulu.

6.6 ARCHAEOLOGY

An evaluation of the archaeological study findings has concluded that there are no remains that should be classified in the "must preserve" category (see Appendix J). Additional data recovery at several sites is recommended as appropriate. This data recovery is proposed to be accomplished during the construction period. One site has been recommended for some level of interpretive development. Further, a written cultural resource management plan for mitigation work will be developed and submitted to the Department of Land and Natural Resources - Historic Sites Section (DLNR-HSS) prior to any work commencing. All mitigation work (data recovery and interpretive development) will be coordinated with DLNR-HSS.

To facilitate State and County review, general significance assessments and recommended general mitigation treatments have been determined for all sites identified during the combined surface and subsurface reconnaissance survey of the West Loch Estates - Golf Course and Parks project area. These assessments and treatments are summarized in Table 10 in Appendix J. Significance categories used in the evaluation process are based on the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60), Section 4). The State Department of Land and Natural Resources - Historic Sites Section (DLNR-HSS) uses these criteria to evaluate eligibility for both the Hawaii State and National Register of Historic Places. Sites determined to be potentially significant for information content (Categories A and X, Table 10) fall under Criterion D, which defines significant resources as ones which "...have yielded, or may be likely to yield, information important in prehistory or history." Sites potentially significant as representative examples of site types (Category B, Table 10) are evaluated under Criterion C, which defines significant resources as those which "...embody the distinctive characteristics of a type, period, or method of construction..., or that represent a significant and distinguishable entity whose components may lack individual distinction."

Sites with potential cultural significance (Category C, Table 10) are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP) entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (ACHP 1985). The guidelines define cultural value as "...the contribution made by a historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth" (1985:1). The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value" (1985:7).

Based on the findings of the combined reconnaissance survey field work, the cultural remains identified within the West Loch Estates - Golf Course and Parks project area appear to range, for the most part, from limited to substantial significance in terms of potential information content. Four of the identified sites (Sites 3318, 3320, 3322, 3324) were determined to be significant for their information content only; appropriate mitigation for these four sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. The site specific scope and scale of data collection and recovery work would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

Two of the identified sites (Sites 3319, 3321) were determined to be significant both for their information content and for their cultural value because of the presence of one or more human burials. With regards to their scientific research value (information content), appropriate mitigation for these two sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. With regards to their cultural value, appropriate mitigation would involve either continued in-place protection (preservation "as is"), or disinterment of skeletal remains according to current State Health Department regulations and procedures.

One site (Site 3323) was determined to be significant both for its information content, and as a good example of a site type. Appropriate mitigation for this site would involve some degree of further data collection (including historical documentary and local informant research) and continued preservation with some level of interpretive development. As with the other six sites for which further work has been recommended, the site specific scope and scale of data collection work, as well as appropriate plans for interpretation, would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

Finally, it is recommended that a qualified archaeologist selectively monitor initial grubbing activity and/or vegetation clearing within the project area. The general significance assessments and recommended general treatments presented here are based on the findings of the combined surface and subsurface reconnaissance survey field work, which involved relatively limited subsurface testing. Therefore, these evaluations and recommendations are given with the general qualification that during any development activity involving the modification of the land surface, there is always the possibility -- however remote, that previously unknown or unexpected subsurface cultural features, deposits, or burials might be encountered. In such a situation, immediate archaeological consultation should be sought.

6.7 NAVY

The Hoaeae Peninsula lies approximately 200 feet outside the U.S. Navy existing ESQD (Explosive Safety Quantity-Distance) arc (blast zone). In any case, the waters of West Loch are owned by the Navy, and the shoreline makai of the OR&L right-of-way has been secured by the Navy as well within the blast zone are in order that its operations may continue without jeopardizing public safety.

Recognizing this, water related activities such as swimming and boating, will be prohibited in West Loch, and the City will post signs throughout the shoreline park that will indicate prohibition of such activities.

6.8 AIR QUALITY

Burning of sugarcane fields prior to harvest is a long-standing practice in Hawaii's sugar industry. Unfortunately for industry, however, as urbanization closes in around agricultural operations, it is inevitable that complaints about air pollution will arise. Cane fires result in the emission of particulates, carbon monoxide, and trace amounts of other organics. Concentrations of particulates can reach high levels within about one mile of the fires. A complete quantitative characterization of cane smoke, however, has yet to be performed. Fortunately, fires are generally infrequent and only last about 20-30 minutes.

The State Department of Health and Federal EPA have indicated that they are continuing efforts to better characterize the exposure and potential health effects. Depending on the results of those efforts, the smoke exposure may be reduced or eliminated before cane cultivation ceases in Ewa.

6.9 AGRICULTURE

Impacts on the project area's agricultural operations were studied by Decision Analysts Hawaii in September 1987. A summary of their findings is presented below with the complete study included in Appendix I.

While most of the golf course land is zoned Agriculture (AG-1 and AG-2) within the City and County Land Use Ordinance, these lands have not been in active cultivation for a few years. Fallow sugarcane land, with attendant weeds and some brush and small trees typify the northern portion of the golf course on the mauka side of Ft. Weaver Road, while the majority of the golf course is located in a drainage swale between the City's proposed West Loch Estates north and south residential communities. Hoaeae Peninsula, which is the feature of the proposed shoreline park, is already zoned for urban use.

The development of the municipal golf course would result in the urbanization of approximately 190± acres of agriculturally zoned land. However, because these lands have been fallow for some time, the project would not adversely affect the economic viability of the sugar industry, nor would it require layoffs of sugar workers.

The development of West Loch municipal golf course on sugarcane acreage would eliminate the possibility of using these lands for diversified agriculture (including aquaculture). However, it is doubtful that this would adversely affect the growth of diversified agriculture in Hawaii. This assessment is based on four reasons: (1) an extensive amount of prime agricultural land and water has been freed from sugar and pineapple production because of past mill closings and reductions in operations; (2) a real possibility exists that additional land and water will be freed from sugar production given the outlook for low sugar prices; (3) some of the sugar operations will make their lands available for profitable replacement crops to the extent that such crops are available; and (4) compared to the available supply, a very small amount of land and water is required to grow proven and promising crops to achieve a realistic level of food and animal-feed self-sufficiency, and to increase exports.

Adjacent Oahu Sugar Company harvesting activities, such as routine cane burning and cane haul trucking along Balfour Boulevard in the southern residential community, will intermittently (harvest occurs every 2.5 years) impact on the park and golf course developments and be mitigated as discussed in the sections on Air Quality and Noise Impacts.

6.10 HYDROLOGY

A development project such as West Loch Estates generally produces alterations in surface water runoff as a result of modifying existing ground conditions. Interest in these runoff changes is generally a result of concern over two factors; public safety and environmental impact. The first requires the identification of changes in peak discharge rates, the magnitudes of which are necessary for designing adequate drainage structures to prevent flooding, while the second concern requires identification of changes in total runoff volume, as well as sediment, nutrient, and other constituent loads, and the effects these will have on the ecosystem of the natural resource serving as the "sink." This study focused on the latter concern of the environmental impact resulting from increased runoff volume and sediment and nutrient loads, and its probable effect on subsequent receiving waters (West Loch and Pearl Harbor).

Representative suspended solids values in stormwater runoff from the project site were derived from a composite measured and estimated suspended solids load per unit area from various Oahu streams, including those out of the entire Kaneohe Bay drainage basin (Jones et al., 1971). This value for predeveloped conditions for comparative purposes was set at 1,000 mg/l.

Quality data for stormwater runoff from developed areas are provided by a compiled derivation from urban water quality data collected from storm drains in different land use drainage areas of Honolulu (residential, commercial and industrial), as shown in Table 6-1. For nitrogen, phosphorus, and suspended solids quality values, 0.60, 0.57, and 250 mg/l, respectively, were used for the project's full development conditions, except for the nitrogen concentration of stormwater runoff for the golf course, which was assumed to be double (1.2 mg/l). This is because of the emphasis given to fertilization on such a development.

Estimated stormwater runoff and constituent changes due to the proposed development are shown in Table 6-2. As indicated, the stormwater runoff volume for the 2-year, 1-hour duration storm under post development conditions is about 3.5 times greater than predeveloped (1987) conditions. However, as the storm duration and recurrence interval increases this difference reduces to approximately 16 percent times greater for the 100-year, 24-hour storm.

The calculated increased runoff from the project area correspondingly indicates less groundwater recharge within the project site. However, since the water features on the golf course will retain some runoff prior to discharge into West Loch, the potential for additional recharge at the golf course area will be enhanced. It should be noted that runoff values (acre-feet/event) represent a volume of water and should not be confused with peak discharge rates which represent the maximum volume of stormwater runoff discharge per unit of time (e.g., cfs), which are required for engineering design purposes.

Relative to the impacts on quality of the various constituents, the summation of nitrogen, phosphorus, and suspended solids loads from both present (1987) and projected (post) development for storms of 1 and 24-hour duration at recurrent intervals of 2, 10, 50 and 100 years are shown in Table 6-2. Any potential impact of the phosphorus load may be somewhat lessened by the runoff being retained in the water features of the proposed golf course.

TABLE 6-1

Representative Storm Water Quality Data for Honolulu [a] (Fujiwara,1973)

	Residential[b]	Commercial[c]	Industrial[d]
Total Solids	511	278	246
Suspended Solids	252	142	12
COD	142	209	40
BOD	10	19	7
Dissolved Oxygen	7.1	5.7	6.7
NO_3-N	0.211	0.045	1.1
TKN	0.381	0.272	2.70
Total P	0.57	0.53	2.17
Ortho P	0.27	0.19	1.27
Grease	2.8	1919	2.2
Lead	0.407	0.987	1.657
Chromium	0.013	0.021	0.013
Zinc	0.512	0.792	0.729
Copper	0.036	0.036	0.021
Iron	0.377	0.295	0.049
Total Coliform	83,300	33,500	11,500
Fecal Coliform	1,965	463	580
Fecal Strep	6,393	7,900	7,350

[a] All units in mg/l except total coliform, fecal coliform, and fecal strep which are listed as No./100 ml

[b] Storm water samples collected on Aupuni Street near Nuhelewai Stream

[c] Storm water samples collected at Beretania Street between Maunakea

[d] Storm water samples collected near Iwilei and Pacific Streets

TABLE 6-2

Estimated Storm Water Runoff and Constituent Changes due to the Proposed West Loch Estates Development, West Loch, Ewa, Oahu

Storm[a]			Storm Water Runoff											
Duration	Recurrence Interval	Quantity	Hydraulic			Nitrogen[b]			Phosphorus[c]			Suspended Solids[d]		
			Development 1987	Development Full	Δ	Development 1987	Development Full	Δ	Development 1987	Development Full	Δ	Development 1987	Development Full	Δ
hr	yr	in.	AF/event	AF/event	AF/event	lb/event	lb/event	lb/event	lb/event	lb/event	lb/event	ton/event	ton/event	ton/event
1	2	1.1	2.7	9.5	+ 6.8	9.7	7.7	- 2.0	1.0	14.8	+ 13.8	3.60	3.24	- 0.36
1	10	1.7	10.4	23.3	+ 12.9	38.2	27.2	- 11.0	4.0	36.1	+ 32.1	14.14	7.92	- 6.22
1	50	2.2	19.6	36.8	+ 17.2	72.0	49.4	- 22.6	7.5	57.1	+ 49.6	26.66	12.53	- 14.13
1	100	2.4	23.8	42.6	+ 18.8	87.4	59.3	- 28.1	9.1	66.1	+ 57.0	32.35	14.49	- 17.86
24	2	3.9	61.5	89.7	+ 28.2	225.6	147.2	- 78.4	23.4	139.1	+ 115.7	83.57	30.50	- 53.07
24	10	7.5	173.3	214.1	+ 40.8	636.2	402.2	- 234.0	66.0	332.0	+ 266.0	235.62	72.81	- 162.81
24	50	10.4	271.9	318.3	+ 46.4	998.5	624.7	- 373.8	103.5	493.5	+ 390.0	369.80	108.22	- 261.58
24	100	11.3	303.3	350.9	+ 47.6	1113.6	695.2	- 418.4	115.5	544.1	+ 428.6	412.45	119.32	- 293.13

a) From "Rainfall Frequency for Oahu" (Giambelluca, et al., 1984).

b) Based on a nitrogen value of 1.35 mg/L for 1987 conditions and 60 mg/L for full development of Residential Phases 1 and 2 and Shoreline Park, and 1.20 mg/L for the Golf Course.

c) Based on a phosphorus value of 0.14 mg/L for 1987 conditions and 0.57 mg/L for full development.

d) Based on a suspended solids value of 1000 mg/L for 1987 conditions and 250 mg/L for full development.

Increases in constituent loads could result from construction activities. The impact of construction activities will be minimized by adhering to strict erosion control measures as outlined in the City and County of Honolulu (1981) ordinance relating to grading, soil erosion and sediment control.

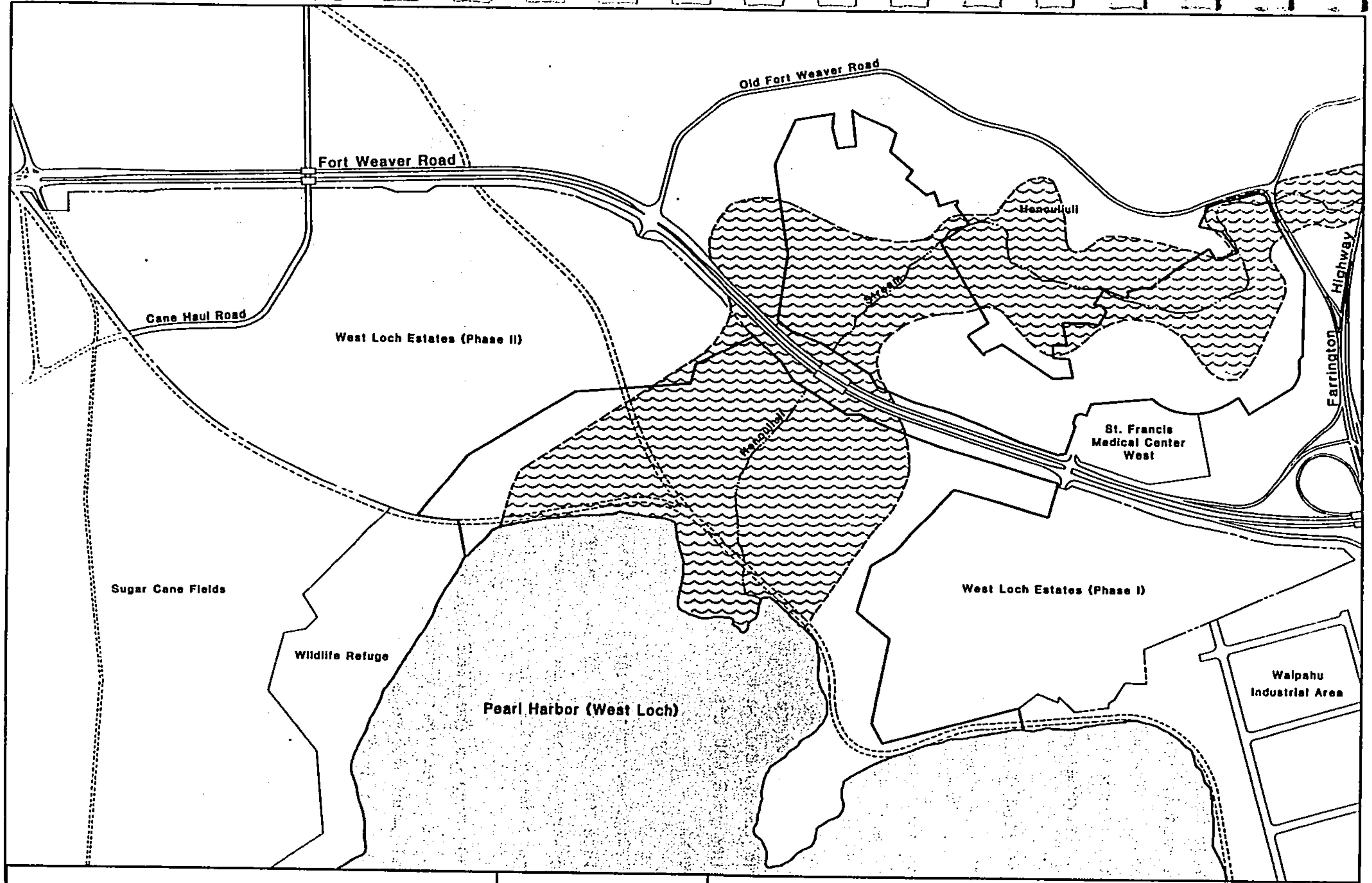
Other water quality constituents of general concern include biocides and heavy metals. Typically, the biocides in general use tend to break down more readily in comparison to the more long lasting types that were used in the past; consequently, except for agricultural runoff the types and concentrations are usually considered insignificant.

Heavy metals, on the other hand, do apparently increase as a result of urbanization. However, for the basis of comparison, although it is not directly applicable for stormwater runoff, only lead and iron, by a slight margin, actually exceed the primary (Department of Health, 1981) and secondary (U.S. Environmental Protection Agency, 1979) drinking water standards, respectively. Because new automobiles have switched to unleaded gasoline since the mid 1970's, lead concentration in residential stormwater runoff would be expected to be decreasing. Iron concerns in drinking water is due to its potential for staining fixtures and producing tastes.

The possible long term effect of any slight increase in heavy metals on biological life of West Loch waters is not presently well defined. However, a biological study of Pearl Harbor, conducted by the U.S. Navy in the 1970's concluded that the heavy metal burden in Pearl Harbor was below the level of concern and the major detriment to marine environment appeared to be silt (Evans et al., 1972). More detailed discussion is provided in another section, "Marine Biology," as part of a separate study. As noted in Table 6-2, the suspended solids load for all storm events are calculated to decrease significantly.

6.11 FLOOD PLAIN CONDITIONS

The proposed golf course will be located within the existing Honouliuli Stream flood plain area with residential developments proposed on the surrounding higher grounds (see Figure 6-1).



WEST LOCH

GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

N

400' 0' 400' 800'

SCALE IN FEET

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Figure 6–1

Flood Plain

------ 100 Year Flood Plain Boundary

The Honouliuli Stream watershed drains runoff into Pearl Harbor from the Waianae Mountains. The lowlying lands are mostly undeveloped. There is some residential, but most of the undeveloped land is used for agricultural purposes. The mid-elevation areas are developed largely for agriculture, mainly in sugar. The upper watershed areas are set aside for conservation. The site receives a median annual rainfall of approximately 23 inches.

A detailed flood study of Honouliuli Stream has been conducted by the Federal Emergency Management Agency (FEMA) for the City and County of Honolulu (CCH), under the National Flood Insurance Program (NFIP). This study covers the stream segment from Farrington Highway to the confluence with Pearl Harbor's West Loch. Delineation of flood zones are reflected on the Flood Insurance Rate Map (FIRM), available for review with the CCH. The FIRM indicates that the majority proposed golf course will be located within Flood Hazard Zone AE. Zone AE refers to special flood hazard areas prone to inundation by a 100-year flood. The FEMA flood study has adopted a flow of 8,030 cfs (at the mouth) as the 100-year flood for Honouliuli Stream.

The floodway, different from the flood boundary, is defined by FEMA to include the portion of the channel and adjacent flood plain that is necessary to convey the 100-year flood. Design of the golf course will be in accordance with the CCH Land Use Ordinance.

In addition to the FEMA requirements for floodway encroachments, the CCH also requires that flooding must not occur in the proposed residential development during a flood with a flow of 12,000 cfs. This flow value was determined by the CCH drainage section.

Other than the bridges on the Ft. Weaver Road and on the Old Ft. Weaver Road, there are no existing flood protection improvements. A few cement rubble masonry walls have been constructed by private individuals, although these structures are substandard and are not considered by FEMA.

The proposed flood plain improvements include the replacing of heavy vegetation obstructions with an open golf course. Portions of the stream through the golf course area will be improved to reduce localized flooding. Due to site conditions, additional soil is required for fill on the golf course fairways. Part of this fill will utilize material from the northern phase of the residential development. Preliminary flood studies using the revised topography of the flood plain indicate that the proposed improvements will not increase the water surface elevations of the 100-year flood at any section along the stream, therefore, satisfying the FEMA and CCH Land Use Ordinance requirements. Evaluation of flood elevations resulting from a 12,000 cfs flood have not yet been made.

6.12 MARINE BIOLOGY: WEST LOCH

The upper West Loch basin can be defined as a shallow estuarine ecosystem, dominated by a generally monotonous mudflat biological community and a less expansive, but more diverse epifaunal community. This estuarine ecosystem has been significantly altered by drainage from upland agricultural lands, domestic sewage and cane processing discharges, and urbanization.

Despite a history of long term and generally manmade abuse, upper West Loch remains an area of apparent high biological productivity, as witnessed by the extant biomass of desirable and less desirable fish, crustaceans and shellfish.

While upper West Loch may have limited access, it appears to provide a small but significant sport and subsistence fishery for tilapia, various crustaceans, and oyster (the latter being harvested frequently, but contrary to Department of Health, and Department of Land and Natural Resources regulations). The basin also appears to constitute a major spawning area and nursery for several important commercial and sport fishes, and a pupping area for at least one species of shark.

With the exception of minor short term siltation and sedimentation resulting from mauka grading activities, impacts to estuarine biota in the upper West Loch basin are expected to be inconsequential. The relatively flat topography of the project site should insure that even these minor impacts can be mitigated through judicious use of various erosion control measures, particularly along the Honouliuli Stream and within the surrounding watershed. The prevailing flat coastal plain, numerous ponds, and dense mangrove stands which border the shoreline would appear to provide for silt and sediment containment under the most severe weather conditions.

Erosion may be more difficult to control around Hoaeae Point, a site designated for the shoreline park. However, given the location of this peninsula relative to the mouth of the Waikele Stream, it is unlikely that construction generated silt and sediment levels would exceed that found naturally in inshore waters.

The fish and benthic invertebrate population found within upper West Loch are those that are generally found in association with any shallow estuarine or mudflat habitat within the state. These species are adapted to changing salinities, high ambient turbidity levels, and unconsolidated bottom sediments. Any short term or long term increase in turbidity levels resulting from increased silt and sediment loading or resuspension of existing bottom sediments would not be expected to affect most represented estuarine species, but may be expected to exert a continuing stress to oysters as well as other filter-feeding organisms. The type of stress characterizes the predevelopment (1987) conditions and would continue to occur with or without the proposed project.

A change in land use from the existing mauka cane lands to housing and a golf course complex would likely reduce silt and sediment deposition at the mouth of Honouliuli Stream. Existing high stormwater runoff and associated sedimentation may in part be responsible for the aggressive advancement of the mangrove vegetation in the former Matsuyama Fishpond (mouth of Honouliuli Stream). Given G. Dugan's stormwater runoff calculations (see

"Hydrology" impacts section), as well as the estuarine character of upper West Loch, the increased runoff values are not expected to produce any adverse effects to resident biota.

Removal of shoreline mangroves is not expected to produce any significant adverse impacts other than a short term rise in turbidity levels, minor habitat losses, and the loss or dislocation of an inshore fauna of low species diversity (Brewer, 1987). Rhizophora mangle is an exotic species originally introduced into Hawaii from Florida in 1902 to reduce shoreline erosion on Molokai's reef flats (Walsh, 1967). This species (and three other species imported from the Philippines in 1922) has subsequently invaded sheltered bays, estuaries, coastal and anchialine ponds statewide, often displacing indigenous vegetation (Walsh, 1967; Maciolek and Broch, 1974).

Unlike other insular areas in the Pacific where mangroves are indigenous, Hawaiian mangrove swamps do not appear to harbor any distinctive floral or faunal assemblages, nor do they appear to constitute important nursery grounds for indigenous marine or brackish water fauna (Walsh, 1967). Removal of mangrove stands may improve water quality in localized areas by enhancing water circulation and flushing (Brewer, 1987).

Urbanization and the corresponding increased population density associated with the proposed West Loch community, combined with expanded opportunities for shoreline recreation in the Honouliuli region would offer the potential for greater utilization of anticipated park facilities in the upper West Loch basin.

The poor sanitary quality of most of the lochs within Pearl Harbor has been documented in several studies, though recent information on the sanitary quality of West Loch waters is not available. Although openly harvested, oyster stocks in West Loch have been restricted for human consumption for many years by regulation of the Department of Land and Natural Resources and the Department of Health.

6.13 TRAFFIC

Impacts on traffic were studied by Pacific Planning and Engineering, Inc., in September 1987. A summary of findings are presented below with the complete study included in Appendix G.

The traffic study assessed traffic impacts measured by the change in level-of-service (LOS) for the intersections planned for the West Loch Estates community, golf course and shoreline park. These intersections are described below. The traffic impact assessment projects anticipated traffic volumes along Ft. Weaver Road to 1991 when the project is expected to be complete.

The analysis was conducted for the following intersections:

A. Ft. Weaver Road and Road "A" (access to golf course parking lot and the West Loch Estates' Increment I);

B. Ft. Weaver Road and Road "B" (access to West Loch Estates' Increment II);

C. Ft. Weaver Road and Renton-Arizona Roads (secondary access to West Loch Estates' Increment II); and

D. Farrington Highway and Leoku-Leoole Street (secondary access to West Loch Estates' Increment I).

The Critical Movement Analysis Planning Application from the revised (1985) Highway Capacity Manual (HCM) was used to estimate the capacity for the above intersections. It was assumed that those intersections not now signalized would be for the purposes of analysis.

Traffic generated by West Loch Estates municipal golf course users, on the other hand, will be occurring in the a.m., and moving generally in the opposite (north to south) direction on Ft. Weaver Road into the project, with entry through the northernmost intersection of the City's residential development. At its peak use in mid-summer when the day is longest, approximately 50 rounds of golf (4 players per round) would be played on this par 72 course. Approximately 200 vehicles may be expected during this period. However, this golf course traffic should be distributed over a 8-10 hour period, allowing for the normal staggered starting times of approximately 15 minutes each, thereby minimally, at best, adding to the total traffic volume.

Users of the proposed 39-acre shoreline park are expected to be residents mainly from the West Loch Estates residential and adjacent communities. Because entry to the park will be designed for pedestrian rather than vehicular access, traffic is expected to be restricted in volume. This is expected to have very little impact on traffic movement into and out of the community.

Use of the district park, which will be located in the City's proposed southern residential increment is expected to be heaviest on weekends, when park goers will be able to park in the Park-and-Ride facility. During the week, use of the district park will probably be by residents of the West Loch Estates community.

6.14 INCREASED ACCESS TO OAHU'S SHORELINE

The Department of Parks and Recreation sets as a standard the provision of eight acres of island based park land to be provided for every 1,000 residents. Based on the estimated current population of 814,500 residents, approximately 6,516 acres of park land is required. With the increase in population in the Ewa district, the demands being placed on existing park facilities are beginning to show. The Department of Parks and Recreation currently has only 4,200 acres of island based park land. Based on these standards, the need for additional island based park land is already substantial.

Adding more public park space to the community and gaining shoreline access are the major objectives of the proposed shoreline park development. While the future residents of the immediate surrounding community of West Loch Estates will have the direct benefit of views from and access to the shoreline park, adjacent communities such as Gentry-West's Soda Creek will also enjoy easy access to the shoreline via West Loch's proposed park.

6.15 MEETING THE DEMAND FOR MORE MUNICIPAL GOLF COURSES

The Department of Parks and Recreation manages all of Oahu's four municipal golf courses. The Department has set as a standard that one 18-hole municipal golf course be provided for every 100,000 residents. Within the Ewa area, there is currently only one such course. With the projected population growth in the leeward part of the island, it has been determined that it would be desirable to provide a second municipal golf course for people residing in that area of Oahu.

A new municipal golf course will fulfill a major public policy objective of helping the City and County of Honolulu meet the growing population's need for recreational activities and space. Drainage improvements on the golf course site to accommodate everyday, and up to 100-year storm flooding will be designed in accordance with the provisions of the City's Land Use Ordinance. All in all, the development of the golf course will improve the current use of the floodplain and alleviate some localized flooding problems.

SECTION 7
RELATIONSHIP TO PLANS, POLICIES, AND CONTROLS

7.1 HAWAII REVISED STATUTES, CHAPTER 226 HAWAII STATE PLAN

The Hawaii State Plan is a guide for the future long-range development of the State which identifies goals, objectives, policies and priorities that are to be pursued. The overall theme of the Hawaii State Plan is:

* Individual and family self-sufficiency
* Social and economic mobility
* Community or social well being

Specifically, the Hawaii State Plan details objectives and policies in the various areas such as population, the economy, physical environment, facility systems, socio-cultural advancement, agricultural lands, and fiscal management. The West Loch Golf Course and Shoreline Park project is consistent with many of the goals and policies of the Hawaii State Plan and substantially fulfills its objectives.

7.1.1 Population, H.R.S. Section 226-5

The West Loch Golf Course and Shoreline Park project will not have any direct impact on population growth in the area.

7.1.2 Economy H.R.S. Section 226-6

The West Loch Golf Course and Shoreline Park project as a major development will involve a substantial amount of construction activity resulting in additional employment opportunities in the Ewa District of Oahu. The project will include commercial and recreational facilities which will create new secondary employment opportunities over the long term.

7.1.3 Scenic, Natural Beauty and Historic Resources H.R.S. Section 226-13

The West Loch Golf Course and Shoreline Park project fulfills the objectives articulated by this part of the plan by providing and/or improving public access to scenic ocean views through the use of open space and landscaping. The project concept respects the rural and historic character of the surrounding area and is consistent with development plans for the Ewa Plain.

7.1.4 Water H.R.S. Section 226-16

The development of a non-potable water source to irrigate the golf course, shoreline park, and other possible open and landscaped areas is contingent on the State Department of Land and Natural Resources (DLNR) approving the transfer of Oahu Sugar Company's EP2 Well (Preserved Use of 0.5 mgd) to the City. The project site is located within the Pearl Harbor Ground Water Control Area. Non-potable water will be utilized to irrigate the golf course, shoreline park, open space and landscaped areas of the project site. Facilities for the development, transmission, storage, and distribution of potable and non-potable water requirements of the project will be installed by the City.

7.1.5 Agriculture H.R.S. Section 226-7

Portions of the West Loch Golf Course are located in the State Agricultural District. The site consists of soils having classification ratings of B and C ratings according to the Detailed Land Classification, Island of Oahu study conducted by the University of Hawaii Land Study Bureau in 1972. A substantial portion of the site has already been withdrawn from cultivation and the remainder is scheduled for fallowing in 1990. The proposed West Loch Estates project will not adversely affect the economic viability of OSCo nor limit the growth of diversified agriculture. As such, the project is consistent with the major thrust of the agricultural portion of the Hawaii State Plan and the State Agriculture Functional Plan, which are intended to preserve the economic viability of sugar and pineapple and to promote the growth of diversified agriculture.

7.2 HAWAII STATE FUNCTIONAL PLANS

As a means of furthering the Hawaii State Plan, Hawaii Revised Statutes, Chapter 226, the 1984 State Legislature, by concurrent resolution, adopted ten Functional Plans to serve as guidelines for the State of Hawaii. The

West Loch Estates project conforms with the applicable objectives and policies of these Functional Plans.

7.2.1 State Water Resources Development Plan

West Loch Golf Course and Shoreline Park will not impair the capacity of the Pearl Harbor Ground Water Control Area as the potable and non-potable water demands will be within the stated limits of the PHGWCA due to the decreased requirements of agriculture, primarily sugar cultivation.

7.2.2 State Energy Plan

The West Loch project site is located in an easily serviceable and concentrated area that is adjacent to existing urban development. Utilization of energy saving devices and energy conservation will be encouraged through homeowner training and orientation programs provided by the City.

7.2.3 State Agriculture Plan

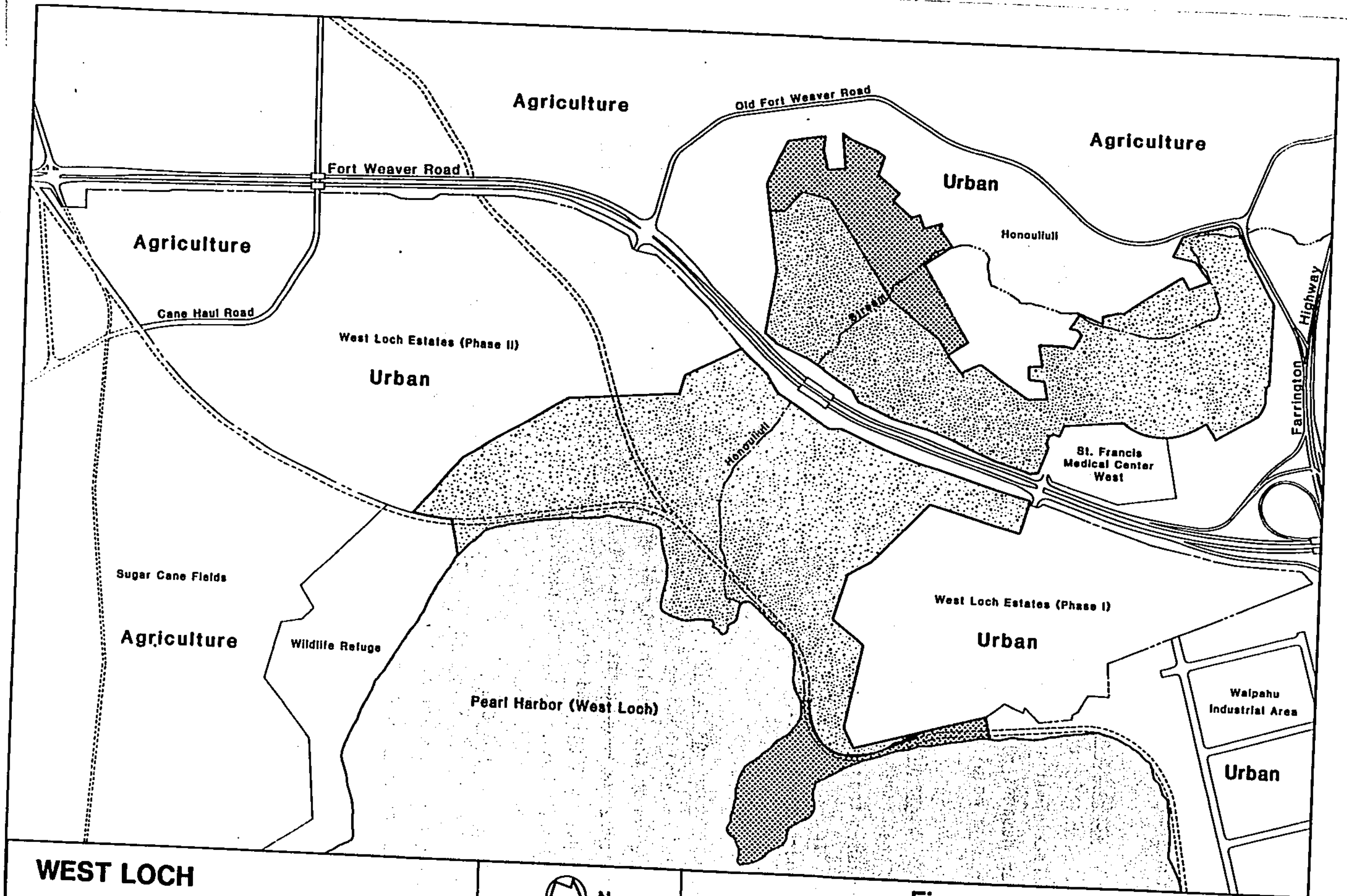
While the West Loch Golf Course and Shoreline Park project will result in a decrease of the availability of agricultural land, the site is already in fallow or scheduled for fallowing in 1990, and will not adversely affect the agricultural industry. The anticipated impact on overall agricultural activity in Hawaii, will be negligible.

7.3 STATE LAND USE

Most of the project site is classified within the State Agricultural District. A small part of the site adjacent to Waipahu is within the Urban District (Figure 7-1).

7.4 GENERAL PLAN

The City's planning policies are embodied in the General Plan which is a statement of long range social, economic, environmental and design objectives for the general welfare and prosperity of the people of Oahu.



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

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Figure 7-1
State Land Use

The General Plan also contains broad policies intended to facilitate the fulfillment of the Plan's objectives. The General Plan is implemented by regional Development Plans which provide relatively detailed guidelines for the physical development of Oahu.

The West Loch Golf Course and Shoreline Park project conforms with the broad objectives and policies contained within the General Plan. Although the project does involve the use of agricultural acreage, there will be no effect upon agriculture on Oahu as the land is either fallow or scheduled for fallowing in 1990. As such, it fully conforms with the requirements of the General Plan, Economic Activity, Objective C.

In other areas, the West Loch Golf Course and Shoreline Park project is consistent with the objectives of the General Plan as it is contiguous with existing urbanized areas, and has reasonable access to the necessary infrastructure. It should be noted that the project is located in the Ewa District which is targeted for major growth and has been designated as the second urban center for Oahu.

7.5 EWA DEVELOPMENT PLAN

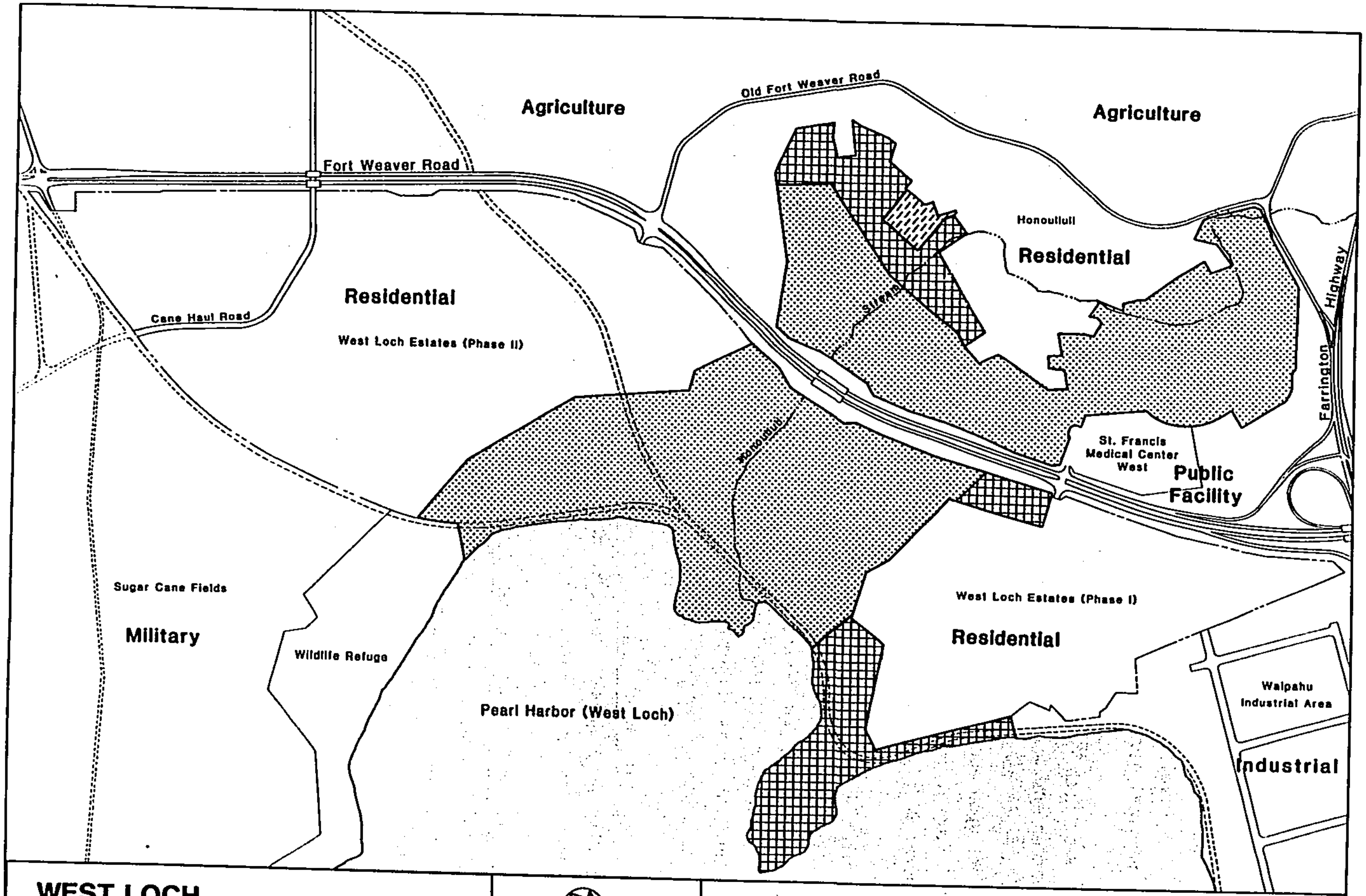
The City Development Plan (DP) Land Use Map designates the West Loch project site for residential, agricultural and park uses (Figure 7-2).

7.6 LAND USE ORDINANCE/COUNTY ZONING

Most of the project area is currently zoned AG-1. Minor portions of the project site are zoned R-5 and reflect existing residential use (Figure 7-3).

7.7 H.R.S. CHAPTER 205-A COASTAL ZONE MANAGEMENT ACT

Portions of the West Loch Golf Course and Shoreline Park project site are within the special management area for which a permit is required pursuant to H.R.S. Chapter 205-A (see Figure 7-4). The entire project site is within an area controlled by the CZMA and is, therefore, subject to H.R.S. Chapter 205-A's objectives and policies.



WEST LOCH

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Department of Parks and Recreation

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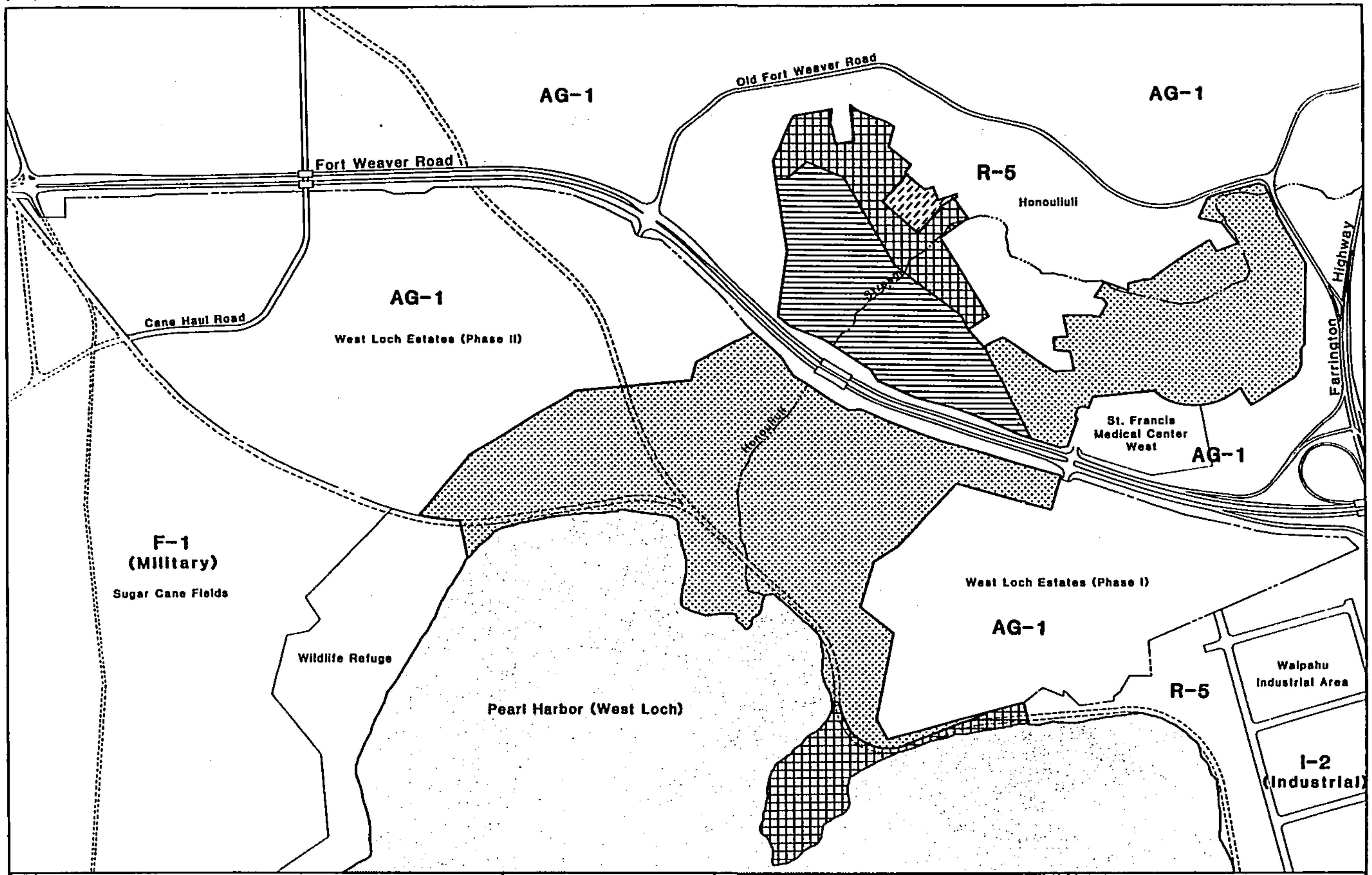
Figure 7-2
Development Plan Land Use

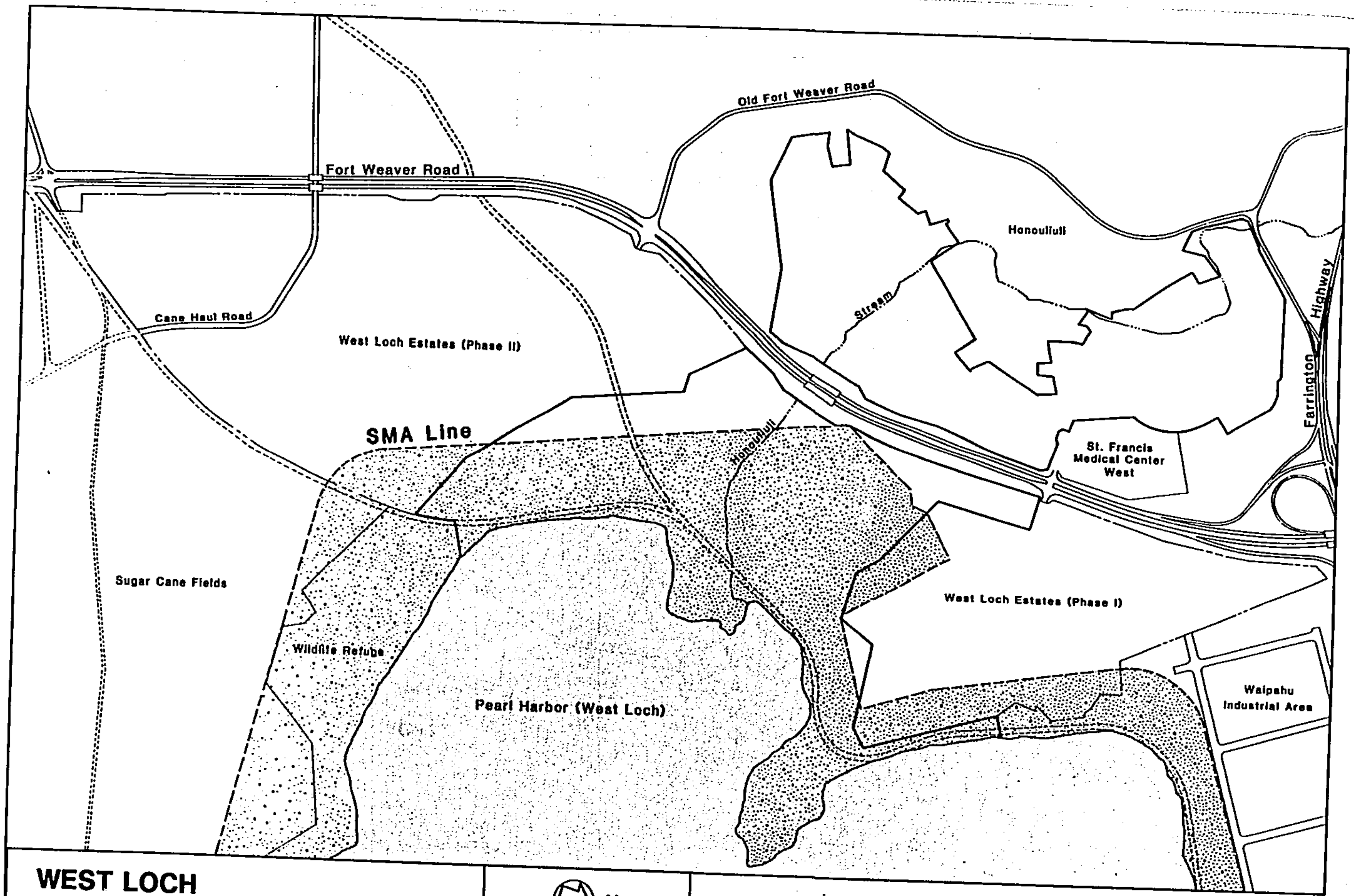


WEST LOCH

GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

Figure 7-3
Existing Zoning



WEST LOCH
GOLF COURSE & SHORELINE PARK

City and County of Honolulu
Department of Parks and Recreation

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Figure 7–4
Special Management Area

7.8 ENVIRONMENTAL IMPACT STATEMENT REQUIREMENTS

Prior to Department of Park and Recreation implementation of the West Loch Golf Course and Shoreline Park project, acceptance of the Final Environmental Impact Statement by the Mayor, through the Department of Land Utilization, is required. This Environmental Impact Statement has been prepared in accordance with Chapter 343 of the Hawaii Revised Statutes.

SECTION 8

RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY AND IRREVERSIBLE/IRRETRIEVABLE COMMITMENTS OF RESOURCES

Implementation of the proposed project will result in the commitment of the necessary construction materials and human resources (in the form of planning, designing, engineering, construction labor, landscaping, and personnel for the sales, management, services, offices, and maintenance functions). Some of the construction materials could be reused if and when the structures are demolished; however, at the present time and in view of the state of our economy, it is believed that the reuse of much of these materials is not practical. The people providing the labor necessary to implement and complete the project will be compensated during its various stages by the developer, construction and related businesses, and the City and State government.

The appearance of the project site will be altered from its present agricultural/fallowed appearance to that of planned recreational facilities. The development will be visually prominent but well integrated with the surrounding areas.

The air and noise environment will be affected by the proposed project, however, these impacts are typical of urban developments. While ambient air quality and noise levels in the area are relatively good, the proposed development will result in a greater number of vehicles going to and from the project areas, resulting in increased vehicular emissions. Existing State and Federal Air and Noise Quality Standards should not be violated. Relative to Air Quality Standards, the Federal requirement to use unleaded fuel, has resulted in "improved" automobile emission levels.

The project will result in a use commitment of the land for a long term period and it is unlikely that the land would revert to another use except over a long term. Commitment of land for these purposes will foreclose certain use options for the land, such as agriculture and residential uses.

The recreational and related use provided by the project will benefit the community over both the short and long term.

SECTION 9

ANY PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The following adverse environmental effects (both short and long term) cannot be avoided.

A. Large scale agricultural use of the land will no longer be possible.

B. The site clearing and construction work will result in temporary fugitive dust, some disruption to traffic, and high noise.

C. Traffic will increase due to the number of additional vehicles utilized by users of the proposed development. Additional impacts associated with increased traffic include probable reduction of air and noise quality. The specialized studies made as a part of preparing this document indicate that adequate setbacks or other mitigation measures such as sound attenuating berms or walls along Ft. Weaver Road will adequately accommodate the traffic noise added by the proposed development.

D. The project will result in additional demand for utilities services.

E. The need for public services such as fire and police protection will increase.

F. Solid waste and sewage generated by the project will increase the demand for disposal and treatment services and increase total waste output in that locale.

G. A number of families and businesses will be displaced by the project. Assistance provided by the Relocation Unit of the City Department of Housing and Community Development in the form of relocation services, compensation and financial assistance will serve as mitigation.

H. Some disturbance of the Wildlife/Bird sanctuary is likely to be caused by the project. Mitigative measures primarily in the form of a 300-foot buffer zone, and landscaping to minimize the effects of noise and lights, fencing, etc., are planned.

I. The adverse effect of increased stormwater runoff and the constituent quality of such runoff on the waters of West Loch will be mitigated by a drainage system within the Honouliuli Flood Plain designed to provide the capacity necessary for retention and settlement prior to outflow.

The manner by which the project meets community and social needs and conforms with the policy objectives of the State and County governments are thoroughly described in SECTION 7: Relationship to Plans, Policies, and Controls. The project is also intended to meet the needs for additional recreational opportunities and conforms with the Hawaii State Plan and the General Plan of the City and County of Honolulu.

SECTION 10
SUMMARY OF UNRESOLVED ISSUES

10.1 LAND USE APPROVAL

The majority of the land area within the project site is currently designated for agricultural use by the State Land Use Commission. A petition for a Special Use Permit will be filed with the Commission to allow the golf course use. Until this petition is filed and approval granted, the project site will remain in agricultural use.

10.2 SITE ACQUISITION

Most of the project site is owned by the James Campbell Estate, however, a number of smaller parcel owners will also be affected. Negotiations between the landowners and the City and County of Honolulu are currently underway and neither agreement to purchase nor the terms of such agreement have yet been finalized. The City may proceed with the project by utilizing its power of eminent domain and acquiring the property through condemnation.

10.3 CITY COUNCIL APPROVAL

The West Loch Golf Course and Shoreline Park project is subject to the review and approval of the City Council of the City and County of Honolulu. That body must authorize the condemnation and appropriate funds for construction before the project can proceed.

SECTION 11

LIST OF PREPARERS

R. M. TOWILL CORPORATION - EIS COORDINATION

Bruce Tsuchida
Chester Koga
Colette Sakoda
Roy Tsutsui

PACIFIC PLANNING AND ENGINEERS - TRAFFIC

Jonathan Shimada
Howard Abe

CHAR AND ASSOCIATES - BOTANICAL STUDY

Winona Char

DECISION ANALYSTS HAWAII - AGRICULTURAL IMPACT

Bruce Plasch

COMMUNITY RESOURCES, INC. - SOCIAL IMPACT

John Knox
David Curry
Berna Cabacungan

Y. EBISU AND ASSOCIATES - NOISE IMPACTS

Y. Ebisu

J.W. MORROW - AIR QUALITY STUDY

ANDREW BERGER - WILDLIFE

PAUL ROSENDAHL AND ASSOCIATES - ARCHAEOLOGY

Paul Rosendahl, Principal Investigator

DR. GORDON DUGAN - STORM WATER RUNOFF

WILLIAM BREWER AND ASSOCIATES - MARINE BIOLOGY

SECTION 12

LIST OF ORGANIZATIONS AND AGENCIES CONSULTED

NOTE: Agencies, organizations and individuals responding to the Preparation Notice and/or the Draft EIS are designated with an asterisk (*) and (**), respectively.

12.1 STATE AGENCIES

*	**	Dept. of Agriculture
*	**	Housing Finance and Development Corporation
*	**	Dept. of Business and Economic Development
	**	Dept. of Defense
*		Dept. of Education
*	**	Dept. of Health
*	**	Dept. of Land and Natural Resources
*		Dept. of Transportation
*	**	Land Use Commission
*		Office of Environmental Quality Control
	**	Accounting and General Services

12.2 UNIVERSITY OF HAWAII

	**	Environmental Center

12.3 CITY AND COUNTY OF HONOLULU

*	**	Board of Water Supply
	**	Building Department
*	**	Dept. of General Planning
*		Dept. of Land Utilization
		Dept. of Parks and Recreation
*	**	Dept. of Public Works
*		Dept. of Transportation Services
		Office of Human Resources
*	**	Fire Department
*	**	Police Department
	**	Dept. of Housing and Community Development

12.4 FEDERAL AGENCIES

** Dept. of the Army, Corps of Engineers
* ** Dept. of the Navy
* ** Dept. of Interior, Fish and Wildlife Services
** Dept. of Interior, Geological Survey, Water Resources Div.
* ** Dept. of Housing and Urban Development
** Dept. of Agriculture, Soil Conservation Services

12.5 PRIVATE ENTITIES

** Hawaiian Electric Company
Hawaii's Thousand Friends
* Waipahu Neighborhood Board

SECTION 13

COMMENTS AND RESPONSES -- PREPARATION NOTICE

U.S. Department of Housing and Urban Development
Honolulu Office, Region IX
300 Ala Moana Blvd., Room 3318, Box 50007
Honolulu, Hawaii 96850-4991

87-277

October 20, 1987

Mr. Hiram Kamaka, Director
Department of Parks & Recreation
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Dear Mr. Kamaka

SUBJECT: West Loch Golf Course and Shoreline Park, Ewa, Oahu

We have reviewed the Preparation Notice Environmental Impact Statement for the subject project. We understand that a 157-acre golf course and a 59-acre shoreline park will be an integral part of the West Loch Housing Project that will provide for 1,350 family units and 150 elderly rental units.

In reviewing the summary of major impacts that will be addressed in the Draft EIS, we do not have any additional issues that should be addressed. We look forward to receiving a copy of the Draft EIS.

Very sincerely yours,

Calvin Lew

Calvin Lew
Director
Community Planning and
Development Division

November 23, 1987

Mr. Calvin Lew
U. S. Department of Housing and Urban Development
Honolulu Office, Region IX
Box 5007
Honolulu, Hawaii 96850-4991

Dear Mr. Lew:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 20, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

FD/175

FD/17

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:
ES
Room 6307

OCT 21 1987

Mr. Hiram Kamaka, Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Re: Environmental Impact Statement Preparation Notice, West Loch Golf Course and Shoreline Park, Ewa, Oahu

Dear Mr. Kamaka:

We have reviewed the referenced Preparation Notice and offer the following comments for your consideration.

We appreciate your efforts to coordinate the development of the West Loch Golf Course and Shoreline Park with my staff. We understand that our April 22, 1987 letter to Mr. Donald Clegg and our June 22, 1987 letter to Mr. Michael Moon regarding potential impacts to the Pearl Harbor National Wildlife Refuge from the proposed development have been forwarded to your office by the Department of Housing and Community Development. We would appreciate being a consulted party on the development of the Draft Environmental Impact Statement for this project.

We appreciate the opportunity to comment.

Sincerely,

Ernest Kosaka

Ernest Kosaka, Field Supervisor
Environmental Services
Pacific Islands Office

ws-27

November 23, 1987

Mr. Ernest Kosaka
Field Supervisor, Environmental Services
U. S. Department of the Interior
Fish and Wildlife Service
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Ms. Peterson:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 21, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

As plans for the golf course and shoreline park are developed, we will share these plans with your staff to input and comment.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR HAWAII 96860-5020

IN REPLY REFER TO
11010
Ser N5B(202)/2459

Mr. Hiram K. Kamaka, Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Dear Mr. Kamaka:

ENVIRONMENTAL IMPACT STATEMENT (EIS) PREPARATION
NOTICE FOR THE WEST LOCH GOLF COURSE AND SHORELINE PARK

The U.S. Navy was not included on the distribution list of your letter dated September 1, 1987, which requested comments on the EIS preparation notice for the subject development. However, through the Office of the Environmental Quality Control (OEQC), State of Hawaii, a copy of the preparation notice was provided.

The Navy commented on West Loch Estates, including the golf course and shoreline park by letter of September 14, 1987, to Mr. Mike Moon, Director, Department of Housing and Community Development of the City and County of Honolulu. The Navy position has not changed since that letter. A copy is enclosed.

On page 3 of your EIS Preparation Notice, you have correctly stated:

> "By prior agreement with the Navy, no boating activity will be allowed. Existing fishponds within the shoreline zone will be retained as one of the park's features and improved to allow use by waterbirds which inhabit that area of West Loch."

The Navy cannot allow Pearl Harbor to be open to sailing or other forms of water recreation for reasons of safety, security, and operations. The EIS should make this position clear.

The preparation notice on page 3 makes reference to existing piers that extend into West Loch that would be restored to provide access over the water. Such piers do not appear in your map. The EIS should make clear where these piers are and how they are to be utilized.

Thank you for the opportunity to comment on the EIS preparation notice. The Navy point of contact is Mr. Bill Liu, phone 471-3324.

Sincerely,

Copy to:
State Office of Environmental
Quality Control (Attn: Faith Miyamoto)
C&C Honolulu Department of
General Planning (Attn: Mr. Donald A. Clegg)
C&C Honolulu Office of City Manager
(Attn: Mr. Jeremy Harris)
C&C Honolulu Department of Housing
and Community Development (Attn: Mr. Mike Moon)

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

December 28, 1987

Captain R. M. Gallen
CEC, U. S. Navy
Base Civil Engineer
Naval Base Pearl Harbor
Box 110
Pearl Harbor, Hawaii 96860-5020

Dear Capt. Gallen:

Subject: West Loch Golf Course and Shoreline Park

Thank you for your comments of October 26, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

We will continue to respect the wishes stated earlier relating to the use of the waters of West Loch. The existing piers that extend into West Loch will be shown in the Draft EIS.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:nt

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSO

October 29, 1987

MEMORANDUM

To: Mr. Hiram Kamaka, Director
Department of Parks and Recreation, City & County of Honolulu

From: Deputy Director for Environmental Health

Subject: West Loch Golf Course and Shoreline Park, Ewa, Oahu

In the preparation of an EIS for the subject project, the following concerns must be addressed:

Vector Control

1. Many areas of the development are bounded by kiawe forests and is a haven for rodents. Oahu Sugar caneland is also affected.

   Rule on "demolition and clearing of vacant land" must be strictly enforced. The developer must be made aware of procedures to ensure this rule is complied with (e.g., rodent indexing by trapping prior to clearing by a knowledgeable pest control operator).

2. The Honouliuli area of this development is mainly marshland and mosquito breeding will be a serious problem. All pools of water, natural and man made, and ditches and streams must be properly and periodically treated by the developer.

Noise

1. The proposed golf course and park will abut existing and future residences. Noise from recreational and ground maintenance activities may adversely affect these residents.

2. Construction activities must comply with the provisions of Title 11, Administrative Rules Chapter 43, Community Noise Control for Oahu.

   a. Construction equipment and onsite vehicles requiring an exhaust of gas or air must be equipped with mufflers.

   b. The contractor must comply with the conditional use of the permit as specified in the rules and conditions issued with the permit.

3. Traffic noise from heavy vehicles travelling to and from the construction site must be minimized near existing residential areas and must comply with the provisions of Title 11, Administrative Rules Chapter 42, Vehicular Noise Control for Oahu.

BRUCE S. ANDERSON, Ph.D.

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

December 28, 1987

Honorable Bruce S. Anderson, Ph.D.,
Deputy Director
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

Subject: West Loch Golf Course and Shoreline Park

Thank you for your comments of October 29, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Vector Control
The rules relating to demolition and clearing of vacant land will be pointed out to the developer of this project.

Noise
Thank you for your comments relating to potential noise impacts on the residential uses within the area. As currently planned, we do not believe that the residential uses will be impacted by noise from the golf course as no homes will be directly adjacent to the golf course, likewise any active playing fields.

We will include provisions in our construction contract to ensure that the contractor/developer is in conformance with Title 11, Administrative Rules Chapter 43 and Chapter 42.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:nt

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

NOV 24 1987

DOC. NO.: 1976E
FILE NO.: 88-189

Honorable Hiram K. Kamaka, Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

SUBJECT: West Loch Golf Course and Shoreline Park

Thank you for the opportunity to review the Environmental Impact Statement (EIS) preparation notice of this project. We offer the following comments:

The quantity and source of irrigation water needed for this project should be addressed. New water source developments or changes in use of existing well sources in the area would require the approval of the new Commission on Water Resource Management. Also, modifications of Honouliuli Stream would require a permit from the Commission.

The identification and evaluation of potential environmental impacts to wetlands should be discussed as well as mitigating measures for same.

The Draft EIS should discuss the sanitary quality of West Loch waters and the impact of public use on shoreline resources and clearly determine what the Navy intends to allow in terms of shoreline and nearshore use for the project's shoreline area.

Finally, any findings of the archaeological survey should be presented in the Draft EIS.

Thank you for taking our concerns into consideration.

Very truly yours,

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

December 28, 1987

Honorable William W. Paty
Chairperson
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: West Loch Golf Course and Shoreline Park

Thank you for your comments of November 24, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Pursuant to your comments we will include information relating to the projected demand for potable and non-potable water for drinking and irrigation. The water requirements for the project are being coordinated with the Board of Water Supply. If new source development or if stream modification are required for this project, we will be seeking this approval from the Commission on Water Resource Management.

The potential impacts to wetlands and wetland resources will be addressed in the Draft EIS.

As part of this project we are conducting a special study to determine the potential impacts on the marine biota of West Loch. As we noted in the Preparation Notice, no activity within West Loch will be allowed by the Navy.

An archaeological study will be conducted as part of this project. The findings and recommendations of the project archaeologist will be coordinated with the Historic Sites Section of your Department.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:nt

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 TELEX: 7430250 HIDPED

ROGER A. ULVELING, DIRECTOR
MURRAY E. TOWILL, DEPUTY DIRECTOR
BARBARA KIM STANTON, DEPUTY DIRECTOR

Ref. No. P-7479

October 21, 1987

The Honorable Hiram Kamaka
Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

Subject: Environmental Impact Statement Preparation Notice for West Loch Golf Course and Shoreline Park, Ewa, Oahu

We have reviewed the subject proposal and have the following comments relative to the Hawaii Coastal Zone Management (CZM) Program.

A CZM policy provides for the protection and preservation of valuable coastal ecosystems of significant biological or economic importance. Relative to this, we note that the Honouliuli or West Loch unit of the Pearl Harbor Wildlife Refuge is situated adjacent to the project site, and serves as habitat, nesting, and feeding grounds for endangered Hawaiian waterbirds.

The EISPN states that a study of the wildlife in the project site will be made as part of the EIS. Because of the close proximity of the refuge to the project site and the fact that the endangered waterbirds and other species are known to frequent the area, we suggest that marine fauna, endangered species, and coastal ecosystem communities near the project site also be included in this study. Appropriate mitigative measures to minimize potential adverse discussions should include, but are not limited to, possible intrusion by humans or domestic animals, and disruption from noise and lighting to the refuge.

Another CZM policy calls for the promotion of water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems. The cumulative impacts of this project and other development projects, such as the West Loch Estates housing project, proposed for the West Loch area is an important consideration. As such, the proposed project should be evaluated in terms of possible cumulative effects on the quality of Pearl Harbor.

The EISPN states that the effect of runoff from the golf course on West Loch will be investigated. Increases in volume and flow rate of surface

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water runoff could adversely affect the Pearl Harbor ecosystem. Of particular concern is pesticide and herbicide use on the proposed golf course, which may result in harmful effects to the marine environment. Relative to this, an analysis of the increased sediment, nutrient, and biocide load in the runoff into Pearl Harbor and any potential effects on both water quality and biota should be provided.

The EISPN also indicates the presence of Honouliuli Stream within the project site and states that "the existing stream course will, to the extent possible, be maintained as an enhancement to the golf course without affecting the drainage characteristics of the area." The EIS should define the term "extent possible" and provide information regarding the existing physical and biological characteristics of the stream. Potential impacts due to possible stream alterations should also be discussed.

In addition to the stream, there are also fish ponds and wetlands located within the project area. Activities which can alter these resources, i.e., dredge and/or fill, must be coordinated with the U.S. Army Corps of Engineers since such activities may require a Department of the Army permit.

Thank you for the opportunity to review this proposal.

Sincerely,

Murray E. Towill

for Roger A. Ulveling

November 23, 1987

Mr. Roger A. Ulveling, Director
Department of Business and Economic Development
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Ulveling:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 23, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

The planning and development of the golf course and shoreline park is being coordinated with the Corps of Engineers and U. S. Fish and Wildlife Service to protect and enhance existing wildlife habitats. Portions of the golf course and shoreline park will be developed in such a manner as to increase the size of the wildlife habitat.

As part of the planning process, we are coordinating two special studies that will address the impacts on aquatic and marine organisms. The findings and conclusions of these studies will be reported in the Draft EIS.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

JOHN WAIHEE
GOVERNOR

RUSSELL N. FUKUMOTO
Acting Executive Director

STATE OF HAWAII
Department of Business and Economic Development
Housing Finance and Development Corporation
P. O. BOX 17907
HONOLULU, HAWAII 96817

IN REPLY REFER TO:

87:PLNG/4497JT

October 21, 1987

Mr. Hiram Kamaka, Director
Department of Parks & Recreation
City & County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Re: Proposed West Loch Golf Course and Shoreline Park, Ewa, Oahu

Dear Mr. Kamaka:

Thank you for the opportunity to review the Environmental Impact Statement Preparation Notice for the proposed project.

The Housing Finance and Development Corporation (formerly a part of the Hawaii Housing Authority) would like to be a consulted party.

Sincerely,

RUSSELL N. FUKUMOTO
Acting Executive Director

November 23, 1987

Mr. Russell N. Fukumoto, Director
Housing Finance Development Corporation
P. O. Box 17907
Honolulu, Hawaii 96817

Dear Mr. Fukumoto:

Subject: West Loch Golf Course and Shoreline Park Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 23, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

S.199
11/23
FD/178

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 SOUTH KING STREET, ROOM 104
HONOLULU, HAWAII 96813

MARVIN T. MIURA, PH.D.
DIRECTOR

TELEPHONE NO.
548-6915

October 8, 1987

Mr. Hiram K. Kamaka
Director
Department of Parks and Recreation
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

Subject: Comments on the Preparation Notice for the West Loch Golf Course and Shoreline Park

Thank you for the opportunity to review this preparation notice. We request that the following items be discussed in your draft EIS.

1. The proposed golf course and the housing project to be built by the Department of Housing and Community Development are in proximity to each other. Although they are being constructed by different agencies, the cumulative impact of the two projects should be discussed.

2. Storm runoff from the golf course will contain herbicides and fertilizer. The effect of the runoff on coastal waters should be discussed. Fertilizer in the runoff may cause an algal bloom, and herbicides may adversely affect fish populations. These problems should be mitigated.

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FD/171

3. The shoreline and mud flats along West Loch are frequented by endangered birds. These endangered birds should be identified, and the project's effects on the birds should be discussed.

Sincerely,

Marvin Miura

Marvin T. Miura, Ph.D.
Interim Director

Roy K. Sakamoto

Roy K. Sakamoto
Environmental Technical Specialist

November 23, 1987

Dr. Marvin T. Miura, Ph.D., Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 20, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

The planning for the golf course/shoreline park and the proposed housing for West Loch have been closely coordinated and the relationship between the two projects will be discussed in the Draft EIS.

The planning for the golf course and shoreline park have been coordinated with the Army Corps of Engineers and U. S. Fish and Wildlife Service to mitigate any adverse impacts to wildlife and botanical resources of the area.

A special study is being prepared to address the impacts of additional runoff burden on West Loch as a result of the development of the golf course. We are also conducting a marine survey of a portion of West Loch to establish a baseline data base to ascertain impact resulting for runoff into West Loch.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

STATE OF HAWAII
DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT
LAND USE COMMISSION
Room 104, Old Federal Bldg., 335 Merchant Street, Honolulu, Hawaii 96813 Telephone 548-4611

JOHN WAIHEE
Governor

TEOFILO PHIL TACBIAN
Chairman

FREDERICK P. WHITTEMORE
Vice Chairman

COMMISSION MEMBERS:
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Lawrence F. Chun
Everett L. Cuskaden
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Toru Suzuki
Robert S. Tamaye
Renton L.K. Nip

ESTHER UEDA
Executive Officer

RMT		WES	
DK		BTT	BT
RYK		WD	
REC'D		1987	RMT
GSY		YJK	

CK

October 13, 1987

Mr. Hiram Kamaka, Director
Department of Parks & Recreation
City & County of Honolulu
650 S. King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

Subject: EIS Preparation Notice for the Proposed West Lock Golf Course and Shoreline Park, Ewa, Oahu

Thank you for the opportunity to review the subject EIS Preparation Notice. We have no comments to offer at this time.

Sincerely,

Esther Ueda

ESTHER UEDA
Executive Officer

EU:to

cc: Chester Koga, R.M. Towill Corp.

November 23, 1987

Ms. Esther Ueda
Executive Officer
Land Use Commission
Honolulu Old Federal Building
335 Merchant Street, Room 104
Honolulu, Hawaii 96813

Dear Ms. Ueda:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 16, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

GOVERNOR

CHARLES T. TOGUCHI
SUPERINTENDENT

STATE OF HAWAII
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAII 96804

OFFICE OF BUSINESS SERVICES

October 16, 1987

Mr. Hiram Kamaka, Director
Department of Parks & Recreation
City & County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

SUBJECT: West Loch Golf Course and Shoreline Park, Ewa, Oahu

Our review of your proposed project indicates that it will have negligible impact on our area schools.

Thank you for the opportunity to comment.

Sincerely,

Eugene S. Imai
Assistant Superintendent

ESI:MRI:ct

cc Leeward Dist. Office

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

S-198
10/23 [illegible]
F-179

November 23, 1987

Mr. Eugene S. Imai
Assistant Suprintendent
Department of Education
P. O. Box 2360
Honolulu, Hawaii 96804

Dear Mr. Imai:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 16, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

EDWARD Y. HIRATA

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION

IN REPLY REFER TO: STP 8.2438

RMT		WES	
DK		BTT	AT
RYK		WD	
REC'D NOV 2 - 19?P			RMT:
GSY		YJK	

October 28, 1987

dk

Mr. Chester Koga, AICP, Senior Planner
R.M. Towill Corporation
677 Ala Moana Blvd., Suite 1016
Honolulu, Hawaii 96813

Dear Mr. Koga:

Environmental Impact Statement Preparation Notice
West Loch Golf Course and Shoreline Park
Ewa, Oahu

The development's draft EIS should contain a traffic impact analysis report which addresses the local and regional effects on our highway system and identifies any needed mitigation measures.

Since an existing 40-foot railroad right-of-way is adjacent to Increment II of the development, you should be aware of City Ordinance No. 84-94. This ordinance incorporated a Unilateral Agreement and Declaration for Conditional Zoning and was signed by the owners of the land, Campbell Estate, and the developer, Hirano Brothers, Ltd. In the Unilateral Agreement, it was agreed to respect the railroad right-of-way and to design projects adjacent to this right-of-way in a manner compatible with its use for transportation improvements. Further, the parties agreed that structures would be setback a minimum of 40 feet from this right-of-way. We feel, therefore, that similar conditions should be imposed on the subject development.

We also noted that a portion of Phase II in the vicinity of the intersection of Fort Weaver Road and what appears to be Renton Road is in an area of potential aircraft single event noise exposure. Accordingly, the draft EIS should address this matter.

Another condition that will need to be considered is the presence of the energy corridor. We have enclosed a map

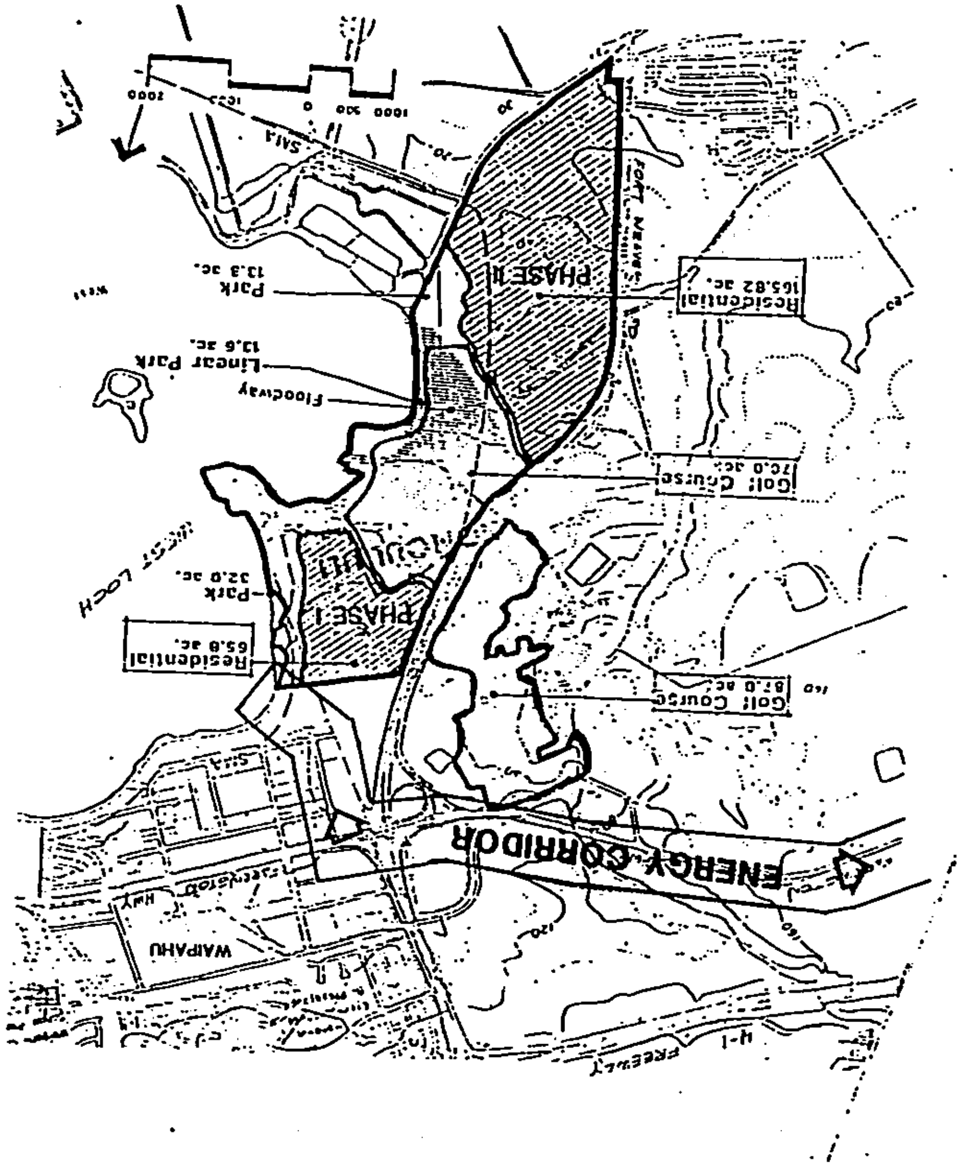
indicating the corridor's relationship with the proposed development. Please note that the affected areas are located at the northern end of Phase I and the mauka golf course. In this regard, close coordination with our Harbors Division is recommended.

Thank you for this opportunity to provide comments.

Very truly yours,

Edward Y. Hirata
Director of Transportation

Enclosure



November 23, 1987

Mr. Edward Y. Hirata, Director
Department of Transportation
State of Hawaii
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Hirata:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 27, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

We have incorporated into our plans provisions for the railroad right-of-way and the energy corridor in the area. We have also included an additional 40 feet setback from the right-of-way.

We have examined the AICUZ study for Naval Air Station, Barbers Point, and find that the noise contour does not impact the project site. We will acknowledge the potential for single event impacts.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

JOHN WAIHEE
GOVERNOR

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

SUZANNE D. PETERSON
CHAIRPERSON, BOARD OF AGRICULTURE

TADASHI TOJO
DEPUTY TO THE CHAIRPERSON

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822-0159

RMT | WES | DK | BTT | RYK | WD
REC'D 1987 RMTC
GSY | YJK

October 9, 1987

MEMORANDUM

To: Mr. Hiram Kamaka, Director
Department of Parks and Recreation
City and County of Honolulu

Subject: Environmental Impact Statement Preparation Notice (EISPN) for West Loch Golf Course and Shoreline Park
Department of Parks and Recreation
TMK: 9-1-17: (various)
9-1-20: 14
9-1-21: 21
9-1-22: (various) Ewa, Oahu
Acres: approximately 230

The Department of Agriculture has reviewed the subject document and has the following comments to offer.

According to the EISPN, an 18-hole municipal golf course and shoreline park located along West Loch are proposed. There is also a residential project planned (Department of Housing and Community Development's West Loch Estates) which was previously included with the golf course and park proposal. These projects are now proceeding separately.

Our Department has previously commented on the proposed park as part of the Development Plan (DP) Public Facility Amendment process (see attached copy of our memorandum to Mr. Donald A. Clegg, dated April 22, 1987). The proposed golf course was included in an Environmental Assessment Notice for West Loch Estates Housing Project on which we commented (see attached copy of our letter to Mr. Mike Moon, dated June 17, 1987).

The subject EISPN contains lands classified "Prime", "Other Important" and not classified according to the Agricultural Lands of Importance to the State of Hawaii (ALISH) system. This information should be included in the draft EIS.

The EIS should also include discussion of the following issues that may be affected by the proposed development:

- a complete soils description, with references to the Land Study Bureau Overall Productivity Rating system and the Soil Conservation Service Soil Survey, which indicate the agricultural suitability of the site;

- the impact on the sugarcane fields adjacent to the project site (the Hawaii Right-to-Farm Act, Chapter 165, HRS, limits the circumstances under which pre-existing farming activities may be deemed a nuisance);

- the impact of this development on future agricultural production and expansion of diversified agriculture; and

- identification of the THK parcels and acreages.

Thank you for the opportunity to comment. We will provide further comment upon our receipt and review of the Draft EIS.

Suzanne D. Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

Attachments

cc: ✓Chester Koga, R. M. Towill Corp.
Mr. William Balfour, President and Manager,
Oahu Sugar Company
DBED
OEQC
DGP

April 22, 1987

Mr. Donald A. Clegg, Chief Planning Officer
Department of General Planning
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Clegg:

Subject: Development Plan (DP) Public Facility Amendment for Central Oahu, West Loch Regional Park--87/E-1012(IC)
Department of Housing and Community Development
TMK: 9-1-17: por. 09, por. 13, 14, 20-33, 44
9-4-48: 74 Ewa, Oahu
Acres: 59.4

The Department of Agriculture has reviewed the subject application and has the following comments to offer.

The applicant proposes to develop a new park facility along West Loch, Pearl Harbor.

The subject site is not classified according to the Agricultural Lands of Importance to the State of Hawaii (ALISH) system.

The Soil Conservation Service Soil Survey identifies the predominant soil as Helemano silty clay (HLMG) with 30 to 90 percent slopes and a soil capability classification of VIIe (soils very severely limited by erosion risk). A smaller portion of the area consists of Fill Land (FL) and Honouliuli clay (HxA).

The Land Study Bureau Overall Productivity Rating is E105 and Urban. By this method of classification, the parcel has poor productivity potential for most agricultural uses.

There is sugarcane production in the immediate vicinity but not on the subject site. We are aware of other urban-type proposals also in the immediate vicinity. The Department of Agriculture does not object to the proposed DP public facility amendment.

Thank you for the opportunity to comment.

Sincerely,

Suzanne D. Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

cc: DPED

June 17, 1987

Mr. Mike Moon, Director
Department of Housing and Community Development
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Moon:

Subject: Environmental Assessment Notice for
West Loch Estates Housing Project
Department of Housing and Community Development
TMK: 9-1-17: 06, 9-11, 13, 14, 18, 31 & 32
Ewa, Oahu
Acres: 448

The Department of Agriculture has reviewed the Environmental Assessment notice for the subject housing project and has the following comments to offer.

According to the project description, the proposed development will provide 1,500 residential units, a 157-acre golf course and another 59.4 acres of parks. The proposed project consists of three nearly adjacent areas. The subject areas are predominantly within the State Agricultural District as indicated on the "project description".

The subject lands are largely classified "Prime" and "Other Important" according to the Agricultural Lands of Importance to the State of Hawaii (ALISH) system, except the proposed shoreline park area which is not classified. This information should be included in the Environmental Assessment.

The Environmental Assessment should also include discussion on the following issues that may be affected by the proposed development:

- a complete soils description, with references to the Land Study Bureau Overall Productivity Rating system and the Soil Conservation Service Soil Survey, which indicate the agricultural suitability of the site;

- the impact on the economic viability of Oahu Sugar Company resulting from the cessation of sugarcane production on the subject lands;
- the impact on the remaining sugarcane fields adjacent to the project site (the Hawaii Right-to-Farm Act, Chapter 165, HRS, limits the circumstances under which pre-existing farming activities may be deemed a nuisance);
- the impact of this development on future agricultural production and expansion of diversified agriculture;
- the potential of establishing viable alternative agricultural uses on the agricultural-designated lands in the project site;
- the broader economic and resource impact on the State from the irrevocable loss of prime agricultural lands at the site;
- conformity to the State Agriculture Functional Plan and its objectives and policies, particularly, Implementing Action B(5)(c);
- conformity to the Hawaii State Plan priority guidelines 226-104(b)(2) and 226-106(1), which direct development into marginal or non-essential agricultural land to meet housing needs and "...(maintain) agricultural lands of importance in the agricultural district";

Thank you for the opportunity to comment. We will provide further comment upon our receipt and review of the Draft Environmental Impact Statement.

Sincerely,

Suzanne D Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

cc: Mr. William Balfour, President and Manager,
Oahu Sugar Company
DPED
OEQC
DGP

November 23, 1987

Ms. Suzanne D. Peterson
Chairperson, Board of Agriculture
Department of Agriculture
1428 South King Street
Honolulu, Hawaii 96814

Dear Ms. Peterson:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 28, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Pursuant to your comments, we will include information relating to the classification of agricultural lands within the project boundaries. The proposed action will involve the discontinuance of agricultural activities within the project boundaries. The proposed action will not have any impact on adjacent (south of project) sugar cane activities.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF HONOLULU

ENV 87-209

October 20, 1987

Mr. Chester Koga
R.M. Towill Corporation
677 Ala Moana Boulevard, Suite 1016
Honolulu, Hawaii 96813

Dear Mr. Koga:

Subject: West Loch Golf Course and Shoreline Park
Ewa, Oahu, Hawaii

We transmit a marked-up copy of the EISPN (September 1987) which was sent to us by letter dated September 23, 1987, for review and comments.

Very truly yours,

ALFRED J. THIEDE
Director and Chief Engineer

Att.

November 23, 1987

TO: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 20, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813
PHONE 523-4181

FRANK F. FASI
MAYOR

MIKE MOON
DIRECTOR

ROBERT MIYASATO
DEPUTY DIRECTOR

October 22, 1987

MEMORANDUM

TO: Hiram K. Kamaka, Director
Department of Parks and Recreation

FROM: Mike Moon

SUBJECT: EIS Preparation Notice
West Loch Golf Course and Shoreline Park
Ewa, Oahu

Thank you for the opportunity to review and comment on the proposed 18-hole municipal golf course and shoreline park located in the Ewa District, Oahu.

As you know, golfing is one of the most popular sports on Oahu and the existing public courses are heavily used. There are currently three 18-hole courses and one 9-hole course. Today, Oahu has 830,000 residents. The golf course standard is one 18-hole course per 100,000 people. There is a need for an additional five 18-hole public courses.

Play at the public golf courses are increasing at a rate of 10-16% per year. The addition of the lands at West Loch would lessen the heavy use of public golf facilities. Also, the proposed water oriented park will provide shoreline public access to the Pearl Harbor waters.

for Robert Miyasato
MIKE MOON
Director

C-1017
11/23 Y
FD/178

November 23, 1987

TO: MIKE MOON, DIRECTOR
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 22, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

DEPARTMENT OF TRANSPORTATION SERVICES

CITY AND COUNTY OF HONOLULU

HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

JOHN E. HIRTEN
DIRECTOR

JOSEPH M. MAGALDI, JR.
DEPUTY DIRECTOR

PL1.0819
TE-8629

October 23, 1987

MEMORANDUM

TO: HIRAM K. KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

ATTENTION: YUKIO TAKETA

FROM: JOSEPH M. MAGALDI, JR., ACTING DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU
ENVIRONMENTAL PREPARATION NOTICE
TMK: 9-1-17

This is in response to the request for comments on the preparation notice for West Loch Golf Course and Shoreline Park.

The Environmental Impact Statement should address the following traffic concerns:

1. The amount and type of traffic to be generated by the golf course and park.
2. The traffic impact of the two projects on the affected roadway system.
3. The adequacy of the on-site parking spaces that must be provided to support the proposed projects.
4. The type of grade separated crossing at Fort Weaver Road for golf carts.

Should you have any questions, please contact Ken Hirata of my staff at local 5031.

JOSEPH M. MAGALDI, JR.

FD119

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

December 28, 1987

TO: JOSEPH M. MAGALDI, JR. ACTING DIRECTOR
DEPARTMENT OF TRANSPORTATION SERVICES

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK

Thank you for your comments of October 23, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

As part of the planning for this study we are conducting a traffic impact assessment. This study will address impacts to the adjacent roadway systems. We will include information on the parking provisions for the golf course and shoreline park.

The proposed crossing for golf carts for the golf course is currently planned to be located as an underpass at the location of the existing vehicular bridge along Fort Weaver Road. The design of this facility is being coordinated with the State Department of Transportation.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:nt

…ER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96843

October 16, 1987

TO: HIRAM K. KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU, TMK: 9-1-17

Thank you for the opportunity to review the environmental document for your proposed golf course and park.

We have the following comments:

1. Page 4, Section 3.1.2: The section on Hydrology should be expanded to indicate that the caprock prevents recharge to the groundwater aquifer. However, parts of the area are underlain by reef limestone at shallow depths which are recharged through the overlying soils (caprock water).

2. Page 4, Section 3.1.3: The term "moderately slow permeability" should be changed to "moderately low permeability".

3. Page 6, Section 3.3.2: This section should indicate that potable water will be obtained from the Board of Water Supply system. Irrigation water will be obtained by drilling and developing brackish water wells in the Ewa Plain caprock.

4. A water master plan for the golf course, shoreline park, and the West Loch Estates Housing Project should be submitted for our review and approval.

If you have any questions, please contact Lawrence Whang at 527-6138.

FOR KAZU HAYASHIDA

Pure Water . . . man's greatest need – use it wisely

F0/175

November 23, 1987

TO: KAZU HAYASHIDA, DIRECTOR AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 16, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

We will incorporate the information you provided. Further, as part of the overall development planning for the project, a water master plan will be prepared and filed with your department.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf

cc: R. M. Towill Corp.

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96814 - AREA CODE (808) 943-3111

FRANK F. FASI
MAYOR

DOUGLAS G. GIBB
CHIEF

WARREN FERREIRA
DEPUTY CHIEF

OUR REFERENCE SS-LK

October 16, 1987

TO: HIRAM KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: DOUGLAS G. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN) FOR WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU

We have reviewed the above EISPN and have no objections to the project at this time.

We ask that we be designated as a consulted party in the preparation of the Environmental Impact Statement.

DOUGLAS G. GIBB
Chief of Police

November 23, 1987

TO: DOUGLAS A. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 16, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

C.999
10/20/87

FO/174

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

DONALD A. CLEGG
CHIEF PLANNING OFFICER

GENE CONNELL
DEPUTY CHIEF PLANNING OFFICER

KK/DGP 10/87-3425

October 19, 1987

MEMORANDUM

TO: HIRAM K. KAHAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

SUBJECT: CHAPTER 343, HAWAII REVISED STATUTES
ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
FOR THE PROPOSED WEST LOCH GOLF COURSE AND
SHORELINE PARK, EWA, OAHU

This is in response to your request for comments on the Environmental Impact Statement Preparation Notice for the proposed West Loch Golf Course and Shoreline Park in Ewa.

The following points should be addressed in the preparation of the Draft Environmental Impact Statement:

1. Water System

The use of non-potable water for irrigation purposes should be considered.

2. Drainage System

The West Loch Golf Course and Shoreline Park development may affect the quality and quantity of runoff flowing into Pearl Harbor's West Loch. The drainage impacts should be reviewed.

3. Parks and Recreation

The applicant should coordinate plans for the shoreline park with the Navy and the Department of Land and Natural Resources.

C-342
10/14

4. Flora and Fauna

The applicant should address Corps of Engineers and U.S. Fish and Wildlife Service concerns regarding the alteration of wetlands and impacts on the Pearl Harbor National Wildlife Refuge, Honouliuli Unit.

We would like to be a consulted party on the subject EIS.

Thank you for giving us an opportunity to comment on this matter.

Donald Clegg
DONALD A. CLEGG
Chief Planning Officer

November 23, 1987

TO: DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 16, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

We will be addressing the utility and drainage system for the golf course and shoreline park in the Draft EIS. It is our plan to use non-potable water sources for the irrigation of the golf course and shoreline park. The Department of the Navy and the Department of Land and Natural Resources will be consulted for work involving the shoreline. We will further be coordinating our efforts with the Corps of Engineers and U. S. Fish and Wildlife Service in matters relating to wetlands and flora and fauna concerns.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813 • (808) 523-4432

FRANK F. FASI
MAYOR

JOHN P. WHALEN
DIRECTOR

LU10/87-5375(AC)

October 22, 1987

MEMORANDUM

TO: HIRAM KAMAKA, DIRECTOR
DEPARTMENT OF PARKS & RECREATION

FROM: JOHN P. WHALEN, DIRECTOR

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS) PREPARATION NOTICE -- WEST LOCH GOLF COURSE & SHORELINE PARK EWA, OAHU

Thank you for providing the Department of Land Utilization the opportunity for input on the preparation of the above-referenced EIS. We offer the following comments:

1. The EIS should provide a map which designates and separates the proposed boundaries of the golf course and the shoreline park.

2. Discussion of the proposed drainage system and the system's potential for water quality impacts within West Loch.

3. The EIS should evaluate any importance that the existing mangrove stands and fish ponds may have as wildlife habitats. The EIS should also discuss any impacts that the projects may have on existing wetland areas.

4. The EIS should describe how any historic and archaeological sites would be preserved if deemed significant in value.

We hope these comments will be helpful to you in preparation of the EIS. If you have any questions, please contact Art Challacombe of our staff at 523-4648.

John P. Whalen
JOHN P. WHALEN
Director of Land Utilization

JPW:sl
1385B

C-1515
1-21-11
EO/176

November 23, 1987

TO: JOHN P. WHALEN, CHIEF PLANNING OFFICER
DEPARTMENT OF LAND UTILIZATION

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 22, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

We will be addressing the utility and drainage systems for the golf course and shoreline park in the Draft EIS. The Department of the Navy and the Department of Land and Natural Resources will be consulted for work along the shoreline. We will further be coordinating our efforts with the Corps of Engineers and U. S. Fish and Wildlife Service in matters relating to wetlands and flora and fauna concerns.

Special studies which address the archaeological and botanical and biological resources of the project site as well as West Loch are currently being prepared for the Draft EIS. The findings and conclusions of these studies will be included in the Draft EIS.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Hiram K. Kamaka
HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 S. BERETANIA STREET, ROOM 305
HONOLULU, HAWAII 96814

FRANK F. FASI
MAYOR

FRANK K. KAHOOHANOHANO
FIRE CHIEF

LIONEL E. CAMARA
DEPUTY FIRE CHIEF

October 22, 1987

TO: HIRAM K. KAMAKA, DIRECTOR
DEPARTMENT OF PARKS AND RECREATION

FROM: FRANK K. KAHOOHANOHANO, FIRE CHIEF

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU

We have reviewed the subject Environmental Impact Statement and have no objections to the proposed project.

Fire protection will be provided by the Waipahu Fire Station with support from Ewa Beach and Pearl City. Future plans include an Ewa-Tenney Village Fire Station.

Should you have any questions, please contact Battalion Chief Kenneth Word at local 3838.

Frank K. Kahoohanohano
FRANK K. KAHOOHANOHANO
Fire Chief

FKK/KAW:sb

cc: R. M. Towill Corporation

C-ICH
1-29-87

FD/177

November 23, 1987

TO: FRANK K. KAHOOHANOHANO, FIRE CHIEF
FIRE DEPARTMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: WEST LOCH GOLF COURSE AND SHORELINE PARK
ENVIRONMENTAL IMPACT STATEMENT, EWA, OAHU

Thank you for your comments of October 22, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Hiram K. Kamaka
HIRAM K. KAMAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

NOV 25 1987

WAIPAHU NEIGHBORHOOD BOARD NO. 22
P.O. Box 103
WAIPAHU, HAWAII 96797

October 23, 1987

Mr. Hiram Kamaka, Director
Department of Parks and Recreation
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kamaka:

The Waipahu Neighborhood Board received the Environmental Impact Statement (EIS) for the West Loch golf course and the shoreline park in Ewa, Oahu. Although both projects are in Ewa, they are closer to the Waipahu town complex and the community, and will have a significant impact on Waipahu's Environment. We are happy to say the impacts are all positive under the circumstances.

The Waipahu community for many years discussed the possibility of a waterfront park, but was discouraged by its cost. West Loch Estate, with its public waterfront park, will fulfill a dream of many Waipahuans. No longer will we have to drive 20 miles in traffic and have to fight for parking when we get there to have a nice family picnic. The waterfront park with its finger piers will encourage family and youth activities for the entire community. The Waipahu Neighborhood Board strongly feels this waterfront park will enhance the environment and improve the quality of life for 40,000 plus Waipahuans.

The rising cost of playing golf and overcrowding of our municipal golf courses have discouraged and driven many (especially seniors) to give up the game of golf. The proposed West Loch municipal golf course will prolong the enjoyment of the game for many of us and truly enhance the quality of life of many Waipahuans.

The only negative impact will be the displacement of the month-to-month lessees of Hoaeae Point. This will be a positive situation for the lessees under the circumstances. The City and County reassured community leaders and lessees that the City would provide whatever relocation assistance to those residents that request assistance to the best of the City's ability. This relocation assistance will not be available to the lessees in the event a private developer purchases the Point for development. Mr. O.K. Stender from Campbell Estate confirmed via a Point paper dated October 14, 1987, to Councilmember DeSoto that an agreement/commitment has been made with a private developer, subject to the City condemnation of the land for public use, to develop the area in question.

G-934
10/23 [illegible]
FD/177

Waipahu Neighborhood Board No. 22
Mr. Hiram Kamaka
October 23, 1987
Page 2

Therefore, the Waipahu Neighborhood Board strongly supports the proposed West Loch municipal golf course and shoreline park in the West Loch Estate Project. Members of this community elected group will be willing to testify on this position at a public hearing.

Sincerely,

Cal Kawamoto

Cal Kawamoto, Chairman
Waipahu Neighborhood Board No. 22

cc: Senators Patsy Young, Joe Kuroda, Ron Menor
Representatives Dan Kihano, Mits Shito, Paul Oshiro, Mike Crozier
Councilmembers Randall Iwase, John DeSoto
Ewa Beach Community Association
Ewa Neighborhood Board No. 23
Waipahu Community Association
Waipahu Business Association
Waipahu 2000+ Council
Neighborhood Commission

RMT		WES	
DK		BTT	BT
RYK		WD	
REC'D NOV 30 198_ RMT:			
GSY		YJK	

November 23, 1987

CK ___

CS ___

Mr. Calvin Kawamoto, Chair
Waipahu Neighborhood Board No. 22
P. O. Box 103
Honolulu, Hawaii 96797

Dear Mr. Kawamoto:

Subject: West Loch Golf Course and Shoreline Park
Environmental Impact Statement, Ewa, Oahu

Thank you for your comments of October 23, 1987. The Draft Environmental Impact Statement for the above named project is being prepared. When the document is finalized, we will forward a copy to you for your review.

The planning for the golf course and shoreline park have considered the recreational needs of the residents in leeward Oahu. We believe that the golf course and shoreline park will greatly enhance the livability of the area.

The Department is working with the residents of the Hoaeae Peninsula to arrive at an amicable solution to their relocation. The City will provide necessary relocation assistance as well as housing assistance as necessary.

Should you have any other comments or desire additional information, please contact Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAHAKA, Director

HKK:jf (Y. Taketa, Facilities)

cc: R. M. Towill Corp.

SECTION 14

COMMENTS AND RESPONSES -- DRAFT EIS

LU 2/88- 1032

JOHN WAIHEE
GOVERNOR

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

SUZANNE D. PETERSON
CHAIRPERSON, BOARD OF AGRICULTURE

ROBERT V. TSUYEMURA
ACTING DEPUTY
TO THE CHAIRPERSON

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822-0159

'88 FEB 18 PM 1 42

February 18, 1988

MEMORANDUM

To: Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu

Subject: Draft Environmental Impact Statement (DEIS) for
West Loch Golf Course and Shoreline Park
Department of Parks and Recreation
TMK: 9-1-17: por. 4, por. 6, por. 9, 14, por. 18
9-1-20: por. 4, 19
9-1-21: 15, por. 16, por. 17, 21, por. 25
9-1-22: por. 2, por. 4, por. 5, 6-11, por. 13
Honouliuli, Ewa, Oahu
Acres: approximately 230

The Department of Agriculture has reviewed the subject document and offers the following comments.

Golf Course

The DEIS addresses the concerns found in our response to the EIS Preparation Notice for the subject project (see our memorandum to Mr. Hiram Kamaka dated October 10, 1987, DEIS, Section 13). We would like to add the following to the applicant's response to one of our concerns:

- the impact of this development on future agricultural production and expansion of diversified agriculture.

The applicant's response to the above as found in the DEIS is based upon the same consultant's study done for the West Loch Estates housing project DEIS and to which our principal concerns and objections have been directed. It is also basically the same study done for a number of other proposed developments in the Central Oahu/Ewa area.

The proposed golf course will displace Oahu Sugar Company (OSC) Field 31 (36 acres at the junction of Fort Weaver Road and Farrington Highway) which is drip-irrigated. The remainder of the golf course site is either abandoned sugarcane land or agriculturally-zoned lands not in use.

The soils information applicable to the project site indicates that, with the exclusion of the aforementioned field, the proposed golf course will be largely situated on lands marginally suited to agricultural use. To the greatest extent possible, effort should be made to avoid the use of agriculturally-suitable and cultivated lands for non-agricultural uses.

Shoreline Park

We have no further comments to offer.

Thank you for the opportunity to comment. We hereby request a copy of the Final EIS as soon as it is available.

Suzanne D. Peterson

SUZANNE D. PETERSON
Chairperson, Board of Agriculture

cc: Mr. Hiram Kamaka, Director
Department of Parks and Recreation
DGP
LUC
OSP (attn. LUD)

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Honorable Suzanne D. Peterson
Chairperson
Board of Agriculture
1428 South Beretania Street
Honolulu, Hawaii 96814

Dear Ms. Peterson:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 18, 1988. We appreciated your review of the document and the comments provided.

The majority of the lands proposed for the golf course and shoreline park was at one time used for sugar production and other agriculturally related activities. Except for Oahu Sugar Company's Field 31, all of the sugar lands have been taken out of production. Because the majority of the lands being proposed for the golf course and shoreline park are not in production, it is felt that there will not be any significant impact of on current agricultural production. The conversion of the lands for golf course use will, however, preclude the potential for other diversified agricultural uses. Field 31 will not be used as part of the golf course, however, as part of the acquisition terms arrived with the landowner, Field 31 will be purchased by the City.

Your willingness to assist in the planning of this development is greatly appreciated. If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88-878

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
Department of Business and Economic Development
Housing Finance and Development Corporation
P. O. BOX 17907
HONOLULU, HAWAII 96817

Joseph K. Conant
Executive Director

IN REPLY REFER
TO:
88:PLNG/577JT

February 9, 1988

'88 FEB 11 PM 1 35

Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Subject: Draft Environmental Impact Statement (EIS) for West Loch Golf Course and Shoreline Park

We have reviewed the subject draft EIS and have no comments to offer.

Thank you for the opportunity to comment.

Sincerely,

JOSEPH K. CONANT
Executive Director

cc: Hiram Kamaka

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Joseph K. Conant, Executive Director
Housing Finance and Development Corporation
P. O. Box 17907
Honolulu, Hawaii 96817

Dear Mr. Conant:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 9, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR
LESLIE S. MATSUBARA
DEPUTY DIRECTOR

'88 FEB 5 PM 2 03

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 TELEX: 7430250 HIDPED

Ref. No. P-8038

February 4, 1988

The Honorable John P. Whalen
Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Subject: Draft Environmental Impact Statement (DEIS) for West Loch Golf Course and Shoreline Park, West Loch, Ewa, Oahu

We have reviewed the subject DEIS and offer the following comments.

1. The final EIS should disclose the sugar yields of the subject property while it was in cultivation. Should the yields be relatively high, some discussion should be directed toward the preference of maintaining agricultural uses in flood plain areas in light of increasing pressures to urbanize agricultural areas outside the flood plain.

2. The EIS should indicate how the transfer of Oahu Sugar Company's EP2 Well (preserved use of 0.5 million gallons per day) to the City for irrigation of the subject project will impact Oahu Sugar Company operations.

3. The final EIS should address how the project site will be "selectively" monitored by a qualified archaeologist during initial grubbing activity and/or vegetation clearing. In the light of the significant archaeological sites already identified, continuous monitoring during these phases of development may be justified.

4. With respect to the major objective of the 39-acre linear park (page 1-5), we suggest that "the provision of public open space along the shoreline" may be a more appropriate description of the park's objective. The draft EIS states the objective as providing public access to the shoreline. Generally, public access to the shoreline implies encouraged public use of the shoreline and nearshore waters. Since no boating or swimming will be allowed here, this statement may be misleading.

5. The final EIS should identify how lighting of the golf course driving range will affect adjacent residential areas.

6. The final EIS should reflect the recent Development Plan amendment which reclassified Increment II of the proposed West Loch Estates from Agricultural to Residential. We note that Figure 7-2 is no longer applicable.

Thank you for the opportunity to review and comment on this DEIS.

Sincerely,

Roger A. Ulveling

Roger A. Ulveling

cc: Department of Parks and Recreation
City and County of Honolulu

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Honorable Roger A. Ulveling, Director
Department of Business and Economic Development
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Ulveling:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 4, 1988. We appreciated your review of the document and the comments provided.

1. We have inquired with Oahu Sugar Company to ascertain the yields of former cane lands proposed for the golf course and shoreline park and they have indicated to us that they do not have any current records available.

2. The EP2 Well will be incorporated into the golf course and shoreline park plan as a non-potable water source. The well will be transferred (the preserved use) to the City and County of Honolulu with the approval of the Department of Land and Natural Resources.

3. An archaeological mitigation plan will be prepared prior to the start of construction. The scope and scale of the mitigation plan will be coordinated with the Department of Land and Natural Resources, Historic Sites Section (DLNR-HSS). In our discussions with the DLNR-HSS we have initially identified sites that require data recovery and those that need monitoring during the construction phase. When the mitigation plan is completed, we will provide your office with a copy.

4. We generally concur with your assessment in noting that the objective of the shoreline park is to provide public open space along the shoreline rather than providing an area for active recreational use.

5. We do not believe that the driving range's lighting will significantly affect adjacent residential uses. The driving range is located below the residential uses and therefore, the lights from the driving range will not be directed towards the residential uses. Further, we believe that by terminating the use of the driving range at a reasonable hour in the evening will effectively mitigate any adverse impacts.

6. We have noted that the Development Plan for the Ewa area has been amended and we will amend Figure 7-2 to conform with the amendment.

Your willingness to assist in the planning of this development is greatly appreciated. If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf

LU 1/88-277

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD, HONOLULU, HAWAII 96816-4495

ALEXIS T. LUM
MAJOR GENERAL
ADJUTANT GENERAL

DEPUTY ADJUTANT GENERAL

Engineering Office

JAN 14 1988

Mr. John P. Whalen, Director
Department of Land Utilization
City & County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

West Loch Golf Course and Shoreline Park
West Loch, Ewa, Oahu

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Sincerely,

Jerry M. Matsuda

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contr & Engr Officer

Enclosure

cc:
Mr. Hiram Kamaka, Director

'88 JAN 15 PM 1 34

FRANK F. FASI
MAYOR

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Major Jerry M. Matsuda
Hawaii Air National Guard
Contract and Engineering Officer
Department of Defense
3949 Diamond Head Road
Honolulu, Hawaii 96816

Dear Major Matsuda:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of January 14, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

Hiram K. Kamaka

HIRAM K. KAMAKA, Director

HKK:jf

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSO

February 1, 1988

MEMORANDUM

To: Mr. John P. Whalen, Director
Department of Land Utilization, City & County of Honolulu

From: Deputy Director for Environmental Health

Subject: Draft Environmental Impact Statement (DEIS) for West Loch Golf Course and Shoreline Park, West Loch, Ewa, Oahu

Thank you for allowing us to review and comment on the subject DEIS. We provide the following comments:

Vector Control

The developer must comply with the requirements of Title 11, Chapter 26, Section 11-26-35: Rodents; Demolishing of Structures and Clearing of Sites and Vacant Lots.

Marsh lands will continue to be mosquito breeding sites, and depending on the situation and ownership of the land, could become the responsibility of the City and County of Honolulu to abate.

BRUCE S. ANDERSON, Ph.D.

cc: Mr. Hiram Kamaka ✓

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Bruce S. Anderson, Ph.D.
Deputy Director for Environmental Health
State Department of Health
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

Subject: Draft Environmenetal Impact Statement for West Loch Golf Course and Shoreline Park

We are in receipt of your memorandum of February 1, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

The developer, in this case, the City and County of Honolulu, will require contractors to comply with the provision of Title 11, Chapter 26, Section 11-26-35: Rodents: Demolition of Structures and Clearing of Sites and Vacant Lots.

Thank you again for your willingness to assist in the planning stages of this project.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88 - 733

JOHN WAIHEE
GOVERNOR OF HAWAII

'88 FEB 5 PM 1 32

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P O BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

FEB 4

Doc. No.: 2610E
File No.: 88-332

Honorable John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen,

SUBJECT: West Loch Golf Course and Shoreline Park
TMK: 9-1-12,20,21,22: var.

We have completed our review of the Draft EIS for this project and have the following comments to offer.

As manipulation of wetland areas are being planned, such as filling in portions of wetlands and constructing islands within ponds for waterbird use, our Division of Forestry and Wildlife and the U.S. Fish and Wildlife Service should be directly consulted in the developmental plans for these areas.

We appreciate the opportunity to comment on this project. Please note that a direct response from our Division of State Parks and Historic Sites has been previously sent to you.

Very truly yours,

William W. Paty, Chairman
Board of Land and Natural Resources

cc: Mr. Hiram Kamaka, DPR

LU 1/88 - 691

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED

'88 JAN 26 AM 10:15

OFC. OF ENVIRONMENTAL QUALITY CONTROL

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF STATE PARKS
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

'88 FEB 4 AM 10 23

January 22, 1988

Marvin T. Miura, Ph.D., Director
Office of Environmental Quality Control
465 South King Street Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

SUBJECT: Review of West Loch Golf Course and Shoreline Park
Honouliuli, Ewa, Oahu
TMK: 9-1-17: various; 9-1-20: various; 9-1-21: various

Thank you for the opportunity to review this Draft EIS.

Section 3 (Affected Environment) of this document should indicate the extent and nature of the inventory of historic sites and should end with a clear statement of how many significant historic sites are present. It does present results of an archaeological survey, in which 7 archaeological sites are briefly described. We believe the survey is likely to have found all surface sites and a representative sample of the subsurface historic sites present. But, as the consulting archaeologist (PHRI) points out (App. J), more buried historic sites may be present in certain areas. This section, however, lacks an important discussion, which is providing a preliminary significance assessment of all 7 sites according to various criteria of the Hawaii and National Register of Historic Places.

In the appended archaeological report by PHRI, preliminary significance evaluations are offered. We concur with these evaluations. We believe that sufficient information has been gathered to evaluate significance, and that the sites' significance is correctly assessed.

Section 6 covers the Anticipated Impacts and Mitigation Measures. It should clearly present an acceptable mitigation plan to treat all 7 significant historic sites. This section is not acceptable as written. Two of the seven sites are omitted from discussion.

The plan bears very little resemblance to the mitigation plan recommended in their consulting archaeologist's report, a plan which we believe is acceptable. The consultant's plan calls for the preservation of 2 sites and archaeological data recovery for the other 5. Additionally, the plan calls for selected monitoring to enable identification and appropriate treatment of any buried sites that might be found during construction.

In summary, we believe that this Draft EIS does not adequately cover historic preservation concerns. Assuming that the applicant has indeed accepted their consultant's recommendations, the resolution of this problem may simply involve revision of the text in the EIS. Section 3 needs to conclude with significance evaluations and a statement of how many significant sites are present. Section 6 of the report needs to present an acceptable mitigation plan. The consulting archaeologist's recommendations may be used as such a plan.

If the applicant has any questions, we will be glad to assist them in revisions, so that an acceptable historic preservation review will result.

Very truly yours,

RALSTON H. NAGATA
State Parks Administrator and
Deputy State Historic Preservation Officer

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Honorable William W. Paty, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Draft Environmental Impact Statement for West Loch Golf Course and Shoreline Park

Thank you for your memo of January 22, 1988 and letter of February 4, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

My staff and our consultants have been in contact with the U. S. Fish and Wildlife Service throughout the master planning and DEIS process regarding the impact of wetland areas identified as various portions of TMK Nos. 9-1-12, 20, 21, and 22. Our consultants have also contacted your Division of Forestry and Wildlife for the staff's input in the DEIS consultation process.

Upon consultation with the consulting archaeologist, discussions of significance assessment would best be covered in Section 6, Anticipated Impacts and Mitigation Measures.

While a summary of seven of the identified sites identified by the archaeologist as significant, was provided in Section 1, Introduction and Project Summary, and reiterated in Section 3, Affected Environment, the list was incomplete in Section 6. This correction has been noted, and the changes will be properly reflected in Section 6 of the final EIS. A summary of the archaeologist's recommended mitigation measures was provided in the draft EIS. Proposed mitigation measures, as well as significant assessment, as reflected in the archaeological report, will be incorporated in the final EIS.

A full mitigation plan is in the process of being developed, and will be offered to your Historic Sites Section for their review as it is prepared.

We appreciate your comments and recommendations.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU '88 - 202

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

LAND USE COMMISSION

Room 104 Old Federal Bldg., 335 Merchant Street
Honolulu, Hawaii 96813 Telephone 548-4611

January 11, 1988

Mr. John P. Whalen, Director
Department of Land Utilization
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Subject: Environmental Impact Statement for the West Loch Golf Course and Shoreline Park

Thank you for the opportunity to comment on the subject Environmental Impact Statement. Portions of the proposed project affect fishponds which may be designated within the State Land Use Conservation District. Any uses of these fishponds may require a district boundary amendment or a Conservation District Use Permit.

We suggest that a boundary determination be requested to clarify the district boundaries for the site.

If you have any questions on this matter, please contact me or my staff at 548-3073.

Sincerely,

Esther Ueda

ESTHER UEDA
Executive Officer

EU:to

'88 JAN 13 AM 9 58

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

February 29, 1988

Honorable Esther Ueda, Executive Officer
Land Use Commission
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813

Dear Ms. Ueda:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of January 11, 1988. We appreciated your review of the document.

Thank you for noting the possibility of portions of the project may be within State designated Conservation District. Upon clarification of the area in question with the Department of Land and Natural Resources and Land Use Commission staffs, we have concluded that no portion of the project is within the Conservation District.

Your willingness to assist in the planning of this development is greatly appreciated. If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

Hiram Kamaka

HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88 - 999

JOHN WAIHEE
GOVERNOR

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

RUSSEL S. NAGATA
COMPTROLLER

KEN KIYABU
DEPUTY COMPTROLLER

LETTER NO. (P)1125.8

FEB 16 1988

'88 FEB 17 AM 10 11

Mr. John P. Whalen
Director
Department of Land Utilization
City and County of Honolulu
650 South King Street, 7th Floor
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Subject: Draft Environmental Impact Statement
West Loch Golf Course and Shoreline Park

We have reviewed the subject document and have no comments to offer.

Very truly yours,

TEUANE TOMINAGA
State Public Works Engineer

CI:jk
cc: Mr. Hiram Kamaka

FRANK F. FASI
MAYOR

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Teuane Tominaga
State Public Works Engineer
Department of Accounting and General Services
P. O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Duncan:

Subject: Draft EIS for West Loch Golf Course
and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 16, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88-1149

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

February 22, 1988
RE:0485

Mr. John P. Whalen, Director
Department of Land Utilization
City & County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Draft Environmental Impact Statement (EIS)
West Loch Golf Course and Shoreline Park
West Loch, Oahu

The above referenced document involves the development of a 197-acre golf course and a 39-acre shoreline park by the City and County of Honolulu. This document was reviewed with the assistance of Bion Griffin, Anthropology; Yu-Si Fok, Henry Gee, and Edwin Murabayashi, Water Resources Research Center; and Jennifer Crummer, Environmental Center.

Archaeology

It is not clear from the archaeological section in the Draft EIS (p. 6-5) how much work will take place during the mitigation period. The mitigation plan should be available for review before the mitigation begins for full commentary.

Fish Ponds

The Draft EIS should provide a map showing the locations of fish ponds within the project vicinity, specifically the Apokeo fish pond. A biological survey should be undertaken for the ponds. The water quality of the ponds is likely be much different from that of outlying waters. There is indication that freshwater seepage occurs in these ponds. Coupled with the potential pesticide, fertilizer, and new urban related pollutants such as high levels of lead and mercury carried in the water, what will be the impact of the project upon the water quality of these ponds. What is the existing water quality? The intent to enhance these ponds as waterbird habitats (p. 1-6) may be undermined by introduction of harmful substances to the pond ecosystem.

Water

The Honolulu City and County Board of Water Supply has made the comment that a water master plan should be included in the Draft EIS. We concur with this request. Our reviewers have also suggested that irrigation water be supplied by brackish water obtained from caprock aquifer.

Regarding the transfer of Oahu Sugar Company's EP2 well to the City and County's Department of Parks and Recreation, we have the following questions: What is the Department of Land and Natural Resources' designation of this well, and what will be the water quality when pumping at full capacity?

We thank you for the opportunity to review this document. We look forward to you consideration and response to our comments.

Sincerely,

John T. Harrison, Ph.D.
Environmental Coordinator

cc: Hiram Kamaka, DPR
OEQC
L. Stephen Lau
Bion Griffin
Y.S. Fok
Henry Gee
Edwin Murabayashi
Jennifer Crummer

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. John T. Harrison, Ph.D.
Environmental Coordinator
Environmental Center
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Dr. Harrison:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 22, 1988. We appreciated your review of the document and the comments provided.

1. An archaeological mitigation plan will be prepared prior to the start of construction. The scope and scale of the mitigation program will be coordinated with the Department of Land and Natural Resources, Historic Sites Section (DLNR-HSS). In our discussions with the DLNR-HSS we have initially identified sites that require data recovery and those that need monitoring during the construction phase. When the mitigation plan is completed, we will provide your office with a copy.

2. The fishponds referred to in the Draft EIS will be identified in the Final EIS. Neither a biological survey nor water quality assessment has been conducted of the fishponds. These ponds are affected by ground water seepage and tidal action. As noted in the study conducted by Dr. Dugan, there is the potential for a decrease in the amount of certain agricultural chemicals entering these ponds. Based on the experience of the adjacent wildlife refuge, we can generally conclude that there will not be significant impact to water birds using the enhanced fishponds.

3. A water master plan will be prepared for the proposed project, however, because the necessary studies for this master plan will be conducted during the design phases of the project, the master plan will not be included in the Final EIS. Irrigation water for the golf course and other landscaped areas will be obtained from the Oahu Sugar Company's EP2 well that will be transferred to the City and County of Honolulu. The EP2 is not now considered a potable source of water. Should the well's chloride concentration prove to be higher than acceptable for irrigation, it will then be mixed with potable water. A secondary source of irrigation water will be from the stream and storm water which will be held in retention ponds.

We are exploring the possibility of developing water from the caprock aquifer, however, the feasibility of this action has not been finally determined.

Your willingness to assist in the planning of this development is greatly appreciated. If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88 - 987

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU HAWAII 96813
PHONE 523-4181

FRANK F. FASI
MAYOR

MIKE MOON
DIRECTOR

ROBERT MIYASATO
DEPUTY DIRECTOR

February 16, 1988

'88 FEB 17 AM 8 36

MEMORANDUM

TO: John P. Whalen, Director
Department of Land Utilization

FROM: Mike Moon

Subject: Draft Environmental Impact Statement for the West Loch Golf Course and Shoreline Park, Ewa Oahu

We have reviewed the Draft Environmental Impact Statement for the subject projects.

We support the development of these projects as they would provide much needed recreation opportunities in the Ewa area.

Thank you for the opportunity to comment.

for Robert Miyasato
MIKE MOON
Director

cc: Mr. Hiram Kamaka

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

TO: MIKE MOON, DIRECTOR
DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT EIS FOR WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU

Thank you for your comments of February 16, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Hiram Kamaka
HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88 - 971

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96843

'88 FEB 15 PM 1 34

February 11, 1988

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR WEST LOCH GOLF COURSE AND SHORELINE PARK,
TMK: 9-1-17: 4, 6, 9, 14, 18;
9-1-20: 4, 19; 9-1-21: 15, 16, 17, 21, 25;
9-1-22: 2, 4, 5, 6, 7, 8, 9, 10, 11, 13

Thank you for the opportunity to review and comment on the Draft EIS for the proposed golf course and park project. In addition to our comments on the EIS Preparation Notice, we offer the following:

1. The developer will be required to install transmission and storage facilities for the project.

2. On pages 2-5 and 2-6, there is an apparent discrepancy between the estimated potable water demand (15,000 gpd) and the anticipated sewage flow (20,000 to 25,000 gpd).

3. The golf course is in the "pass zone" where disposal of wastewaters is permitted.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: Hiram Kamaka, Director
(Department of Parks and Recreation)

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

February 29, 1988

TO: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR WEST LOCH GOLF COURSE AND SHORELINE PARK

We are in receipt of your memorandum of February 11, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

While the estimated potable water demand (15,000 gpd) and the anticipated sewage flow (20,000 to 25,000 gpd) on pages 2-5 and 2-6 may appear to conflict, the methods and practices of the engineer in designing for these facilities do not necessarily interface due to the nature of these services. Based on our discussions with the engineers, we understand these apparent discrepancies are accepted practice.

This is also to acknowledge items number 1 and 3 regarding installation of transmission and storage facilities for the project, and location of the golf course relative to the disposal of wastewaters.

We again would like to thank you for your willingness to assist in the planning of this project.

HIRAM K. KAMAKA, Director

HKK:jf

BUILDING DEPARTMENT

CITY AND COUNTY OF HONOLULU

HONOLULU MUNICIPAL BUILDING
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HERBERT K. MURAOKA
DIRECTOR AND BUILDING SUPERINTENDENT

PB 88-27

January 13, 1988

MEMO TO: MR. JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: HERBERT K. MURAOKA
DIRECTOR AND BUILDING SUPERINTENDENT

SUBJECT: DRAFT EIS FOR WEST LOCH GOLF COURSE AND SHORELINE PARK

We have reviewed the subject draft EIS and have no comments.

Thank you for the opportunity to review the document.

Herbert K. Muraoka

HERBERT K. MURAOKA
Director and Building Superintendent

cc: J. Harada

'88 JAN 14 AM 8 05

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

TO: HERBERT K. MURAOKA, DIRECTOR AND BUILDING SUPERINTENDENT
BUILDING DEPARTMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT EIS FOR WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU

Thank you for your comments of January 13, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

Hiram K. Kamaka

HIRAM K. KAMAKA, Director

HKK:jf

LU/88-587

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

'88 JAN 29 PM 1 20

FRANK F. FASI
MAYOR

DONALD A. CLEGG
CHIEF PLANNING OFFICER

GENE CONNELL
DEPUTY CHIEF PLANNING OFFICER

KK/DGP 1/88-34

January 27, 1988

MEMORANDUM

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

SUBJECT: CHAPTER 343, HAWAII REVISED STATUTES
DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED WEST LOCH GOLF COURSE AND SHORELINE PARK SITUATED IN EWA, OAHU

We have reviewed the subject Draft Environmental Impact Statement (EIS) and have found that the concerns we presented on the EIS Preparation Notice have been addressed.

We recommend, however, that Figure 7-2, Development Plan Land Use, be corrected to reflect that the area south of the Golf Course (West Loch Residential, Phase II) is now designated Residential as a result of Council action taken in December 1987.

Thank you for giving us an opportunity to comment on this matter.

Donald Clegg
DONALD A. CLEGG
Chief Planning Officer

cc: Department of Parks and Recreation
Department of Housing and Community Development
R.M. Towill Corporation

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

TO: DONALD A. CLEGG, CHIEF PLANNING OFFICER
DEPARTMENT OF GENERAL PLANNING

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR WEST LOCH GOLF COURSE AND SHORELINE PARK

Thank you for your memorandum of January 27, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

With regard to Figure 7-2, Development Plan Land Use, the area south of the golf course will be revised to reflect the redesignation action from Agriculture to Residential by the Council in December 1987. This revised map will appear in the final EIS.

We appreciate your comments and recommendations.

Hiram Kamaka
HIRAM K. KAMAKA, Director

HKK:jf

LU 1/88- 499

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

ALFRED J. THIEDE
DIRECTOR AND CHIEF ENGINEER

ENV 88-21

January 25, 1988

MEMORANDUM

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER

SUBJECT: DRAFT EIS FOR WEST LOCH GOLF COURSE AND SHORELINE PARK
EWA, OAHU (TAX MAP KEY: 9-1-17, 20, 21, 22; VARIOUS PARCELS)

We have reviewed the subject Draft EIS and have the following comments:

1. In addition to the comfort station on the golf course, will cesspools be utilized on the shoreline park and the maintenance facility?

2. Proposed filling in the Honouliuli Stream flood plain may require a Section 404 permit from the U.S. Army Corps of Engineers.

for ALFRED J. THIEDE
Director and Chief Engineer

cc: Department of Parks and Recreation

'88 JAN 26 PM 1 38

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 19, 1988

TO: ALFRED J. THIEDE, DIRECTOR AND CHIEF ENGINEER
DEPARTMENT OF PUBLIC WORKS

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR
WEST LOCH GOLF COURSE AND SHORELINE PARK

Thank you for your memorandum of January 25, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

In response to your question regarding the use of cesspools, the maintenance facility on the golf course will be served by cesspool. However, the comfort station on the shoreline park will be hooked into the West Loch Estates's Phase I Residential development's sewer system.

The proposed filling in the Honouliuli Stream flood plain will require a Section 404 permit from the U. S. Army Corps of Engineers as a few areas of the stream are within designated wetlands. Because the area to be filled is less than 10 acres, we will be applying for a nationwide permit. The actual filling will be done in accordance with Section 7.10, Article 7, Special District Regulations, of the City and County's Land Use Ordinance, and in consultation with the Army Corps of Engineers.

Thank you again for your comments.

HIRAM K. KAMAKA, Director

HKK:jf

WU-/88-862

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 S. BERETANIA STREET ROOM 305
HONOLULU, HAWAII 96814

'88 FEB 11 AM 8 15

FRANK F. FASI
MAYOR

FRANK K. KAHOOHANOHANO
FIRE CHIEF

LIONEL E. CAMARA
DEPUTY FIRE CHIEF

February 9, 1988

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: FRANK K. KAHOOHANOHANO, FIRE CHIEF

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT--WEST LOCH GOLF COURSE AND SHORELINE PARK, WEST LOCH, EWA, OAHU

Reviewing the materials provided, we foresee no adverse impact on Fire Department facilities or services.

We have no further comments at this time.

Should you have any questions, please contact Battalion Chief Kenneth Word at local 3838.

FRANK K. KAHOOHANOHANO
Fire Chief

FKK/LD:sb

cc: Mr. Hiram Kamaka, Director
Department of Parks & Recreation

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

TO: FRANK KAHOOHANOHANO, CHIEF
FIRE DEPARTMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT EIS FOR WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA, OAHU

Thank you for your comments of February 9, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

HIRAM K. KAMAKA, Director

HKK:jf

LU 1/88 - 381

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96814 - AREA CODE (808) 943-3111

FRANK F. FASI
MAYOR

'88 JAN 21 AM 10 03

DOUGLAS G. GIBB
CHIEF

WARREN FERREIRA
DEPUTY CHIEF

HONOLULU

OUR REFERENCE SS-LK

January 18, 1988

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: DOUGLAS G. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS) - WEST LOCH GOLF COURSE AND SHORELINE PARK

We have reviewed the EIS for the above proposal and offer the following comments.

The recreational facilities included in the proposal--the clubhouse, lighted driving range and putting green and shoreline park--will most likely attract some of the public during evening hours. To insure public safety, we recommend that all parking areas be provided with adequate lighting. Since the shoreline park will also provide recreational facilities such as jogging and bike paths, benches, pedestrian walkways, picnicking areas and a comfort station, we recommend that these areas also be lighted to insure the safety of park users.

Thank you for the opportunity to comment.

Douglas G. Gibb
DOUGLAS G. GIBB
Chief of Police

cc: Mr. Hiram Kamaka
Department of Parks and Recreation

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

TO: DOUGLAS G. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

FROM: HIRAM K. KAMAKA, DIRECTOR

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR WEST LOCH GOLF COURSE AND SHORELINE PARK

Thank you for your letter of January 18, 1988 regarding the Department of Parks and Recreation's West Loch Golf Course and Shoreline Park DEIS.

We appreciate your comments regarding the need to provide proper lighting for the recreational facilities and their parking areas. Public safety will be of primary concern in providing proper lighting for the parking areas. It has been recently decided that lighting for the golf course driving range will be stubbed out initially in order that lights may be installed by the City and County in the future when funds are available.

On the other hand, lights will not be provided in the shoreline park facility because night use of the park and its amenities will not be allowed by the City. We will be cordoning off the facility's parking lot in the evenings to carry out this policy.

Thank you again for your comments and recommendations.

Hiram K. Kamaka
HIRAM K. KAMAKA, Director

HKK:jf

LU 488-603

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT. SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

January 27, 1988

Planning Branch

'88 FEB 1 AM 8 16

CITY & COUNTY OF HONOLULU

Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 S. King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

We have reviewed the Draft Environmental Impact Statement (DEIS) for West Loch Golf Course and Shoreline Park, West Loch, Ewa, Oahu, Hawaii and offer the following comments:

a. Although representatives of the City and its consultants have met with the Corps on Department of the Army permit requirements for the project, a formal determination on nationwide authorization for wetland fill has not been made, pending finalization of wetland boundaries under Corps jurisdiction, completion of archaeological/cultural studies, and receipt of an accurate description of the nature and extent of the project's impact on the designated wetland areas.

b. Based on previous consultation and on the information contained in the DEIS, we recommend that the Department of Parks and Recreation submit an official notification request pursuant to the nationwide permit at 33 CFR 330.5(a)(26). A copy of the pertinent regulations is enclosed. The request should be submitted in accordance with Section 330.7. Within twenty days of receipt of the written notification, the specific activities will be evaluated for compliance with the nationwide permit criteria, and a determination, based on concerns for the aquatic environment, will be made on whether nationwide authorization or an individual permit is appropriate in this case.

c. The discussion of flood hazards on pages 6-14 and 6-15 of the DEIS appears to be correct. As noted on page 6-14, the majority of the proposed golf course will be located in Zone AE; Zone AE should therefore be added to the list on page 3-7 of the DEIS.

d. Based on the most recent (September 1987) Flood Insurance Study for the City and County of Honolulu, the definition of Zone X presented on page 3-7 of the DEIS should be changed to "area outside of the 500-year flood plain."

e. Please address all future correspondence on this project to Operations Branch.

Sincerely,

C. Fung

Kisuk Cheung
Chief, Engineering Division

Enclosure

Copy Furnished:

Mr. Hiram Kamaka, Director
Department of Parks and Recreation
City and County of Honolulu
650 S. King Street
Honolulu, Hawaii 96813

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
U. S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Attention: Planning Branch

Dear Mr. Cheung:

Subject: Draft Environmental Impact Statement for
West Loch Golf Course and Shoreline Park

Thank you for your letter of January 27, 1988 regarding the City and County of Honolulu's West Loch Golf Course and Shoreline Park DEIS.

With regard to the proposed filling of some of the identified wetlands, specific areas and acreages as well as related actions to be taken will be reflected in the Final EIS.

We will be submitting an official notification request pursuant to the nationwide permit at 33 CFR 330.5(a) (26) shortly. Per your recommendation, the request will be submitted in accorance with Section 330.7, and in consultation with the Operations Branch of the Army Corps.

Thank you again for your participation in the planning of this project.

Sincerely yours,

Hiram Kamaka

HIRAM K. KAMAKA, Director

HKK:jf

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860-5020

IN REPLY REFER TO
11000
Ser N5B(202)/481
2 : FEB 1988

Mr. John P. Whalen, Director
City and County of Honolulu
Department of Land Utilization
650 King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR THE WEST LOCH GOLF COURSE AND SHORELINE PARK

Thank you for your letter of January 5, 1988 which requested comments on the West Loch Golf Course and Shoreline Park DEIS. The subject report has been reviewed. Comments listed below supplement the Navy position stated in our letter of October 26, 1987:

a. Siltation control is an area of critical concern to the Navy. This project proposes to utilize the golf course drainage system to retain and settle surface runoff from the adjacent West Loch Estates Subdivision, the golf course itself, and the drainage areas mauka of the project. The capacity of the golf course drainage system must be sufficient to reduce velocities and to provide adequate detention times necessary to ensure acceptable water quality prior to discharge into West Loch.

b. As part of the Shoreline Park, the proposed Peninsula Park Area development includes the repairs of the existing piers that are located along the waters edge. The Navy continues to question the advisability of improving these piers in view of the fact that no boating can be authorized within West Loch. It is requested that the pier repair plans be provided to the Navy for review. A real estate agreement will also be required to ensure that the Navy's operational and security requirements are satisfied.

Thank you for the opportunity to comment on the DEIS. The Navy point of contact is Mr. Bill Liu, phone 471-3324.

Sincerely,

R. M. GALLEN
CEC U.S. Navy
Base Civil Engineer
By direction of
the Commander

Copy to:
Mr. Hiram Kamaka, Director
City and County of Honolulu
Department of Parks and Recreation
650 South King Street
Honolulu, Hawaii 96813

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DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Captain R. M. Gallen
CEC, U. S. Navy
Base Civil Engineer
Naval Base Pearl Harbor
P. O. Box 110
Honolulu, Hawaii 96860-5020

Dear Captain Gallen:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 26, 1988. We appreciated your review of the document and the comments provided.

1. Siltation Control. We have provided for a series of retention ponds in the golf course plan to minimize siltation from "average (10-year storms)". In order to further minimize siltation during the construction period, we will not commence with any mangrove removal until the ponds are constructed. While the system of ponds will minimize siltation during "average storms", during more severe storms (100-year) it is anticipated that the golf course will be inundated and will afford little protection against silt from entering West Loch.

2. Shoreline Park. The repair of the existing piers along the shoreline is seen as a valuable feature of the park. As we have represented to you previously, we not allow any activity within West Loch. As plans for the park are developed, we will review these plans with the Navy.

Your willingness to assist in the planning of this development is greatly appreciated. If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

LU 7/88-1080

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

ES
Room 6307

18 FEB 1988

Mr. John P. Whalen, Director
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813

Re: Draft Environmental Impact Statement for West Loch Golf Course and Shoreline Park, Honouliuli, Oahu

Dear Mr. Whalen:

We have reviewed the referenced document and offer the following comments for your consideration.

General Comments

The City and County of Honolulu, as the developer of the West Loch Estates housing project, golf course, and shoreline park, has agreed to provide mitigation measures to protect the wildlife resources of the Pearl Harbor National Wildlife Refuge, Honouliuli Unit (Enclosure 1). However, development plans that may affect two other wetlands in the project site have not been finalized.

Specific Comments

a. Page 6.1, Botanical Resources. We disagree with the statement that the construction of water features for the golf course will compensate for the loss of wetland habitat from filling. We recommend that no wetland habitat in the project site be filled. In addition, we request that the boundaries of these wetlands be delineated jointly by the City and County of Honolulu, Department of Land and Natural Resources, U.S. Army Corps of Engineers, and our office.

b. Pages 6.2, 6.15-6.19, Mangrove Removal. We recommend that the removal of mangrove trees be initiated after the golf course and sedimentation basins have been completed. This will limit the release of stormwater runoff and sediments into West Loch in the event of a storm during the removal of mangrove trees. We recommend that heavy machinery not be used to remove mangrove trees without coordinating this activity with the Department of Land and Natural Resources, National Marine Fisheries Service, U.S. Army Corps of Engineers, and our office.

Summary Comments

Many of the potential impacts identified by the Service have been mitigated by the City and County of Honolulu. We appreciate the opportunity to review this project.

Sincerely,

Ernest Kosaka, Field Supervisor
Environmental Services
Pacific Islands Office

Enclosure

cc: Mr. Hiram Kamaka
DLNR
CE, Operations Branch

ES
Room 6307

8 FEB 1988

Esther Ueda, Executive Officer
Land Use Commission
Old Federal Building, Room 104
335 Merchant Street
Honolulu, Hawaii 96813

Re: Docket Number A87-616, Land Use District Boundary Amendment Petition, West Loch Estates Housing Project, Honouliuli, Oahu

Dear Ms. Ueda:

We have reviewed the proposed Land Use District Boundary Amendment Petition and offer the following comments for your consideration.

We have worked closely with representatives of the City and County of Honolulu and their consultants to mitigate potential adverse impacts of their proposed project on the Pearl Harbor National Wildlife Refuge, Honouliuli Unit. The City and County of Honolulu, as the developer, has agreed to provide the following mitigation measures:

a. A visual screen of native shrubs will be established outside the refuge fence line along the existing railroad right-of-way. This hedge will visually isolate the refuge from human activities along the right-of-way.

b. A 300-foot wide buffer zone will separate the refuge from the housing development. This buffer zone will be planted with trees, shrubs, and groundcover to block noise and street lights from disturbing endangered Hawaiian waterbirds and migrant waterfowl in the refuge. This buffer zone and plantings should be completed before construction of the Phase II housing increment begins.

c. The railroad right-of-way abuts the boundary of the refuge. To limit human disturbances to the refuge, a foot path will be constructed in the buffer zone and gates will be constructed across the right-of-way to direct pedestrian traffic away from the right-of-way and refuge.

d. Trees will be planted along the right-of-way setback in the southern section of the Phase II housing increment to screen the refuge from housing and lights.

e. The four fishponds adjacent to the refuge will not be filled. The City and County of Honolulu intends to clear dense vegetation surrounding the fishponds, plant a visual buffer of shrubs around the ponds, consolidate the four ponds into a single large pond, construct nesting islands, and manage this site as waterbird habitat. This improved waterbird habitat will be incorporated into the interpretive program of the shoreline park. Wetland habitat improvements will be coordinated with the Service and U.S. Army Corps of Engineers, as appropriate.

f. The City and County of Honolulu has stated that a covenant prohibiting the ownership of dogs and cats in the housing development could not be implemented because there is no legal means of extending the covenant to individually owned fee simple lots. We remain concerned that an increase in the local populations of dogs and cats may elevate predation levels on ground-nesting endangered waterbirds that use the refuge. The next best alternative is to enclose the refuge with a chain-link fence and to construct moats around the wetland sections of the refuge. We anticipate constructing the moats with the assistance of the U.S. Army this year. We request that the City and County construct a chain-link fence along the Pearl Harbor boundary of the refuge to exclude dogs and cats associated with the proposed housing project and to limit trespassing onto the refuge. The chain-link fence should be at least six feet in height and have its bottom edge buried approximately ten inches into the ground. The Service will assume maintenance and replacement responsibilities for the fence. Construction of the fence and vegetation screen should parallel housing and shoreline park development.

The following recommendations have not yet been formally accepted by the City and County of Honolulu:

a. The City and County recommends removing all of the mangrove trees along the project shoreline as part of the linear shoreline park. The Fish and Wildlife Service recommends that the removal of mangrove trees be initiated after the golf course and sedimentation basins have been completed. In this way, the sediment retention function of the mangrove tree fringe will be replaced by the golf course and sedimentation basins. This will limit the release of storm water runoff and sediments into West Loch in the event of a storm during the removal of mangrove trees. In addition, we recommend that heavy machinery not be used to remove mangrove trees without coordinating this activity with the Department of Land and Natural Resources, National Marine Fisheries Service, U.S. Army Corps of Engineers, and our office.

b. There are two additional wetlands within the project site. These wetlands provide habitat for endangered waterbirds and migratory shorebirds. In addition, these wetlands collect storm water runoff and silt, thereby protecting water quality in Pearl Harbor. We recommend that these wetlands not be filled.

We will not object to the proposed Land Use Boundary Amendment provided that all of the mitigation measures described above are included as conditions for approval to the amendment.

We appreciate this opportunity to comment.

Sincerely,

Original signed by
Ernest Kosaka, Field Supervisor
Environmental Services
Pacific Islands Office

cc: DBED, Land Use Division
BW
DLNR
City and County of Honolulu, DHCD
R.M. Towill

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DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988.

Mr. Ernest Kosaka, Field Supervisor
Environmental Services, Pacific Islands Office
U. S. Department of the Interior
Fish and Wildlife Service
300 Ala Moana Boulevard
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Draft Environmental Impact Statement for
West Loch Golf Course and Shoreline Park

We appreciate your letter of comments dated February 18, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

General Comments:

We are in receipt of your February 8, 1988 letter to Ms. Esther Ueda of the State Land Use Commission, in which you outlined the mitigation measures agreed to by the City and County as a result of various meetings and discussions relative to the West Loch Estates residential, golf course and shoreline park development.

Your comments and recommendations have been noted, and implementation of mitigation actions outlined will be done in close coordination with pertinent affected agencies.

Specific Comments:

a. With regard to the proposed filling of some of the identified wetlands, while we acknowledge importance of these areas, we note that these wetlands are marginal and in transition. Field studies, conducted by our consultants did not reveal usage by water birds nor did they encounter any rare or endangered species. Thus, we believe that water features proposed will create safe habitat for water birds. Further, as discussed with the U. S. Army Corps of Engineers, a nationwide permit will be filed with the agency for the filling of the wetlands shortly. These areas which will be filled will be identified in the final EIS, and your staff will be consulted in the planning and design process of this project.

b. Mangrove removal has also been discussed in our meetings with your staff and the staff of the Army Corps of Engineers. We agree that removal of the mangrove trees will be initiated after the golf course and sedimentation basins have been completed. As to the method of removal, we will not proceed until we have closely coordinated our plans with your office, the Department of Land and Natural Resources, National Marine Fisheries Service, and the U. S. Army Corps of Engineers.

Thank you again for your comments and recommendations.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

United States Department of the Interior
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
P.O. Box 50166
Honolulu, Hawaii 96850

February 19, 1988

Mr. John P. Whalen
Director
City & County of Honolulu
Dept. of Parks & Recreation
650 S. King Street
Honolulu, Hawaii 96813

Dear Mr. Whalen:

Subject: West Loch Golf Course and Shoreline Park

The staff of the Hawaii District Office of the U.S. Geological Survey, Water Resources Division, has reviewed the subject environmental impact statement, but has no comments to make at this time.

Thank you for allowing us to review the subject statement and we are returning the report for your further use.

Sincerely,

Dan A. Davis
Dan A. Davis
Acting District Chief

Enclosure

cc: Mr. H. Kamaka, Director, City & County of Honolulu, Dept. of Parks & Recreation, Honolulu, HI 96813
R.M. Fowin

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Dan A. Davis, Acting District Chief
U. S. Department of the Interior
Geological Survey, Water Resources Division
P. O. Box 50166
Honolulu, Hawaii 96850

Dear Mr. Davis:

Subject: Draft EIS for West Loch Golf Course and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 19, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

Hiram K. Kamaka
HIRAM K. KAMAKA, Director

HKK:jf

LU 2/88 - 754

U.S. Department of Housing and Urban Development
Honolulu Office, Region IX
300 Ala Moana Blvd., Room 3318, Box 50007
Honolulu, Hawaii 96850-4991

88-34

February 5, 1988

Mr. John P. Whalen, Director
Department of Land Utilization
City & County of Honolulu
650 South King Street
Honolulu, HI 96813

Dear Mr. Whalen:

SUBJECT: Draft Environmental Impact Statement (EIS)
West Loch Golf Course and Shoreline Park

We have reviewed the Draft EIS for the proposed project that will provide for an 18-hole golf course and a 39-acre shoreline park on 197 acres adjacent to the West Loch of Pearl Harbor. It is understood that HUD assisted programs will not be used to implement the project; therefore, we don't have any further comments.

We are returning the Draft EIS to the Office of Environmental Quality as requested.

Very sincerely yours,

Janet Nevelstein [signature]
for Calvin Lew
Director
Community Planning and
Development Division

cc:
H. Kamaka

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DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Calvin Lew, Director
Community Planning and Development Division
U. S. Department of Housing and Urban Development
Honolulu, Office, Region IX
300 Ala Moana Boulevard, Room 3318
Honolulu, Hawaii 96813

Dear Mr. Lew:

Subject: Draft EIS for West Loch Golf Course
and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 5, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely,

HIRAM K. KAMAKA, Director

HKK:jf

WLU/88- 1034

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. BOX 50004
HONOLULU, HAWAII
96850

February 10, 1988

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Mr. John P. Whalen, Director
City and County of Honolulu
Dept. of Land Utilization
650 S. King Street
Honolulu, HI 96813

Dear Mr. Whalen:

Subject: Environmental Impact Statement (EIS) -
West Loch Golf Course and Shoreline Park,
West Loch, Ewa, Oahu

We have no comments to offer at this time. Thank you for the opportunity in reviewing the above-referenced matter.

Sincerely,

RICHARD N. DUNCAN
State Conservationist

cc:

Mr. Hiram Kamaka, Director, City and County of Honolulu,
Dept. of Parks and Recreation, 650 S. King Street,
Honolulu, HI 96813

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Richard N. Duncan
State Conservationist
U. S. Department of Agriculture
Soil Conservation Service
P. O. Box 50004
Honolulu, Hawaii 96850

Dear Mr. Duncan:

Subject: Draft EIS for West Loch Golf Course
and Shoreline Park, Ewa, Oahu

Thank you for your comments of February 10, 1988. We appreciated your review of the document. Your willingness to assist in the planning of this development is greatly appreciated.

If you should have any questions or additional comments and suggestions, please direct them to Mr. Yukio Taketa, Facilities Development Division at 527-6301.

Sincerely yours,

HIRAM K. KAMAKA, Director

HKK:jf

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

ENV 2-1
West Loch, Ewa, Oahu
JA/G
LU 2/88 - 757

Brenner Munger, Ph.D., PE
Manager
Environmental Department
(808) 548-6880

February 4, 1988

'88 FEB 8 AM 8 40
CITY & COUNTY OF HONOLULU

Mr. John P. Whalen, Director
City & County of Honolulu
Department of Land Utilization
650 South King Street
Honolulu, HI 96813

Dear Mr. Whalen:

Subject: Environmental Impact Statement for West Loch Golf Course and Shoreline Park, Ewa, Oahu, Hawaii

We have reviewed the above document and have the following comment:

1. There are no existing substations or 138kv transmission lines crossing in or in proximity to the subject development. However, our present route selection study for the proposed Waiau-CIP 138kv line, as well as the proposed Ewa Nui Substation (138kv), may be impacted.

Sincerely,

Brenner Munger

An HEI Company

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

HIRAM K. KAMAKA
DIRECTOR

WALTER M. OZAWA
DEPUTY DIRECTOR

February 29, 1988

Mr. Brenner Munger, Ph.D., P.E.
Manager, Environmental Department
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, Hawaii 96840-0001

Dear Dr. Munger:

Subject: Draft Environmental Impact Statement for West Loch Golf Course and Shoreline Park

We are in receipt of your letter of February 4, 1988 regarding the West Loch Golf Course and Shoreline Park DEIS.

While we are aware of Hawaiian Electric, Inc.'s present route selection study for the proposed Waiau-CIP 138kv line, as well as the proposed Ewa Nui Subdivision (138kv), we would appreciate being kept apprised of your study's progress and findings.

Thank you again for your willingness to participate in the plannning stages of this project.

Sincerely yours,

Hiram K. Kamaka

HIRAM K. KAMAKA, Director

HKK:jf

APPENDIX

APPENDIX A

Botanical Survey
West Loch Estates
Ewa District, Island of Oahu

by

Winona P. Char

CHAR & ASSOCIATES

September 1987

BOTANICAL SURVEY

WEST LOCH ESTATES

'EWA DISTRICT, ISLAND OF O'AHU

by

Winona P. Char

CHAR & ASSOCIATES
Botanical/Environmental Consultants
Honolulu, Hawaii

Prepared for: R. M. TOWILL CORPORATION
September 1987

Table of Contents

BOTANICAL SURVEY
WEST LOCH ESTATES
'EWA DISTRICT, ISLAND OF O'AHU

INTRODUCTION

The Department of Housing and Community Development, City and County of Honolulu, plans to develop approximately 450 acres of land in the 'Ewa District. The proposed West Loch Estates Development will include residential units, a golf course, and a number of waterfront parks along its West Loch boundary. The proposed project will require the preparation of an Environmental Impact Statement (EIS) in accordance with Chapter 343 of the Hawaii Revised Statutes. A flora survey to describe the major vegetation types; inventory the species; search for rare, threatened and endangered species; and identify areas of probable environmental problems or concerns was conducted on 30 and 31 July 1987. The findings of this survey will be incorporated into the EIS.

The project area consists largely of gently sloping lands, most of which are presently under sugar cane cultivation by Oahu Sugar Company. Abandoned cane fields covered by weedy species occupy the northern portion of the project area. Scattered patches of scrub vegetation are generally found along the margins of the cane fields. Pasturelands are found in the middle portion of the property and wetlands, composed of mangrove swamp and cattail-bulrush marsh, occur along the West Loch margin.

The vegetation types found on the project area are composed primarily of introduced (or alien) species. Of a total of 164 species inventoried during this survey, 142 or 86.6% are introduced species. No federal and/or state listed, proposed or candidate endangered and threatened plant species were found on the project area.

SURVEY METHODS

Prior to undertaking the field survey, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies in the general area.

Existing topographic maps and recent aerial photographs were examined to determine access, terrain characteristics, and potential logistical and technical problems. The major access onto most parts of the project area was provided by the unpaved roads which run through the site. Tentative vegetation types were delineated from the aerial photographs and later ground-checked.

A walk-through survey method was employed. Species identifications were made in the field; plants which could not be positively identified were collected for later determination in the laboratory and herbarium. Notes were made of the species present in each vegetation type. The species recorded are indicative of the time and environmental conditions under which the survey was conducted. A survey taken during the rainy season (November through January) would no doubt yield variations in abundance ratings, especially of the annual species. Slight differences in the number of species inventoried would also be expected.

DESCRIPTION OF VEGETATION TYPES

A number of botanical surveys have been made in the 'Ewa Plains area. Two studies pertinent to the West Loch Estates Development are discussed below. The U. S. Fish and Wildlife Service (USFWS) funded a general botanical reconnaissance survey (Char and Balakrishnan 1979) of the entire 'Ewa Plains area which also included the proposed West Loch Estates Development. The focus of this survey was to locate and map listed, proposed or candidate threatened and endangered plant species. The nearby West Loch Branch of Naval Magazine Lualualei (NAVMAG LLL) was recently surveyed during the Navy's biological and water resources studies (Hawaiian Agronomics 1986).

Most of the vegetation types described in these two reports also occur on the West Loch Estates Development area. Sugar cane fields cover areas which are actively cultivated, while vegetation types dominated by introduced species, mostly koa-haole and kiawe, occur on the more or less undisturbed sites. No threatened and endangered plant species were recorded from the proposed West Loch Estates Development site in the USFWS report and none were found on the nearby NAVMAG LLL, West Loch Branch.

In this botanical survey report, seven major vegetation types are recognized on the project area and are discussed in detail below.

Abandoned Cane Fields (aC)

A large parcel of land formerly under sugar cane cultivation is found on the northern sector of the project area adjacent to Waipahu town. Roughly 65.8 acres of this parcel is planned for residential use; the remaining acreage will be incorporated into the planned waterfront park.

The vegetation on the abandoned cane fields is composed primarily of Guinea grass (Panicum maximum), which forms dense clumps up to 3 to 4 ft.high. Other commonly occurring grass species are buffelgrass (Cenchrus ciliaris), swollen fingergrass (Chloris inflata), and sourgrass (Tricachne insularis).

Scattered frequently throughout the grass cover are small, shrubby plants such as 'uhaloa (Waltheria indica var. americana), hoary abutilon (Abutilon incanum), weedy achyranthes (Achyranthes aspera), spiny amaranth (Amaranthus spinosus), fuzzy rattlepod (Crotalaria incana), indigo (Indigofera suffruticosa), and cow-pea (Macroptilium lathyroides). In some places, these shrubby species, especially the last three mentioned above, may form localized patches and be the dominant plant cover.

Along the edges of these abandoned cane fields, woody, perennial species have become established. Scattered plants of koa-haole (Leucaena leucocephala) are occasional. A few saplings of kiawe (Prosopis pallida) and 'opiuma (Pithecellobium dulce) trees can also be found here.

The network of cane-haul roads and irrigation systems which once serviced

the fields are still evident, although overgrown in some places. Small clumps of dried out sugar cane plants (Saccharum officinarum) are found scattered throughout the abandoned fields.

A number of species used in landscaping have become established in this vegetation type, usually in low numbers. These plants are associated with the trash and yard trimmings which have been dumped alongside the roads. Some of these plants include coconut (Cocos nucifera), mango (Mangifera indica), be-still tree (Thevetia peruviana), spineless opuntia (Nopolea sp.), cassava (Manihot esculenta), and monkeypod (Samanea saman).

Cane Fields (C)

The sugar cane fields which lie on the southern sector of the project area, along with their associated network of cane-haul roads and irrigation and drainage systems, cover approximately 165.8 acres. These fields are actively cultivated by Oahu Sugar Company; the lease on these fields will expire in 1990.

The cane fields occur on gently sloping, well-drained soils of alluvial origin.

Agricultural lands are geared to more or less intensive crop production and generally support monodominant stands of plants. Weedy species associated with these cultivated areas are often annual species adapted to the frequent disturbances related to cultivation practices. They are often found along the margins of fields, drainage ditches, and roads.

On the project area, weedy species frequently found in the cane fields include wild bittermelon (Momordica charantia var. pavel), little bell (Ipomoea triloba), swollen fingergrass (Chloris inflata), Bermuda grass (Cynodon dactylon), nutgrass (Cyperus rotundus), two species of amaranth (Amaranthus spinosus, Amaranthus viridus), red pua-lele (Emilia fosbergii), and hairy spurge (Euphorbia hirta). Along the drainage ways, shrubby species such as koa-haole (Leucaena leucocephala), castor bean (Ricinus communis), Chinese violet (Asystasia gangetica), and Indian pluchea (Pluchea indica) predominate. Grasses often associated with the drainage ways include Californiagrass (Brachiaria mutica), buffelgrass (Cenchrus ciliaris), Guinea grass (Panicum maximum), and Job's tears (Coix lachryma-jobi).

Pasturelands

Pasturelands which provide forage for cattle, horses, and goats are found in the middle portion of the project area. Two types of pastureland are recognized based on the most abundant plant species. Mixed grass and herb pastures generally occur on fill lands, while Brachiaria or Californiagrass pastures are found in the Honouliuli Stream drainage area.

1. Mixed grass-herb pastures (mgh) - The largest of these pasture areas lies mauka (inland) of the Apokeo Fish Ponds; a smaller mixed grass-herb pasture lies below the highway near some homes.

A mixture of various grass and herbaceous species characterizes this vegetation type, no single species is dominant. The most common grass components are Bermuda grass (Cynodon dactylon), buffelgrass (Cenchrus ciliaris), Guinea grass (Panicum maximum), and sourgrass (Tricachne insularis); the most frequent herbaceous plants encountered are nettle-leaved goosefoot (Chenopodium murale), golden crown-beard (Verbesina encelioides), hairy horseweed (Erigeron bonariensis), hairy spurge (Euphorbia hirta), and little mallow (Malva parviflora). Patches of bare soil with a few, low-growing, matted plants of Australian saltbush (Atriplex suberecta) and kipukai (Heliotropium curassavicum) are also occasionally observed.

Two pluchea species (Pluchea indica, Pluchea odorata) occur as scattered shrubs throughout the pastures. Around the margins of the pastures, the pluchea along with koa-haole (Leucaena leucocephala) may form extensive thickets.

2. Brachiaria (Californiagrass) pastures (B) - These pastures occur in the Honouliuli Stream drainage area and the soils here are wetter. A number of smaller streams and drainages cross these pasturelands and a few wetland species are found here.

Californiagrass (Brachiaria mutica) is a spreading, long-lived perrenial species widely planted for forage throughout the tropics (Whitney et al 1939). In the Hawaiian Islands, it is one of the most important pasture grasses of lowland areas, growing best in wet localities. Californiagrass forms a dense cover which often excludes most other species.

On the project area, pastures which have been recently grazed have grass cover 1 to 2 ft. high; pastures which have not been grazed for a while may have dense mats of Californiagrass up to 4 ft. tall.

Large shrubs and trees of koa-haole (Leucaena leucocephala), Christmas berry (Schinus terebinthifolius), Indian pluchea (Pluchea indica), and kiawe (Prosopis pallida), as well as napiergrass (Pennisetum purpureum), form somewhat dense clusteres on the margins of these pastures and on elevated areas within the pastures. Where the Brachiaria pastures adjoin the Typha (cattail)-Scirpus (bulrush) marsh, scattered plants of cattail and bulrush can be found in the dense grass cover.

Wetlands

In this report, wetlands have been defined as those areas in which obligate plant species are the dominant component of the vegetation. Obligate wetland species or obligate hydrophytes are plant species which generally (more or less greater than 99% of the time) are found only in wetlands under natural conditions. Obligate species are often characterized by a number of morphological features which indicate their ability to occur in wet areas. These include pneumatophores; adventitious roots; spongy leaves, stems or roots; and floating leaves. Obligate wetland species which occur in the Hawaiian Islands have been inventoried in Elliott and Hall's Wetlands and Wetland Vegetation of Hawaii (1977).

The wetlands on the project area may be divided into marsh and swamp depending on the vegetation present. Marshes are wet areas dominated by herbaceous or nonwoody plants, frequently grasses and sedges (Fosberg (1960). Swamps are dominated by woody plants, shrubs and trees. Both types of wetland are present on the project area.

1. Rhizophora (mangrove) swamp (Rs) - The mangrove (Rhizophora mangle), a native of tropical America, was introduced into the Hawaiian Islands in 1902 on the island of Moloka'i. Since then it has spread rapidly into estuaries and sheltered coastal areas. Many of Pearl Harbor's coastal areas have become overgrown with mangrove swamps. Mangrove is considered a noxious weed by the State Department of Agriculture, Plant Pest Control Branch, as it blocks coastal and harbor waterways.

On the project area, mangrove may reach 40 ft. in height. Prop roots and aerial roots form a dense, tangled, impenetrable thicket. The mangrove swamps themselves support very few other species. Most of the other species occur along the margins of the mangrove swamp where there is more available light. These species usually include pickleweed (Batis maritima), Guinea grass (Panicum maximum), and Indian pluchea (Pluchea indica). Fruits of Rhizophora mangle germinate while still on the parent tree, this is known as vivipary. The young plants then fall to the mud or water below. In some parts of the mangrove swamp, the area beneath the larger trees is covered with a mass of young plants.

2. Typha (cattail)- Scirpus (bulrush) marsh (T-Sm) - This vegetation type occurs primarily along the margins of the Apokeo Fish Ponds; somewhat smaller areas lie in the Honouliuli Stream drainage basin.

Cattail (Typha latifolia) and bulrush (Scirpus validus) propagate rapidly by creeping underground rhizomes (or stems) and often form large, monodominant stands.

A number of obligate wetland species are associated with this vegetation type. These include Eleocharis geniculata, makai sedge (Scirpus maritimus var. paludosus), seashore paspalum (Paspalum vaginatum), duckweed (Lemna minor), and primrose willow (Ludwigia octivalvis). Widgeon grass (Ruppia maritima), an aquatic flowering plant, was found in one of the Apokeo ponds.

The cattail-bulrush marsh on the project area provides cover for aquatic wildlife including a number of endangered Hawaiian waterbirds as well

as migratory waterfowl.

Scrub (s)

Scattered throughout the project area are patches of scrub vegetation. These usually occur as irregularly-shaped strips bordering other vegetation types. The scrub vegetation generally consists of koa-haole shrubs (Leucaena leucocephala), 12 to 18 ft. tall, with scattered trees of kiawe (Prosopis pallida) and 'opiuma (Pithecellobium dulce) up to 30 or 40 ft. tall. In some places, however, the kiawe and 'opiuma trees may form somewhat dense forests. Guinea grass (Panicum maximum) often forms a dense cover beneath the taller trees and shrubs.

Old house sites are often associated with the scrub vegetation and a number of ornamental, landscape species are found in small numbers here. For example, the scrub located on a small bluff in the middle of the cane fields contains plants such as mango (Mangifera indica), date palms (Phoenix dactylifera), tamarix (Tamarix apylla), night-blooming cereus (Hylocereus undatus), pomegranate (Punica granatum), alokon (Allaeanthus sp.), red hibiscus (Hibiscus rosa-sinensis), and plumeria (Plumeria rubra).

RARE, THREATENED AND ENDANGERED SPECIES

Two officially listed federal and state endangered plant species are known from the 'Ewa Plains area. These two species are the 'Ewa Plains 'akoko (Euphorbia skottsbergii var. kalaeloana) and Achyranthes rotundata. Both species, however, are restricted to the Campbell Industrial Park and Naval Air Station, Barbers Point.

During this survey no federal and/or state listed, proposed or candidate threatened and endangered species (U.S. Fish and Wildlife Service 1980; Herbst 1987) were found on the proposed West Loch Estates Development. Other botanical surveys which have included the project area and nearby areas (Char and Balakrishnan 1979; Hawaiian Agronomics 1986) have also recorded simiiliar findings. No species considered "Rare" (Fosberg and Herbst 1975) occur on the project site.

RESULTS AND DISCUSSION

The vegetation on the proposed West Loch Estates Development is dominated by introduced (or alien) species. Of a total of 164 plant species inventoried, 86.6% or 142 species are introduced; 16 are indigenous, i.e., native to the islands and elsewhere; 1 is endemic, i.e., native only to the islands; and 5 are of early Polynesian introduction. There is little of botanical interest on the project site. The native species are found in similar environmental habitats throughout the islands. Some plants, such as the koali (*Ipomoea cairica*), koali-'awania (*Ipomoea indica*), 'uhaloa (*Waltheria indica*), and hoary abutilon (*Abutilon incanum*) are considered rather "weedy" natives which do well in open, more or less disturbed areas. None of the native species are considered rare, threatened or endangered. The proposed project is not expected to have a significant impact on the total island populations of these species.

While the wetlands do not contain any species of botanical significance, they do provide habitat for a number of endangered Hawaiian waterbirds. The cattail-bulrush marsh around the Apokeo Fish Ponds is especially valuable as wetland habitat. A cooperative program to manage these pond areas for wildlife should be established with the U. S. Fish and Wildlife Service.

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APPENDIX 1. PLANT SPECIES LIST, WEST LOCH ESTATES DEVELOPMENT, 'EWA DISTRICT, ISLAND OF O'AHU

In the plant species list which follows, families are listed alphabetically within each of two groups of flowering plants: Monocotyledons and Dicotyledons. Taxonomy and nomenclature follow St. John (1973) except where more recently accepted names have been used. Hawaiian names used are in accordance with Porter (1972) or St. John (1973). The following information is provided:

1. Scientific name with author citation.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of the species. The following symbols are used:

   E = endemic = native only to the Hawaiian Islands

   I = indigenous = native to the Hawaiian Islands and also to one or more other geographic areas

   P = Polynesian = plants of Polynesian introduction; all those plants brought by the Polynesian immigrants prior to contact with the Western world

   X = introduced or alien = not native to the islands; brought here intentionally or accidentally after Western contact.
4. Vegetation types. Seven major vegetation types are recognized on the project area and are discussed in detail in the text. They are:

   1 = abandoned Cane fields (aC)

   2 = Cane fields (C)

   3 = mixed grass and herb pastures (mgh)

   4 = *Brachiaria* (Californiagrass) pastures (B)

   5 = *Rhizophora* (mangrove) swamp (Rs)

   6 = *Typha* (cattail)-*Scirpus* (bulrush) marsh (T-Sm)

   7 = Scrub (s)
5. Relative abundance within the different vegetation types. These ratings reflect the abundance or absence (-) of a particular species within the project area and are not applicable to areas outside the project. The following symbols are used in each vegetation type column:

A = abundant = the dominant species in a given vegetation type

C = common = distributed throughout a given vegetation type in large numbers

L = locally abundant = found in localized patches where it occurs in large numbers but otherwise occasional or uncommon in a given vegetation type

O = occasional = distributed widely throughout a given vegetation type in moderate numbers

U = uncommon = observed infrequently but more than 10 times within a given vegetation type

R = rare = observed less than 10 times within a given vegetation type.

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
MONOCOTYLEDONS									
ARACEAE (Arum Family)									
Colocasia esculenta var. antiquorum (Schott) Hubb. & Rehd.	taro, kalo	P	-	-	-	R	-	-	-
CANNACEAE (Canna Family)									
Canna indica L.	canna	X	-	-	-	-	-	-	R
COMMELINACEAE (Spiderwort Family)									
Commelina benghalensis L.	hairy honohono	X	U	-	-	-	-	-	-
Commelina diffusa Burm. f.	honohono	X	-	-	-	O	-	-	-
CYPERACEAE (Sedge Family)									
Cyperus alternifolius L.	umbrella plant	X	-	-	-	R	-	-	-
Cyperus gracilis R. Br.	McCoy grass	X	-	-	-	R	-	-	R
Cyperus rotundus L.	nutgrass	X	U	O	-	-	-	-	R
Cyperus sp.		X	-	-	-	-	-	-	R
Eleocharis geniculata (L.) R. & S.		X	-	-	-	-	-	R	-
Scirpus maritimus var. paludosus (A. Nels.) Kuk.	makai	I	-	-	-	-	-	L	-
Scirpus validus Vahl	great bulrush, 'aka'akai, neki	I	-	-	-	O	-	A	-
GRAMINEAE (Grass Family)									
Brachiaria mutica (Forsk.) Stapf	Californiagrass	X	-	L	-	A	L	L	L
Brachiaria reptans (L.) Gard. & C. E. Hubb.		X	R	-	-	-	-	-	-
Cenchrus ciliaris L.	buffelgrass	X	C	O	C	-	-	-	O
Cenchrus echinatus L.	common sandbur	X	-	R	-	-	-	-	-
Chloris inflata Link	swollen fingergrass, mau'ulei	X	C	L	-	-	-	-	L
Coix lachryma-jobi L.	Job's tears	X	-	U	-	U	-	-	U
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	-	O	C	U	-	L	L

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
Echinochloa colona (L.) Link	jungle-rice	X	-	-	-	U	-	-	R
Echinochloa sp.		X	-	-	-	-	-	R	-
Eleusine indica (L.) Gaertn.	goosegrass, wiregrass	X	-	U	-	-	-	-	U
Eragrostis cilianensis (All.) Vigno-Lutati	stinkgrass	X	-	-	-	-	-	-	R
Leptochloa uninervia (Presl.) Hitchc. & Chase	leptochloa	X	-	-	-	R	-	-	U
Panicum maximum Jacq. var. maximum	Guinea grass	X	A	L	O	L	O	U	A
Paspalum vaginatum Sw.	seashore paspalum	X	-	-	-	-	-	L	-
Pennisetum clandestinum Hochst. ex Chiov.	kikuyugrass	X	-	R	-	-	-	-	-
Pennisetum pupureum Schumach.	napiergrass, elephantgrass	X	-	-	-	L	-	U	-
Rhynchelytrum repens (Willd.) C. E. Hubb.	Natal redtop	X	-	O	-	-	-	-	O
Saccharum officinarum L.	sugar cane, ko	P	R	A	-	R	-	-	R
Setaria verticillata (L.) Beauv.	bristly foxtail	X	-	U	O	-	-	-	U
Sorghum halepense (L.) Pers.	Johnson grass	X	-	U	-	-	-	-	U
Tricachne insularis (L.) Nees	sougrass	X	O	-	O	-	-	-	O
LEMNACEAE (Duckweed Family)									
Lemna minor L.	duckweed	X	-	-	-	-	-	R	-
LILIACEAE (Lily Family)									
Aloe vera L.	aloe	X	-	-	-	-	-	-	R
MUSACEAE (Banana Family)									
Musa X paradisiaca L.	banana, mai'a	P	-	-	-	R	-	-	R
PALMAE (Palm Family)									
Cocos nucifera L.	coconut, niu	P	R	-	-	-	-	-	R
Phoenix dactylifera L.	date palm	X	-	-	-	R	-	-	R
Roystonea elata (Barbr.) Harper	royal palm	X	-	-	-	-	-	-	R
RUPPIACEAE (Ruppia Family)									
Ruppia maritima var. pacifica St. John & Fosberg	ruppia, widgeon grass	I	-	-	-	-	-	R	-

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
TYPHACEAE (Cattail Family)									
Typha latifolia L.	common cattail	X	-	-	-	O	-	A	-
DICOTYLEDONS									
ACANTHACEAE (Acanthus Family)									
Asystasia gangetica (L.) T. Anders.	Chinese violet, asystasia	X	L	L	-	-	-	-	L
AIZOACEAE (Carpetweed Family)									
Sesuvium portulacastrum (L.) L.	'akulikuli	I	-	-	-	-	-	-	R
Trianthema portulacastrum L.		X	R	-	-	-	-	-	R
AMARANTHACEAE (Amaranthus Family)									
Achyranthes aspera L.	weedy achyranthes	X	O	-	O	-	-	-	L
Alternanthera pungens HBK.	khaki weed	X	-	-	-	-	-	-	R
Amaranthus hybridus L.	amaranth	X	-	-	-	-	-	-	R
Amaranthus spinosus L.	spiny amaranth	X	O	O	-	-	-	-	O
Amaranthus viridus L.	slender amaranth	X	-	O	-	-	-	-	U
ANACARDIACEAE (Mango Family)									
Mangifera indica L.	mango	X	R	-	-	-	-	-	R
Schinus terebinthifolius Raddi	Christmas berry	X	U	-	U	L	-	-	O
APOCYNACEAE (Periwinkle Family)									
Catharanthus roseus (L.) G. Don	periwinkle	X	-	-	-	-	-	-	R
Nerium oleander L.	oleander	X	-	-	-	-	-	-	R
Plumeria rubra L.	plumeria hybrid	X	-	-	-	-	-	-	R
Thevetia peruviana (Pers.) K. Schum.	be-still tree	X	R	-	-	-	-	-	-
ARALIACEAE (Ginseng Family)									
Brassaia actinophylla Endl.	octopus tree	X	R	-	-	-	-	-	-
Polyscias guilfoylei (Bull) Bailey	panax	X	-	-	-	-	-	-	R
BASELLACEAE (Basella Family)									
Boussingaultia gracilis Miers.	Madeira vine	X	-	-	-	-	-	-	R

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SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
BATIDACEAE (Batis Family)									
Batis maritima L.	pickle weed	X	-	-	-	-	L	L	R
BIGNONIACEAE (Bignonia Family)									
Spathodea campanulata Beauv.	African tulip tree	X	-	-	-	-	-	-	R
BORAGINACEAE (Heliotrope Family)									
Cordia sp.		X	-	-	R	-	-	-	R
Heliotropium curassavicum L.	nena, kipukai	I	-	-	L	-	-	-	U
Heliotropium ovalifolium var. depressum (Cham.) Merr.		X	-	-	-	-	-	-	R
CACTACEAE (Cactus Family)									
Hylocereus undatus (Haw.) Britt. & Rose	night-blooming cereus	X	-	R	-	-	-	-	U
Opuntia ficus-cairica (L.) P. Mill.	prickly pear, panini	X	-	-	-	-	-	-	R
Nopalea sp.	spineless opuntia	X	R	R	-	-	-	-	-
CAPPARACEAE (Caper Family)									
Gynandropsis gynandra (L.) Briq.	African spider flower	X	-	-	U	-	-	-	U
CASUARINACEAE (Casuarina Family)									
Casuarina equisetifolia Stickm.	ironwood	X	-	-	-	-	-	R	-
CHENOPODIACEAE (Goosefoot Family)									
Atriplex suberecta Verdoorn	Australian saltbush	X	-	-	L	-	-	-	O
Chenopodium aff. hircinum Schrad.		X	-	-	-	-	-	-	R
Chenopodium murale L.	nettle-leaved goosefoot	X	U	O	O	-	-	-	-
COMPOSITAE (Daisy Family)									
Bidens pilosa L.	Spanish needle, beggar's tick	X	U	U	-	-	-	-	-
Calyptocarpus vialis Less.	herba del cabello	X	-	-	-	-	-	-	U
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum	X	-	-	-	U	-	U	-

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SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES						
			1	2	3	4	5	6	7
Eclipta alba (L.) Hassk.	false daisy	X	-	-	-	O	-	-	R
Emilia fosbergii Nicolson	red pua-lele, flora's paintbrush	X	O	O	-	U	-	-	-
Erigeron bonariensis L.	hairy horseweed	X	-	-	O	-	-	-	O
Pluchea X fosbergii Cooperrider & Galang	hybrid pluchea	X	-	R	R	-	-	-	-
Pluchea indica (L.) Less.	Indian pluchea	X	R	O	L	L	L	L	L
Pluchea odorata (L.) Less.	pluchea	X	R	O	O	U	R	R	L
Sonchus oleraceus L.	sow thistle, pua-lele	X	U	O	U	O	-	-	O
Tridax procumbens L.	coat buttons	X	O	-	U	-	-	-	-
Verbesina encelioides (Cav.) B. & H. ex Gray	golden crown-beard	X	O	O	O	-	-	-	O
Xanthium saccharatum Wallr.	cocklebur	X	O	U	-	R	-	-	-
CONVOLVULACEAE (Morning-glory Family)									
Argyreia nervosa (Burm. f.) Bojer	woolly morning-glory	X	R	-	-	-	-	-	-
Ipomoea aquatica Forsk.	ung-choi	X	-	-	-	R	-	-	-
Ipomoea cairica (L.) Sweet	koali	I	-	U	U	O	-	-	-
Ipomoea indica (Burm.) Merr.	koali'awania	I	-	-	-	R	U	-	U
Ipomoea obscura (L.) Ker-Gawl		X	-	R	O	-	-	-	U
Ipomoea triloba L.	little bell	X	O	L	-	-	-	-	O
Jacquemontia sandwicensis Gray	pa'u-o-Hi'i-'aka	E	O	R	-	-	-	-	R
Merremia aegyptia (L.) Urban	hairy merremia, koali-kua-hulu	I	O	U	U	-	-	-	O
Merremia tuberosa (L.) Rendle	wood rose	X	-	-	-	-	-	-	R
CUCURBITACEAE (Squash Family)									
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber	X	-	-	-	-	-	-	R
Momordica charantia var. pavel Crantz	wild bittermelon	X	O	L	-	-	-	-	O
EUPHORBIACEAE (Spurge Family)									
Euphorbia geniculata Ortega	wild spurge	X	U	-	-	-	-	-	-
Euphorbia glomerifera (Millsp.) L. C. Wheeler	glomerate spurge	X	-	O	-	-	-	-	O
Euphorbia heterophylla L.	false poinsettia	X	-	U	-	-	-	-	-
Euphorbia hirta L.	hairy spurge	X	-	O	O	-	-	-	O
Euphorbia prostrata Ait.	prostrate spurge	X	-	-	-	-	-	-	U

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES						
			1	2	3	4	5	6	7
Jatropha curcas L.	physic nut	X	-	-	-	-	-	-	R
Manihot esculenta Crantz	cassava, manihot	X	R	-	-	-	-	-	-
Ricinus communis L.	castor bean	X	U	L	U	O	-	-	O
LABIATAE (Mint Family)									
Hyptis pectinata (L.) Poir.	comb hyptis	X	-	-	-	R	-	-	U
Leonotis nepetaefolia (L.) Ait. f.	lion's-ear	X	O	U	-	-	-	-	O
LEGUMINOSAE (Pea Family)									
Acacia farnesiana (L.) Willd.	klu	X	R	R	-	-	-	-	-
Canavalia cathartica Thouars	mauna-loa	X	-	R	-	-	-	-	-
Cassia bicapsularis L.		X	R	-	-	-	-	-	-
Cassia surattensis Burm.	kolomona	X	-	-	-	-	R	-	-
Cassia sp.		X	-	-	-	-	-	-	R
Crotalaria incana L.	fuzzy rattlepod	X	L	O	U	-	-	-	U
Desmanthus virgatus (L.) Willd.	virgate mimosa	X	O	O	-	-	-	-	U
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X	-	O	-	-	-	-	R
Indigofera endecaphylla Jacq.		X	-	-	-	-	-	-	R
Indigofera suffruticosa Mill.	indigo	X	L	-	-	-	-	-	-
Leucaena leucocephala (Lam.) de Wit	koa-haole	X	O	L	L	L	-	L	A
Macroptilium lathyroides (L.) Urban	cow-pea, wild bushbean	X	L	-	-	R	-	-	O
Mimosa pudica var. unijuga (Ducass. & Walp.) Griseb.	sensitive plant, pua-hilahila	X	-	-	-	U	-	-	U
Phaseolus sp.		X	-	R	-	-	-	-	-
Pithecellobium dulce (Roxb.) Benth.	'opiuma	x	R	-	L	-	-	-	O
Prosopis pallida (HUmb. & Bonpl. ex Willd.) HBK.	algaroba, kiawe	X	U	-	O	L	-	U	C
Samanea saman (Jacq.) Merr.	monkeypod	X	R	-	-	-	-	-	R
Tamarindus indica L.	tamarind	X	R	-	-	-	-	-	-

SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
LOGANIACEAE (Strychnine Family)									
Buddleja asiatica Lour.	dogtail, Asiatic butterfly bush	X	-	-	-	-	-	-	R
MALVACEAE (Mallow Family)									
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X	O	U	U	-	-	-	O
Abutilon incanum (Link) Sweet	hoary abutilon	I	C	-	-	-	-	-	U
Gossypium barbadense L.	cotton	X	-	-	-	-	-	-	R
Hibiscus rosa-sinensis L.	red hibiscus	X	-	-	-	-	-	-	R
Hibiscus tiliaceus L.	hau	I	-	-	-	-	-	-	R
Malachra alceaefolia Jacq.	malachra	X	-	-	-	U	-	R	R
Malva parviflora L.	little mallow	X	-	-	O	-	-	-	U
Malvastrum coromandelianum Garcke	false mallow	X	O	-	O	-	-	-	O
Sida acuta Burm.		X	-	-	-	-	-	-	U
Sida fallax Walp.	'ilima	I	O	-	-	-	-	-	U
Sida rhombifolia L.	Cuba jute	X	-	-	-	R	-	-	O
Sida spinosa L.	prickly sida	X	U	U	O	-	-	-	-
Thespesia populnea (L.) Soland. ex Correa	milo	P	-	-	-	-	U	U	U
MORACEAE (Mulberry Family)									
Allaeanthus sp.	alokon	X	-	-	-	-	-	-	R
Ficus microcarpa L.	Chinese banyan	X	-	-	R	-	-	-	U
MORINGACEAE (Moringa Family)									
Moringa oleifera Lam.	kalamungai, horse-radish tree	X	R	-	-	-	-	-	R
MYRTACEAE (Myrtle Family)									
Syzygium cumini (L.) Skeels	Java plum	X	R	-	-	U	-	-	U
NYCTAGINACEAE (Four o'clock Family)									
Boerhavia coccinea Mill.		X	U	U	U	-	-	-	R
Boerhavia diffusa L.	alena	I	U	R	U	-	-	-	-
Mirabilis jalapa L.	common four o'clock	X	-	-	-	-	-	-	U

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SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
ONAGRACEAE (Evening Primrose Family)									
Ludwigia octivalvis (Jacq.) Raven	primrose willow, kamole	I	-	-	-	R	-	R	-
OXALIDACEAE (Wood Sorrel Family)									
Oxalis corniculata L.	yellow wood sorrel, 'ihi	I	-	-	-	-	-	-	R
PASSIFLORACEAE (Passionflower Family)									
Passiflora edulis f. flavicarpa Deg.	yellow lilikoʻi	X	-	-	-	-	-	-	R
Passiflora foetida L.	scarlet-fruited passionflower	X	O	U	-	-	R	-	U
PLANTIGINACEAE (Plantain Family)									
Plantago major L.	common plantain	X	-	-	-	R	-	-	-
PLUMBAGINACEAE (Leadwort Family)									
Plumbago auriculata Lam.	blue plumbago	X	-	-	-	-	-	-	R
PORTULACACEAE (Purslane Family)									
Portulaca oleracea L.	common purselane, pigweed	X	U	-	U	-	-	-	U
PUNICACEAE (Pomegranate Family)									
Punica granatum L.	pomegranate	X	-	-	-	-	-	-	R
RHIZOPHORACEAE (Rhizophora Family)									
Rhizophora mangle L.	American mangrove	X	-	-	-	-	A	U	R
SOLANACEAE (Tomato Family)									
Capsicum annuum L.	chili pepper	X	R	-	-	-	-	-	U
Datura stramonium L.	jimson weed	X	-	R	-	R	-	-	-
Lycopersicon pimpinellifolium Mill.	currant tomato	X	L	-	-	-	-	-	U
Nicandra physalodes (L.) Gaertn.	apple-of-Peru	X	U	-	-	-	-	-	U
Nicotiana glauca Grah.	wild tobacco, paka	X	-	-	U	-	-	-	U

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SCIENTIFIC NAME	COMMON NAME	STATUS	VEGETATION TYPES 1	2	3	4	5	6	7
Nicotiana tobaccum L.	tobacco, paka	X	-	-	-	-	-	-	R
Solanum nigrum L.	popolo	I?	U	-	-	-	-	-	U
Solanum seaforthianum Andr.	blue potato vine	X	-	-	R	-	-	-	R
STERCULIACEAE (Cocoa Family)									
Waltheria indica var. americana (L.) R. Br. ex Hosaka	hi'aloa, 'uhaloa	I	C	O	-	-	-	-	O
TAMARICACEAE (Tamarix Family)									
Tamarix apylla (L.) Karst.	Athel tamarisk	X	-	-	-	-	-	-	R
VERBENACEAE (Verbena Family)									
Stachytarpheta jamaicensis (L.) Vahl.	Jamaica vervain	X	-	-	-	R	-	-	-
ZYGOPHYLLACEAE (Tribulus Family)									
Tribulus terrestris L.	puncture vine	X	-	O	-	-	-	-	R

APPENDIX B

Terrestrial Vertebrate Animals
of the West Loch Estates

by

Andrew J. Berger

Terrestrial Vertebrate Animals of the West Loch Estates

By Andrew J. Berger

This study was made on instructions received from Mr. Chester Koga in the offices of R. M. Towill Corporation on August 3, 1987, and according to details in a contract signed August 12, 1987. I talked via telephone with Ms. Colette Sakoda on August 18, 1987, and I arrived at the R. M. Towill Corporation offices at 7:15 a.m. on August 19. Field studies were conducted on August 19 and August 21, 1987. I deemed two days of field work adequate, because I have done work in the project region in the past.

The Habitat

The entire region has been drastically disturbed for more than 100 years. There is no semblance of any endemic ecosystem in the vicinity of the project area. As stated in the Environmental Impact Statement Preparation Notice for the West Loch Estates Subdivision (page 4): "The proposed site of West Loch Estates Increment I is former sugar land that is now permanently fallow. The proposed sites of Increment II and portions of the district park are presently still cultivated by Oahu Sugar Company. Portions of the proposed West Loch Beach Park are in residential and quasi-commercial uses, and portions are unused and undeveloped." Ms. Winona Char, the botanist, found no rare or threatened Hawaiian plants in the area.

Amphibians and Reptiles

There are no endemic amphibians or land reptiles in the Hawaiian Islands. All, therefore, have been introduced (either intentionally or accidentally) by man. None are endangered of threatened species and none are of any significance for an environmental impact statement.

I. Amphibians

Four species of frogs have been introduced to the island of Oahu: the green-and-black poison-arrow frog (*Dendrobates auratus*), the bullfrog (*Rana catesbeiana*), the wrinkled frog (*Rana rugosa*), and the giant neotropical toad (*Bufo marinus*). The four species typically occupy different habitats, and none is of any concern for an environmental impact assessment (Hunsaker and Breese 1967).

II. Reptiles

1. Blind Snake, *Typhylina bramina*

"This small, secretive snake was apparently introduced from the Philippines in the dirt surrounding plants that were brought in for landscaping the campus of Kamehameha Boys School in Honolulu. It was first found there in January 1930" (Oliver and Shaw, 1933). These blind, worm-like snakes are rarely seen until they are flooded from underground burrows by heavy rain or unless one looks for them under branches and other debris on the ground. These harmless snakes are of no significance for an environmental assessment. They now are found on all of the main islands (McKeown, 1978).

2. Skinks and Geckos

Eleven species of skinks (family Scincidae) and geckos (family Gekkonidae) occur on Oahu. All are foreign to the islands, all are insect eaters, and all adapt well to both urban and rural areas. They are of no significance to an impact assessment.

Birds of the West Loch/Waipio Region

Three groups of birds are found in the Hawaiian Islands: 1. endemic, 2. indigenous, and 3. introduced or alien birds.

I. Endemic Birds

These are birds that are unique to the Hawaiian Islands; they occur naturally no place else in the world. Many of these endemic birds are classified as endangered or threatened with extinction by the U.S. Fish & Wildlife Service and by the State Division of Forestry and Wildlife. Most of these endangered species are forest birds, few of them still exist on Oahu, and there is no suitable habitat on or near the project site.

Four species of endangered Hawaiian waterbirds do occur on Oahu: Koloa or Hawaiian duck (Anas whyilliana), Hawaiian gallinule or 'Alae 'Ula (Gallinula chloropus sandvicensis), Hawaiian coot or 'Alae Ke'oke'O (Fulica americana alai), and the Hawaiian stilt or Ae'O (Himantopus mexicanus knudseni).

It is because of these endangered waterbirds that we can point out that the only concern for the proposed project deals with any possible detrimental affects on the bird sanctuaries in West Loch of Pearl Harbor, specially the Waiawa and Honouliuli National Wildlife Refuges in the area. For example, when a Chevron Oil Company jet fuel pipeline ruptured on May 13, 1987, some 1,000 gallons of fuel were pumped into Waiawa spring, from which water was pumped into the Waiawa NWR. This pollution caused the death of several waterbirds and caused the desertion of at least six Hawaiian stilt nests (Stephen Berendzen, in Stine, 1987; Honolulu Star-Bulletin, May 14, 1987, page 1, and May 15, 1987, page A-3).

We note, however, that "Plans for the beach park and golf course areas will be developed to address Corps of Engineers and U.S. Fish and Wildlife Service concerns regarding alteration of wetlands and impacts on Pearl Harbor National Wildlife Refuge Honouliuli Unit" (page 5, item C. of the Environmental Impact Statement Preparation Notice).

With that in mind, I now will discuss the Hawaiian waterbirds.

1. Koloa or Hawaiian duck

To the best of our knowledge, this duck became extinct on Oahu during the 1950s. A Koloa restoration project was initiated by the State Division of Fish and Game in 1972. As of April 1979, 347 Hawaiian ducks had been released on Oahu in an attempt to reestablish the species on this island: 199 birds were released in Kawainui Swamp; 103 at Waimea Falls Park; and 45 at Nuupia Pond on the Kaneohe Marine Corps Air Station. "Although release of cage-reared Koloa began on the windward side of Oahu in 1969, we can find no reports of the species in the Pearl Harbor area until 7/18/76, when two birds were counted on the ponds on Waipio Peninsula. Since that time, they have also been observed at the Honouliuli refuge unit. Because of the distance involved, it is questionable whether or not birds from the windward side will successfully disperse in greater numbers to this area" (Shallenberger, 1977:299). However, much more is involved than a "greater dispersal." It seems doubtful that the Pearl Harbor habitat offers the necessary food and safe nesting sites required by this ground-nesting duck. I know of no documented records of this duck nesting in the vicinity of salt water.

2. Hawaiian Gallinule

The Pearl Harbor area does not provide good habitat for the Hawaiian gallinule, and Shallenberger (1977) wrote that: "Hawaiian Gallinule are even less common in Pearl Harbor areas than are coots. No more than two birds have been reported in the Honouliuli refuge in recent years." Walker et al. (1986) reported no birds there during the summer census in 1985. Shallenberger did find the gallinule nesting at the prawn farm at Honouliuli. However, gallinule prefer fresh or brackish water to salt water so that it is doubtful that the Pearl Harbor habitat can ever be changed to provide optimal habitat for any

large numbers of gallinule. Walker et al. (1985) point out that Hawaiian gallinule habitat "consists of thickly vegetated marsh interspersed with fresh water ponds, taro patches, lagoons, reedy margins of water courses (streams, irrigation ditches, etc.) reservoirs, and wet pastures. . . . The key features of these areas for gallinules are, 1) dense stands of robust emergent vegetation near open water, 2) floating or barely emergent mats of vegetation, 3) water less than 3 feet deep and 4) fresh water as opposed to saline or brackish." The ecology of nesting by the gallinule has been discussed by Byrd and Zeillemaker (in press).

3. Hawaiian Coot

According to Shallenberger (1977:298), "Coots find far less suitable habitat in the Pearl Harbor wetlands than do stilt. No more than 3 coots have been reported on individual counts at Honouliuli refuge unit. . . . Greatest numbers in the Pearl Harbor area have generally been found in small fish ponds in the Waikele area, although HDF&G/USF&WS counts for this area average less than 15 birds." Walker et al. (1985:11) state that the Hawaiian subspecies of the coot "is not known to nest adjacent to salt water." One can conclude, therefore, that the Pearl Harbor region does not provide good habitat for the feeding and nesting of the Hawaiian coot.

4. Hawaiian Stilt

This is a subspecies of the North American black-necked stilt. The largest populations now occur on Maui and Oahu. Personnel of the State Division of Forestry and Wildlife take censuses of the Hawaiian waterbirds during the winter and the summer. The number of stilts in the state has varied from 523 birds during the winter of 1979 to 1,492 during the summer of 1986 (after the breeding season; see Walker, et al., 1986). The endangered status of all of the Hawaiian waterbirds results from a number of factors. Eggs and newly hatched young are easy prey to mongooses, cats, and dogs. The downy young also enter the water shortly after hatching, where they are prey to bass, bullfrogs, and black-crowned night herons (Berger, 1981). Sudden changes in water level also causes the destruction of nests. Of equal importance to these predators is the historical destruction of so many lowland marsh areas. A potential problem that has been very little studied in Hawaii is that of the effects of various pesticides on birds and their reproduction, although the U.S.Fish and Wildlife Service has been studying this problem on the mainland for the past 40 years (see Hall, 1987).

II. Indigenous Birds

These are species that occur naturally in Hawaii and also in other parts of the world. These birds are native to the Hawaiian Islands but are not unique to them. In this category are 22 species of seabirds, the Hawaiian black-crowned night heron, and a number of migratory species that spend their winter

or non-breeding season in the islands.

1. Black-crowned night heron, Nycticorax n. hoactli.

The 'Auku'u is considered to be an indigenous rather than an endemic species because the Hawaiian birds have not been recognized as subspecifically distinct from the North American birds. Hence, it is not classified as threatened or endangered even though its fate depends upon the preservation of suitable wetlands. Although these herons feed predominantly on aquatic insects, fish, frogs, and mice, they also sometimes prey on the downy young of terns and undoubtedly on the other marsh birds. Fourteen herons were counted in Waipio Peninsula, the Honouliuli NWR, and the Waiawa NWR during the Christmas Bird Count of the Hawaii Audubon Society on December 22, 1986 (Bremer, 1987). It may be pointed out here that the State Land Board gave prawn producers "a 120-day permit to destroy black-crowned herons which have been causing economic havoc at Oahu's Kahuku prawn farm as well as other aquaculture farms statewide" (Honolulu Star-Bulletin, October 26, 1985, page A-8).

2. Winter Residents

The most conspicuous of these birds is the lesser golden plover (Pluvialis dominica fulva), which occurs from sea level to about 10,000 feet elevation on Hawaii and Maui. The birds frequent lawns in residential areas, golf courses, weedy pastures, open areas in the mountains, and mud flats along the shore. However, a number of other shorebirds and ducks spend the winter season in the islands. Some 13 species were observed on one day during December 1986 (Bremer, 1987). None of these migratory species is endangered or threatened and their occurrence is of no concern in an environmental assessment.

3. Seabirds

There are no nesting seabirds in the vicinity of the project site.

III. Introduced or Alien Birds

More than 170 species of alien birds have been intentionally introduced to the Hawaiian Islands. The following have been reported in the Waipio/West Loch region.

A. Order Ciconiiformes

b. Family Ardeidae, Herons

1. Cattle egret, *Bubulcus ibis*.

This egret was imported to Hawaii to "aid in the battle to control house flies, horn flies, and other flies that damage hides and cause lower weight gains in cattle" (Breese, 1959). Most of the funds were provided by ranchers to have the birds released on their land. Cattle egrets were released on Oahu in 1959 and 1961. Thistle (1962) reported that the population of egrets on Oahu exceeded 150 birds by July 1962; 621 egrets were counted by personnel of the State Division of Forestry and Wildlife during January 1986 (Walker *et al.*,

1986); and 116 egrets were counted in the Waipio region December 22, 1986 (Bremer, 1987). Thus, the Cattle egret is an abundant species in the Pearl Harbor area and I saw several flocks of 25 and more birds,

B. Order Galliformes

b. Family Phasianidae, Pheasants, Quail, Partridges

2. Ring-necked pheasant, *Phasianus colchicus*

According to Caum (1933), this Asian pheasant was introduced to the islands in 1865 "probably by Dr. Hillebrand." It also has been imported a number of times since then "through dealers in the United States as well as from the territorial game farm on Oahu" (Schwartz and Schwartz, 1949). It now is not a very successful species on Oahu. Hunters killed 235 birds during the 1960-1961 hunting season, but only one bird was reported during the 1983-1984 season (Saito, 1984). I did not see any pheasants during my recent field work, but four birds were reported on the Christmas count on December 22, 1986 (Bremer, 1987).

C. Order Columbiformes

c. Family Columbidae, Pigeons and Doves

3. Rock Dove or feral Pigeon, *Columba livia*

The pigeon probably was the first exotic bird introduced to the Hawaiian Islands; its importation has been traced back to 1796. Schwartz and Schwartz (1949) wrote that feral pigeons roost and nest the year around in sheltered portions of cliffs along the sea coast, in rocky gulches, and in collapsed lava tubes up to 10,000 feet on Mauna Kea. They noted that "in certain places where rookeries are accessible to humans, it was and still is the custom for local residents to periodically take the squabs for food." These authors also found heavy parasitism by tapeworms, and they stated that tapeworm infestation retards proper nutrition and "occludes the intestine, produces undesirable toxins, and hinders breeding." Kishimoto and Baker (1969) reported finding the fungus <u>Cryptococcus neoformans</u> in 13 out of 17 samples of pigeon droppings collected on Oahu. The full significance of their findings has not yet been determined, but, in humans, this fungus causes a chronic cerebrospinal meningitis; Hull, 1963:468) remarked that "in all but the cutaneous form the prognosis [in humans] is very grave." The rock dove is found in the project area.

4. Lace-necked or Spotted Dove, <u>Streptopelia chinensis</u>.

This Asian dove was introduced to the islands at an early date; the exact date is unknown, but

the birds are said to have been very common on Oahu by 1879. The species is now common to abundant on all main islands, and, like the other doves in Hawaii, is classified as a game bird. Although this dove occurs where the rainfall exceeds 100 inches per year, the highest densities are found in drier areas where the introduced kiawe is one of the dominant plants. Schwartz and Schwartz (1949) estimated densities as great as 200 birds per square mile in dry areas on Molokai. It is a common bird in the fallow cane fields, along cane haul roads, and in residential areas.

5. Barred or Zebra Dove, <u>Geopelia striata</u>

This dove is said to have been introduced to Hawaii sometime after 1922 (Bryan, 1958). It has been a remarkable successful species and it is now abundant on all of the islands. The zebra dove also prefers drier areas where seeds are abundnat. Schwartz and Schwartz (1949) estimated densities as great as 400 to 800 birds per square mile in some areas on Oahu (e.g., from Barber's Point to Makaha) and on Molokai. One study of the food habits of this dove in Hawaii revealed that the diet consists of 97 percent seeds and other plant materials; the 3 percent animal matter included several species of beetles, weevils, and wireworm larvae. The zebra dove is an abundant species throughout the project area.

D. Order Strigiformes

d. Family Tytonidae, Barn Owls

6. Barn owl, Tyto alba pratincola

Barn owls differ from other owls in that they have a heart-shaped facial disc of feathers, hence, the name "mokey-faced owl." Barn owls were first released on Oahu in 1959. Like the mongoose much earlier, the owls were introduced with the hope that they would prey upon rats in sugarcane fields. Few studies of the food habits of the barn owl have been conducted in Hawaii, but one study revealed that about 90 percent of the food consisted of house mice (Tomich, 1971). Byrd and Telfer (1980) reported that barn owls had killed more than 100 seabirds and their chicks on Kauai and Kaula island. These owls are nocturnal in habits and I did not see any during my daytime field work. However, Bremer (1987) reported four barn owls in the Waipio area during December 1986.

E. Order Passeriformes

e. Family Alaudidae, Skylarks

7. Eurasian skylark, Alauda arvensis

The first skylarks were brought to Hawaii from

England in 1865; others were imported from New Zealand (where they had previously been introduced from England in 1864) in 1870. Henshaw (1904) wrote that the introduction of the Skylark to Oahu had been "a great success," and that some birds had been released on the windward side of Hawaii. Skylarks were fairly common in suitable habitat on Oahu 20 years ago, but have become increasingly uncommon in many areas as the years have passed. The Waipio region continues to provide good habitat for the skylark and 17 birds were counted there during December 1986 (Bremer, 1987).

f. Family Pycnonotidae, Bulbuls

8. Red-vented bulbul, Pycnonotus cafer

Although all members of this Old-world family are listed as "prohibited entry" by the State Quarantine Division of the Department of Agriculture, two species are now well established on Oahu.

The history of the spread of this species since the mid-1960s has been discussed by Berger (1975, 1981). Bulbuls are a scourge to both fruit and flower growers. The birds eat buds, flowers, and ripe fruits of all kinds. They are found throughout the project area

g. Family Turdidae, Thrushes and Bluebirds

9. White-rumped Shama, Copsychus malabarica

Shama is the Indian name for this thrush, which is native to India, Nepal, Burma, Malaysia, and throughout Indochina. The Hui Manu imported Shamas in 1940 and released them in Nuuanu Valley "and at some homes in the 2400 block on Makiki Heights road" (Harpham, 1953). The Shama is now common on both the windward and leeward slopes of the Koolau mountain. The birds prefer lush vegetation, but seven birds were seen in the Waipio region during December 1986.

h. Family Mimidae, Mockingbirds and Thrashers

10. Mockingbird, <u>Mimus polyglottos</u>

Very little has been published on the mockingbird in Hawaii. The Hui Manu released birds on Oahu in 1931, 1932, and 1933. The mockingbird has a very spotty distribution on Oahu, being absent from many areas but common in others (e.g., Diamond Head, Fort Shafter, Radford Terrace, and Barber's Point). A few birds inhabit the Waipio area.

i. Family Zosteropidae, White-eyes and Silver-eyes

11. Japanese White-eye, <u>Zosterops japonicus</u>

Long a favorite cage bird in the Orient, this species was first imported for release by the Territorial Board of Agriculture and Forestry in 1929 (Caum, 1933). Later importation were made by the Hui Manu.

The Japanese name is Mejiro, and Mejiro clubs held singing competitions with these birds. The white-eye has been a remarkably successful introduction and this species undoubtedly is the most abundant song bird in the Hawaiian Islands. It occurs from sea level to 10,000 feet elevation on Hawaii, and it occupies near-desert areas (e.g., Kawaihae) and those with an annual rainfall of more than 300 inches. The white-eye is a very common species through the project region.

j. Family Sturnidae, Mynas and Starlings.

12. Common Indian Myna, <u>Acridotheres tristis</u>

This myna is native to Sri Lanka, India, Nepal, and adjacent regions. It "was introduced from India in 1865 by Dr. William Hillebrand to combat the plague of army worms that was ravaging the pasture lands of the islands. . . . reported to be abundant in Honolulu by 1879, it now is extremely common throughout the Territory" (Caum, 1933). The myna continues to be common on Oahu and it occurs in the vicinity of man and his buildings, on golf courses, and throughout the Waipio region.

k. Family Ploceidae, Weaverbirds and their allies

13. Red Avadavat or Red Munia, <u>Amandava amandava</u>

Known as the strawberry finch in the petstore trade, Caum (1933) wrote that "it is not known with certainty just when these birds came to Hawaii, but it was probably sometime between 1900 and 1910. Many were imported as cage birds during this period and it is supposed that the present population is derived from individuals escaped from captivity." Ord (1967) wrote that the strawberry finch "can usually be found near grassy open areas around sugar cane fields . . . in the lowlands about Pearl Harbor." The birds still inhabit this area, and 57 birds were counted during the December 1986 Hawaii Audubpn Society Christmas Count.

14. Nutmeg Mannikin or Ricebird, Lonchura punctulata
Also known as the spotted munia, this Asian species was released in Hawaii by Dr. William Hillebrand about 1865 (Caum,1933) Caum wrote that the ricebird "feeds on the seeds of weeds and grasses and does considerable damage to green rice." Rice is no longer grown in Hawaii, but the ricebird has recently become a serious pest by eating the seeds of sorghum (to be discussed under house finch). The ricebird is another abundant species on all islands. I saw large flocks during my August field trips.

15. Black-headed Munia, Lonchura malacca atricapilla
This bird also is called the chestnut mannikin and black-hooded nun. The species was first reported in the wild by Udvardy (1960), who observed 10 adults and 15 juvenile birds near West Loch,

Pearl Harbor, on April 26, 1959. Ord (1967) reported that the species was abundant "in open grassy areas around Middle Loch and West Lochs of Pearl Harbor." The species has spread since that time (e.g., to the West Beach area) and still is abdunant in the Waipio--West Loch region. More than 200 birds were counted during the Audubon Society Christmas Count during December 1986.

16. Red-eared or Common Waxbill, Estrilda troglodytes
Also called the black-rumped waxbill, this species was first reported at Diamond Head on January 2, 1966. Little has been published on this species in Hawaii but its range has expanded considerably and it now is found in the Waipio region and west at least to West Beach. More than 180 birds were counted during December 1986 in the Waipio region (Bremer, 1987).

17. House Sparrow, Passer domesticus
The house sparrow (erroneously called the English Sparrow) was first imported to Oahu in 1871 when nine birds were brought from New Zealand (where the species had previously been introduced from England). Caum (1933) wrote that "whether or not there were further importations is not known, but the species was reported to be numerous in

Honolulu in 1879." The House Sparrow in North America (first introduced to Brooklyn, New York, in 1852) became a serious pest, and tens of thousands of dollars were spent in attempting to control the population. The house sparrow apparently never became a pest in Hawaii. It is omnivorous in diet, eating weeds seeds as well as insects and their larvae. The house sparrow is common throughout the project area.

1. Family Fringillidae, Sparrows, Cardinals, and Buntings.

18. Red-crested Cardinal, <u>Paroaria coronata</u>
This species traditionally has been called the Brazilian cardinal in Hawaii, but the native range includes Uruguay, Paraguay, Brazil, and parts of Bolivia and Argentina. This species was released in Hawaii several times between 1928 and 1931 (Caum, 1933). This cardinal is a common species in urban and residential areas as well as in the introduced vegetation of leeward Oahu. It is widespread in the general Waipio region.

19. Cardinal, <u>Cardinalis cardinalis</u>
This species has been given a number of vernacular names: Virginia cardinal, Kentucky cardinal, Red cardinal. Its native range is the eastern part of North America east of the plains and northward into Ontario. The cardinal was released several times in

Hawaii between 1929 and 1931 (Caum, 1933). The species is fairly common in some lowland areas, and is a characterisitc bird of the leeward parts of Oahu. The birds visit the edges of cane fields but spend most of their time in kiawe and other thickets whether inland or along the shore. They are found throughout the Waipio area.

20. House Finch, <u>Carpodacus mexicanus frontalis</u>
Also known as the Papayabird in Hawaii, the house finch was introduced from California "prior to 1870, probably from San Francisco" (Caum, 1933). The house finch is now an abundant species in both urban and rural areas on all of the islands, and probably is the second most common land bird species in Hawaii now. Although house finches do eat overripe papaya and other soft fruits at times, the species is predominantly a seed eater. House finches and ricebirds caused substantial damage to the experimental sorghum crops planted on Kauai and Hawaii during 1971-1972. "A report by the Senate Committee on Ecology, Environment and Recreation says rice birds and linnets [house finch] caused a 30 to 50 percent loss in the sorghum fields at Kilauea on Kauai last year. . . . seed-eating birds at Kohala ate about 50 tons of sorghum grain in a 30-acre experimental field that was expected to

produce 60 tons" (Honolulu Advertiser, March 14, 1972, p.B-2).

The house finch is an abundant species in the Waipio region. The birds feed along the edges of cane fields, in the fallow fields, as well as in any habitat where there are weed seeds.

Mammals

I. Endemic Mammals

The only endemic land mammal in the Hawaiian Islands is the Hawaiian bat (Lasiurus cinereus semotus), a subspecies of the North American hoary bat. The Hawaiian bat occurs primarily on the Islands of Hawaii and Kauai (Tomich, 1969; Kramer, 1971; Ten Bruggencate, 1983). I know of no evidence that there is a resident population on the island of Oahu.

II. Introduced Mammals

All of these introduced species of mammals in Hawaii have proven highly detrimental to man, his buildings, products, agricultural crops and/or to the native forests and their animal life. None is an endangered species and none is of conern as far as detrimental effects resulting from the proposed project. It would, in fact, be a great boon to the islands if it were possible to exterminate all of them.

With the possible exception of the house mouse (Mus musculus), all of the smaller alien mammals prey on birds, their eggs, or young. These small mammals include the roof rat

(Rattus rattus), Polynesian rat (Rattus exulans), Norway rat (Rattus norvegicus), and the small Indian mongoose (Herpestes auropunctatus), as well as feral cats (Felis catus), and dogs (Canis familiaris). Because all of these mammals are serious pests, I did not set traplines in order to sample the nocturnal rodents. It is reasonable to assume that all of them occur in the project site (Tomich, 1969; Kramer, 1971).

Summary and Conclusions

1. A substantial portion of the project site and adjacent areas consists either of sugarcane land (some now fallow and some still under cultivation) or of a dense growth of exotic or alien trees, shrubs, vines, and grasses (especially along the shore of West Loch). In its present condition, therefore, the area properly can be called a "waste land" as far as endemic or native vegetation and its animal life is concerned.

2. There are no endemic forest birds in the project area or anywhere near it.

3. The Honouliuli and Waiawa National Wildlife Refuges are of special value to the endangered Hawaiian stilt and, to a lesser degree, for the other Hawaiian waterbirds. As pointed out on page 4 (above), it is of utmost importance that no polluting substances reach these sanctuaries. This potential problem has been addressed on page 5 (item C) of the Environmental Impact Statement Preparation Notice where it states that plans for the beach park and the golf courses will be coordinated

with personnel of the U.S. Fish and Wildlife Service and the Corps of Engineers. If this is done, I see no problem in the development of the project.

A buffer zone may be necessary, but there is ample evidence that the birds become habituated to both buildings and people (see, for example, Berger, 1973, 1976; Berger and Walker, 1976).

To the best of my knowledge, the only extensive published results of research on the effects of noise on birds are those of the U.S. Environmental Protection Agency (1971, 1980). The two reports give the results of research on a number of bird species that show that birds are little affected by artificially produced noises, airplanes, and sonic booms. "It was reported that to scare birds a noise level of approximately 85 dB SPl at the bird's ear was required" (1971: 36). The two reports cite many other examples of research dealing with behavior and reproductive biology in relation to both airplane and construction noises. In Hawaii, Berger (1973), in writing about the Hawaiian stilt said that "all of the bird species that inhabit Kanaha Pond ignore automobile traffic on the highway as well as airplanes that fly over the Pond," and Kridler (in Doty, 1969), also writing about Kanaha Pond, reported that "we did not notice one instance when planes frightened ducks or any other waterbird into flight." Finally, speaking on behalf of the Board of Land and Natural Resources in testimony

before the State Senate Committee on Ecology, Environment, and Recreation on February 10, 1976, Mr. Ronald L. Walker of the then State Division of Fish and Game said, in part: "Contrary to commonly held opinion that resident and migratory waterbirds do not adapt well to habitat subjected to human disturbance, it has been our experience that the Hawaiian stilt and migratory shorebirds and waterfowl are highly tolerant of human activities in the vicinity of their feeding and resting areas. This has been demonstrated not only at Paiko Lagoon . . . , but at Keehi Lagoon off the International Airport, which is subjected to daily disturbance by aircraft, motorboats, vehicles and recreationists on foot."

4. None of the 20 species of introduced or alien birds found in the project area is an endangered species and a number have proven to be serious pests in Hawaii. The destruction to sorghum crops by the ricebird and the house finch already has been mentioned. The doves and the myna have been implicated in spreading the seeds of such noxious plants as _Lantana camara_. The red-vented bulbul and the Japanese white-eye cause considerable damage to ornamental flowers and to fruit crops (see Keffer, _et al_., 1976). The barn owl is known to eat birds on Kauai and perhaps on other islands (Byrd and Telfer, 1980). Some of the introduced birds apparently cause no damage to crops or to the endemic forest birds, and they do provide pleasure for many people. However,

development, including landscaping, actually would provide habitat for many of the introduced species.

5. All of the mammals, land reptiles, and amphibians that occur in the project area are introduced or alien mammals. Many of them are predators on birds and several are destructive to agriculture and forest lands and/or to man, his buildings, and products. None of these animals is of any significance for an environmental impact statement.

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APPENDIX C

Traffic Noise Impact Study
For the Proposed
West Loch Estates Subdivision

by

Y. EBISU & ASSOCIATES

September 1987

TRAFFIC NOISE IMPACT STUDY
FOR THE PROPOSED
WEST LOCH ESTATES SUBDIVISION

PREPARED FOR
R. M. TOWILL CORPORATION

BY
Y. EBISU & ASSOCIATES

SEPTEMBER, 1987

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I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed West Loch Estates Subdivision were evaluated for their potential impact on present and future residences in the project environs. The traffic noise level increases along Fort Weaver Road were calculated for the CY 1991 and 1997 time periods, and traffic noise increases associated with project and non-project traffic were assessed. Increases in traffic noise of 3.8 to 4.2 Ldn are predicted to occur as a result of project and non-project traffic on Fort Weaver Road. Traffic noise increases of 0.4 to 1.3 Ldn are projected to occur as a result of project traffic on Fort Weaver Road.

Project traffic noise impacts on existing residences along Fort Weaver Road in the vicinity of Renton Road are predicted to be relatively small, with project related increases in the order of 0.5 Ldn. Although significant increases in non-project traffic noise levels are predicted to occur by 1991, existing residences should remain in the "Acceptable, Moderate Exposure" category due to the large setbacks of the residences from Fort Weaver Road.

The existing Hale O Ulu School on the west side of Fort Weaver Road is currently in the "Normally Unacceptable, Significant Exposure" category. Projected increases in non-project traffic by 1991 are expected to increase traffic noise levels at the school by 2.0 Ldn. Project related traffic is not expected to be a significant noise source at the school, with the contribution from project traffic predicted to be 0.5 Ldn.

Future traffic noise impacts on West Loch residents can be minimized by the use of buffer zones of adequate depth on the Diamond Head side of Fort Weaver Road, and along the internal roadways of the development. In order to not preclude federal assistance on the project, it is suggested that minimum setback distances to the future 65 Ldn contour be used when practical in siting future residential units. Because these setback distances are large along some sections of Fort Weaver Road, the use of

other noise mitigation measures may be desirable. These other measures include the construction of sound attenuating berms or walls along Fort Weaver Road, or the use of sound attenuating windows for two story homes.

II. PURPOSE AND METHODOLOGY

The purposes of this noise study were to predict the traffic noise level increases associated with the proposed West Loch Estates Subdivision project, and to evaluate possible noise impacts on the surrounding area resulting from the project's traffic noise sources. Additionally, the possible traffic noise impacts on future residents of the proposed subdivision along Fort Weaver Road and internal roadways were evaluated.

Traffic noise predictions were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (Reference 1), and traffic assignments from the traffic study for the project (Reference 2). Historical traffic counts obtained by the State Department of Transportation at stations on Fort Weaver Road (References 3 and 4) were used to develop the relationships between peak hour Leq(h) and daily Ldn traffic noise levels. (See Worksheet #1 of APPENDIX C). Natural shielding effects from the terrain features along Fort Weaver Road were included in the traffic noise prediction model. As-built plans of the roadway were used to obtain roadway and Right-of-Way elevations. Receptor elevations were assumed to be 5 FT above existing terrain.

Existing traffic noise measurements at three locations along Fort Weaver Road were obtained in August, 1987 to calibrate the noise prediction model, and to refine future traffic noise predictions. The relative noise contributions from project and non-project traffic were obtained from the traffic projections of Reference 2 for the 1991 time period. Additionally, the project plus non-project traffic volumes for the 1997 time period contained in Reference 2 were used to describe the future traffic noise environment along Fort Weaver Road. Potential traffic noise impacts resulting from non-project and project traffic in CY 1997 were identified, and possible noise mitigation measures were described.

III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

Two noise descriptors currently used to relate outdoor noise levels to land use compatibility, and to assess environmental noise in general, are the Equivalent Noise Level (Leq) and the Day-Night Average Sound Level (Ldn). Both of these descriptors are averages of instantaneous A-Weighted Sound Levels as read on a standard Sound Level Meter. In traffic noise evaluations, the averaging period for the Leq descriptor is usually an hour, and more specifically, the peak hour of traffic. In all evaluations, the minimum averaging period for the Ldn descriptor is 24 hours (by definition), with the recommended averaging period being one year for land use compatibility evaluations. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) prior to computing the 24-hour average by the Ldn descriptor. A glossary of acoustical descriptors is contained in APPENDIX B.

TABLE 1, which was derived from information contained in Reference 5, presents current federal standards and acceptability criteria for residential land uses exposed to various levels of environmental noise. As a general rule, noise levels of 55 Ldn or less occur in rural areas or urbanized areas which are shielded from high volume streets. In urbanized areas, Ldn levels generally range from 55 to 65 Ldn, and are usually controlled by motor vehicle traffic noise. Buildings which front major roadways are generally exposed to levels of 65 Ldn, and as high as 72 Ldn when the roadway is a high speed freeway. Due to noise shielding effects from intervening structures, buildings which are located within interior lots are exposed to lower exterior noise levels of 60 Ldn or less.

For the purposes of determining noise acceptability for funding assistance from federal agencies (FHA/HUD and VA), an exterior noise level of 65 Ldn or lower is considered acceptable for residential developments. This standard is applied nationally

TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION
(RESIDENTIAL LAND USE)

Noise Exposure Class	Day-Night Sound Level	Equivalent Sound Level	Federal Standard (1)
Minimal Exposure	Not Exceeding 55 Ldn	Not Exceeding 55 Leq	Unconditionally Acceptable
Moderate Exposure	Above 55 Ldn But Not Above 65 Ldn	Above 55 Leq But Not Above 65 Leq	Acceptable (2)
Significant Exposure	Above 65 Ldn But Not Above 75 Ldn	Above 65 Leq But Not Above 75 Leq	Normally Unacceptable
Severe Exposure	Above 75 Ldn	Above 75 Leq	Unacceptable

Note: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the Leq instead of the Ldn descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours.

Source: Reference 5.

(see Reference 6), including Hawaii. Because of our open living conditions, the predominant use of naturally ventilated dwellings, and the relatively low exterior to interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 Ldn in local residential neighborhoods does not eliminate all risks of noise impacts. For these reasons, and as recommended in Reference 7, a lower level of 55 Ldn is considered as the "Unconditionally Acceptable" (or "Near Zero Risk") level of exterior noise for residential uses. However, after considering the cost and feasibility of applying the lower level of 55 Ldn, government agencies such as FHA/HUD and VA have selected 65 Ldn as a more appropriate regulatory standard.

For commercial and light industrial developments, exterior noise levels in the order of 65 to 75 Ldn are considered acceptable. FIGURE 1, extracted from Reference 8, depicts suggested noise level compatibility guidelines for various land use categories. Note that for commercial land uses, "Compatible" (or "Unconditionally Acceptable") noise levels are approximately 10 Ldn higher than for residential uses. This is due to the generally higher tolerance for noise in nonresidential settings, and the higher probability of total closure and air conditioning of commercial structures. Federal agencies utilize similar land use compatibility guidelines (Table 2 of Reference 5) for commercial and light industrial developments.

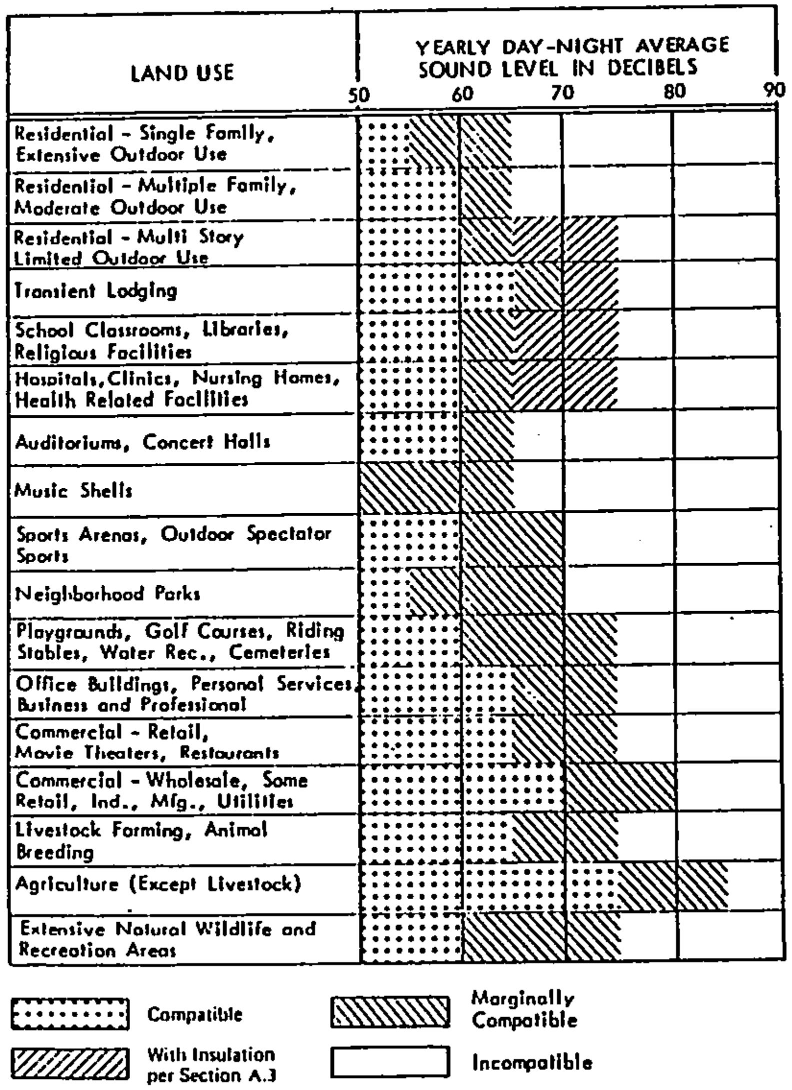

FIG. 1. Land use compatibility with yearly day-night average sound level at a site for buildings as commonly constructed [For information only; not a part of American National Standard for Sound Level Descriptors for Determination of Compatible Land Use S3.23-1980.]

IV. EXISTING NOISE ENVIRONMENT

Along the Fort Weaver Road Right-of-Way, existing traffic noise levels are in the "Significant Exposure, Normally Unacceptable" category. Existing setback distances to the 65 Ldn contour line are estimated at 235 FT and 128 FT from the centerline of the roadway at the north and south sections, respectively, of the roadway (see FIGURE 2). In the vicinity of the proposed residential subdivisions of West Loch Estates, which are located on the Diamond Head (east) side of the roadway, traffic noise levels are in the "Significant Exposure, Normally Unacceptable" category (approximately 67 to 73 Ldn) along the first row of proposed lots which will front the highway.

The results of the August, 1987 highway noise measurements are summarized in TABLE 2. The locations of the measurement sites and their relationships to the existing Ldn contours are shown in FIGURE 2. The agreement between the measured highway noise and the computed values was good at all three measurement Sites A thru C, as indicated in the last column of TABLE 2.

In the vicinity of the Renton Road intersection, existing residences of Fernandez Village are in the "Moderate Exposure, Acceptable" category due to the large setback distances (240+ FT) from the centerline of Fort Weaver Road, and due to the lower vehicle speeds near the signaled intersection. To the north, the existing Hale O Ulu School on the west side of Fort Weaver Road is exposed to traffic noise levels of 65 to 70 Ldn, which are considered "Unacceptable" for naturally ventilated schools. Existing quonset huts on the project site and south of the Honouliuli Stream Bridge are in the "Significant Exposure, Normally Unacceptable" category (approximately 65 to 70 Ldn). These existing structures will be removed under the proposed project.

Along the existing cane haul road which runs through the southern portion (Phase II) of the project, haul trucks are the dominant noise sources during the harvesting season, which occurs

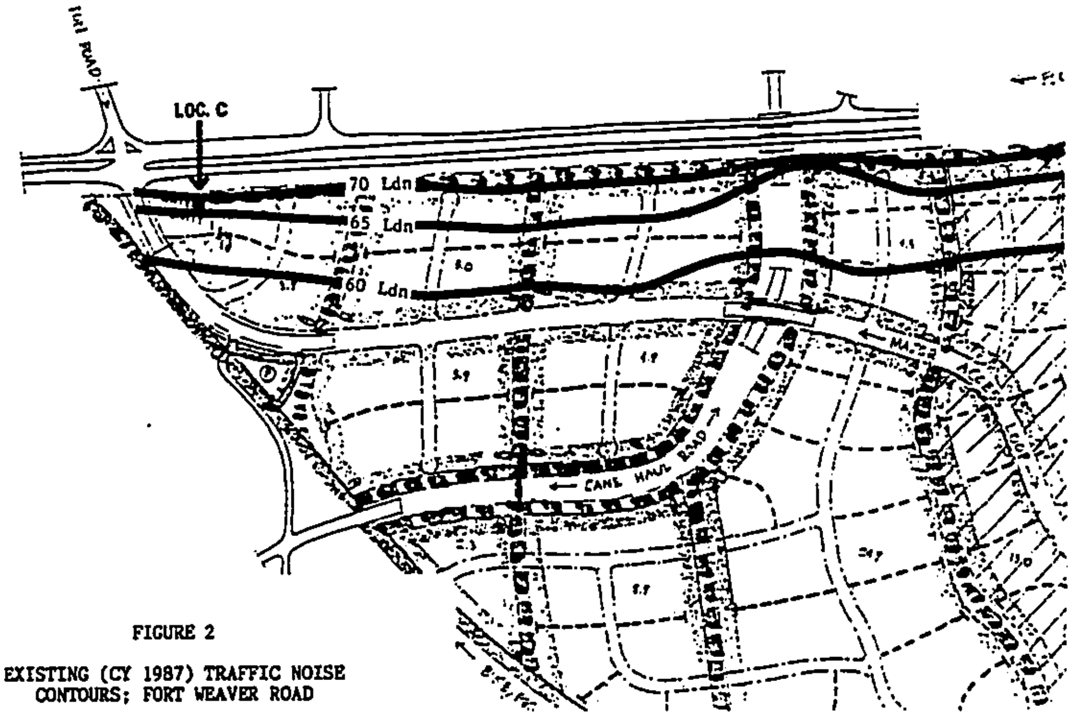

FIGURE 2

EXISTING (CY 1987) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

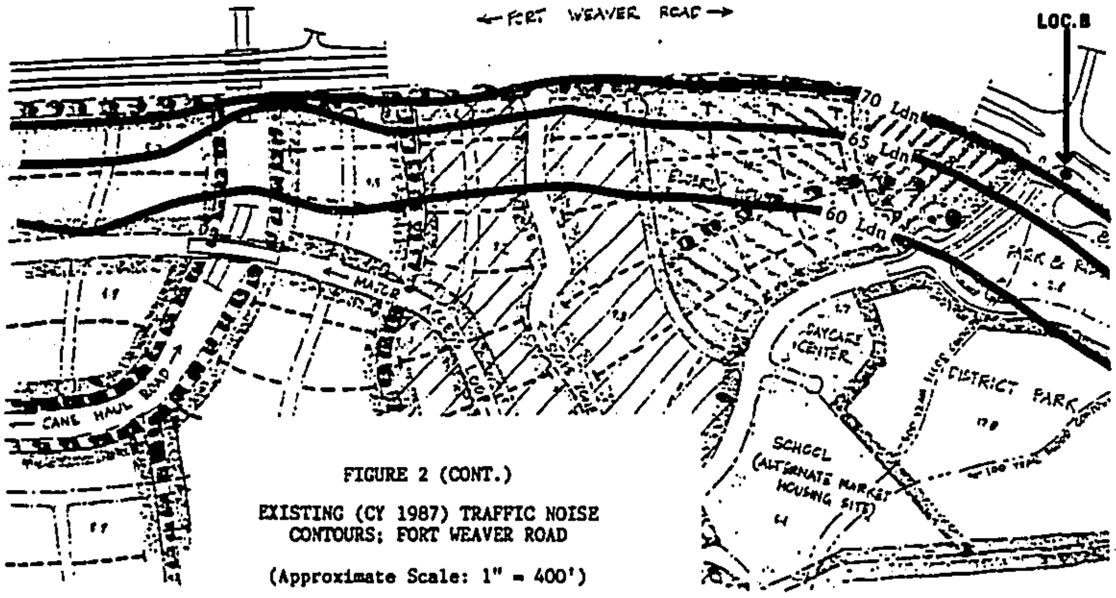

FIGURE 2 (CONT.)

EXISTING (CY 1987) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

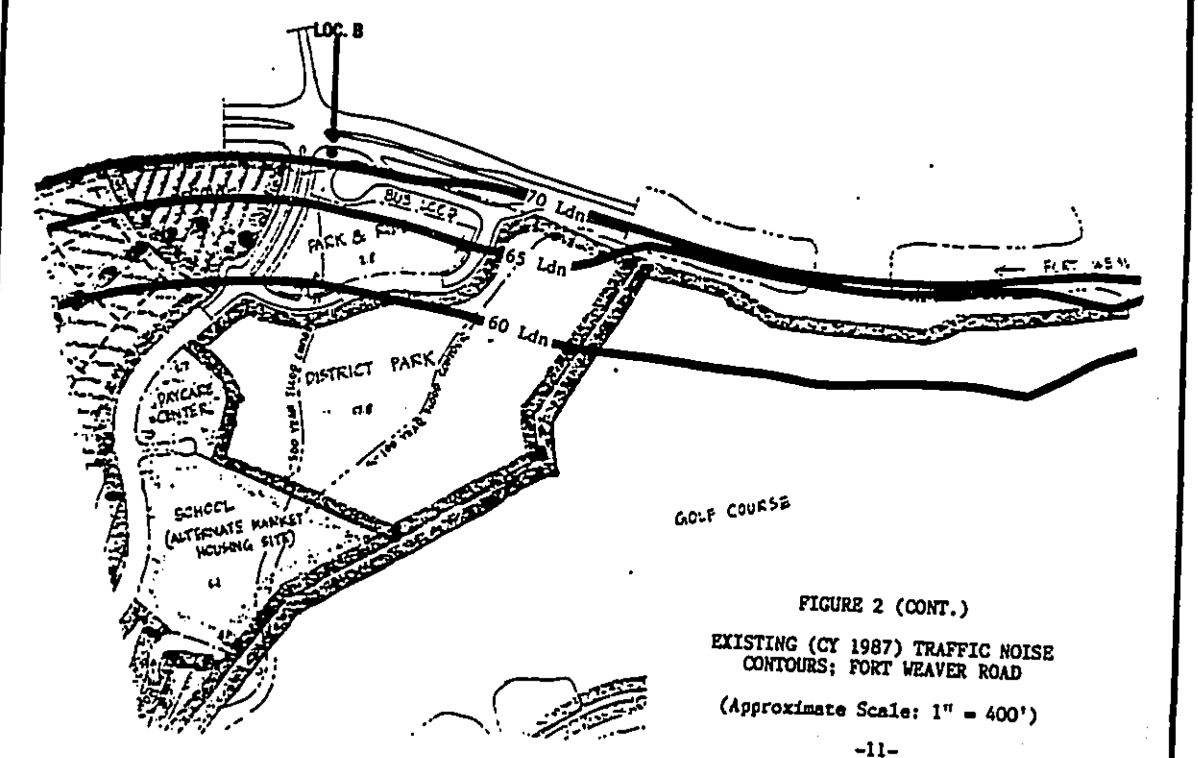

FIGURE 2 (CONT.)

EXISTING (CY 1987) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

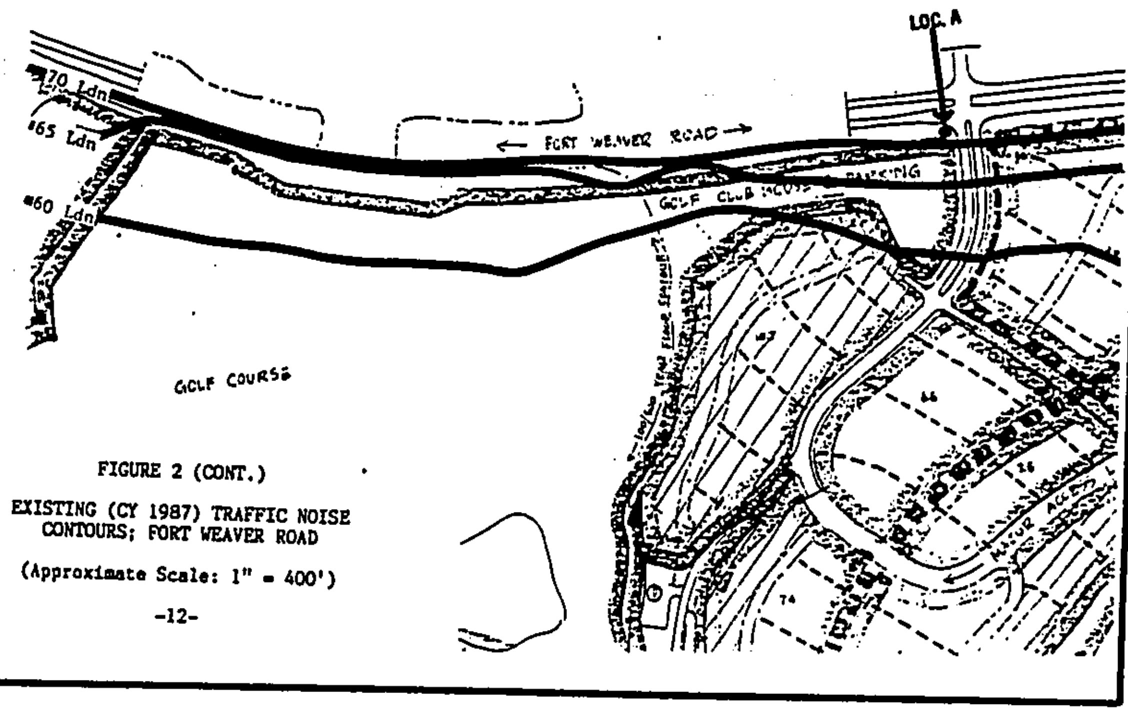

FIGURE 2 (CONT.)

EXISTING (CY 1987) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

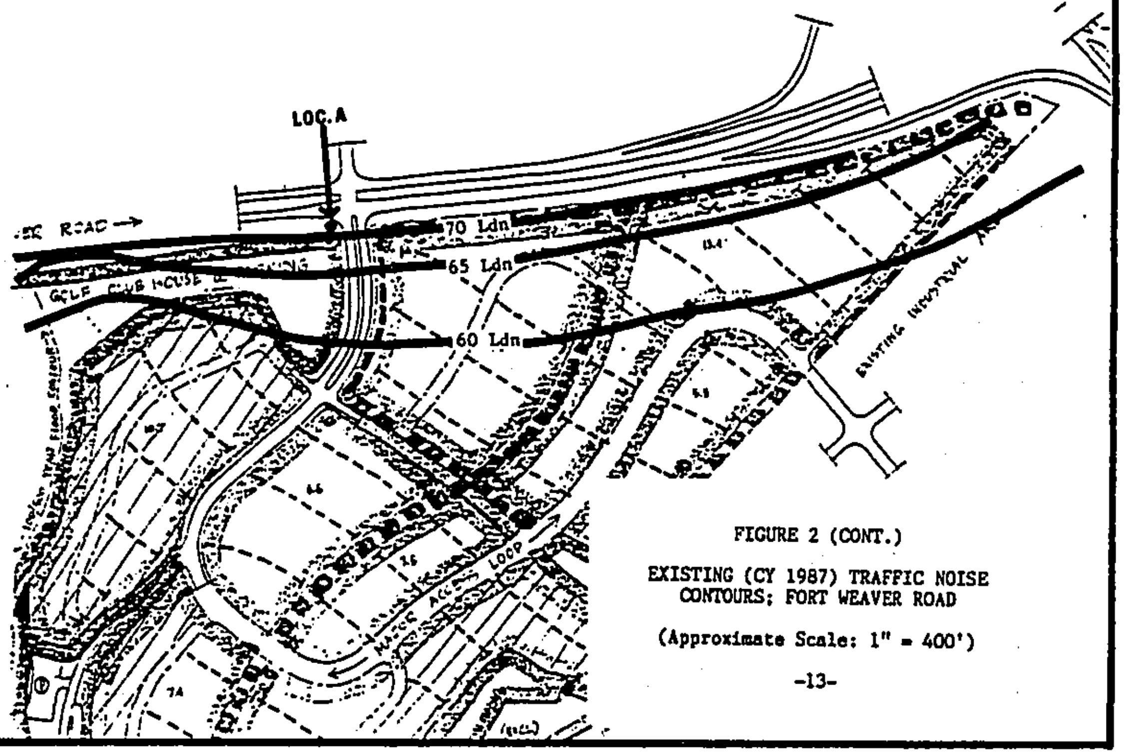

FIGURE 2 (CONT.)

EXISTING (CY 1987) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

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TABLE 2

AUGUST, 1987 TRAFFIC NOISE MEASUREMENTS

Location	Time of Day (HRS)	Ave. Speed (MPH)	——Hourly Traffic Volume—— Auto	Med. Truck	Heavy Truck	Measured Leq (dB)	Predicted Leq (dB)	Measured Minus Predicted (dB)
1. SITE A On project site, 110' from Fort Weaver Rd. centerline.	0830 TO 0915	35	1,114	23	23	63.4	62.6	0.8
2. SITE A On project site, 110' from Fort Weaver Rd. centerline.	1400 TO 1500	35	1,175	24	24	62.0	62.9	-0.9
3. SITE B On project site, 80' from Fort Weaver Rd. centerline.	0700 TO 0815	50	1,335	28	28	71.1	69.9	1.2
4. SITE B On project site, 80' from Fort Weaver Rd. centerline.	1600 TO 1650	50	1,897	40	40	69.7	71.4	-1.7
5. SITE C On project site, 100' from Fort Weaver Rd. centerline.	0930 TO 1015	50	1,175	24	24	66.8	66.9	-0.1
6. SITE C On project site, 100' from Fort Weaver Rd. centerline.	1700 TO 1800	50	1,939	40	40	68.5	69.1	-0.6
7. SITE C On project site, 100' from Fort Weaver Rd. centerline.	1800 TO 1830	50	1,712	36	36	69.1	68.5	0.6

Notes:

1. Field-of-View at Sites A, B, and C assumed from 90 degrees (left) to 90 degrees (right).
2. Soft ground conditions assumed along Fort Weaver Road.

on a 2.5 year cycle. FIGURE 3 presents the worst case (hard ground or elevated sources) Ldn vs. centerline distance curves along the haul road for the peak and average hauling days of the harvesting season, and for the annually averaged day. The following assumptions were used in computing the existing Ldn values associated with haul truck noise:

a. Total cultivated area serviced: 1,828 acres.

b. Total cane haul truck loads per acre harvested: 4.49 loads (or inbound trips) per harvested acre.

c. Total hauling (work) days per harvesting season: 190 days per season.

d. Total 24-hour (3-shift) hauling days per harvesting season: 11 days per season.

e. Maximum number of loads during 24-hour hauling day: 72 daytime (7:00 AM to 10:00 PM) loads, and 44 nighttime (10:00 PM to 7:00 AM) loads.

f. Average daily number of loads during 190 day harvesting season: 41 daytime loads, and 2.6 nighttime loads.

g. Annually averaged (365 days/year), daily number of loads during year of harvest: 21.3 daytime loads, and 1.4 nighttime loads.

During a peak harvesting day of 24-hour operation, haul truck noise levels could exceed 65 Ldn within 190 FT setback distance from the haul road's centerline. However, average Ldn values for the 190 day harvest season or for the 365 day annual period do not exceed 65 Ldn at setback distances of 80 FT, and cane haul truck noise levels are in the "Moderate Exposure, Acceptable" category at the proposed residential lots along the haul road.

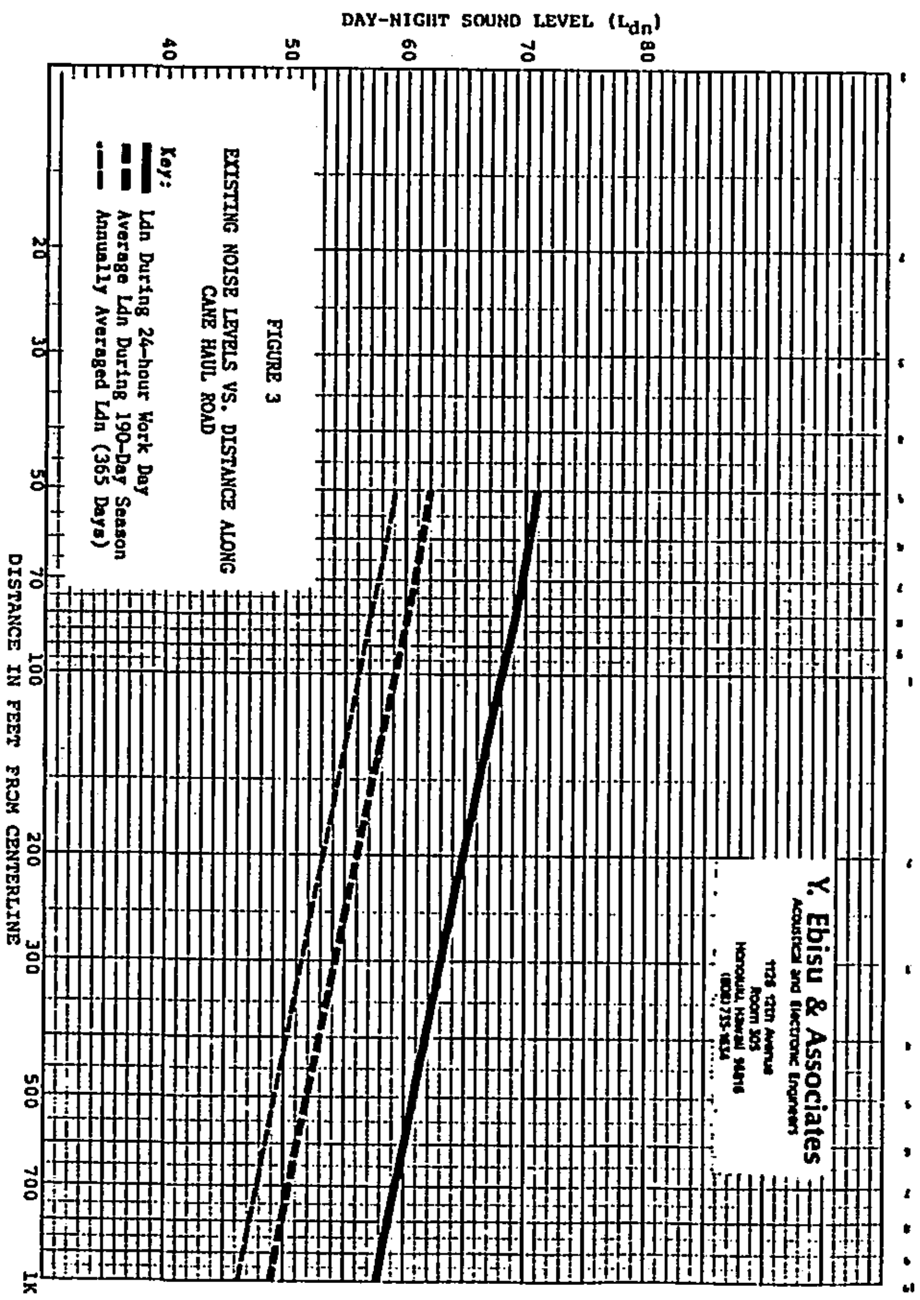

FIGURE 3

EXISTING NOISE LEVELS VS. DISTANCE ALONG CANE HAUL ROAD

V. FUTURE TRAFFIC NOISE ENVIRONMENT

Predictions of future traffic noise levels were made using the traffic volume assignments for the 1991 and 1997 time periods as contained in Reference 2. FIGURE 4 depicts the future traffic noise contours on the Diamond Head side of Fort Weaver Road following project completion by the Year 1997. The contours of FIGURE 4 do not include the sound attenuation effects of sound barriers or berms which may be incorporated into the project, or the shielding effects of the structures planned within the project. The contours do include the shielding effects from natural terrain features as well as from the elevated roadway shoulders. Portions of the north and south residential parcels which are located within 400 FT of the Fort Weaver Road centerline are predicted to be within the 65 Ldn traffic noise contour, and are expected to be in the "Significant Exposure, Normally Unacceptable" category.

The predicted increases in PM peak hour traffic noise levels from the present to CY 1997 are shown in TABLE 3 for the various sections of Fort Weaver Road in the project environs. TABLE 4 presents the predicted increases in the setback distances to the 60, 65, and 70 Ldn traffic noise contours under unobstructed line-of-sight sound propagation conditions, and with the project traffic included. As noted in TABLE 4, the difference between Ldn and peak hour Leq(h) was computed to be equal to 1.3 dB. By CY 1997, increases in the setback distances to the 65 Ldn contour are predicted to be approximately 200 FT along Fort Weaver Road at the north and central portions of the project, and approximately 150 FT along Fort Weaver Road at the south portion of the project. It should be noted that the predicted increases in the noise contour setback distances are the result of both project and non-project traffic volume increases.

Future traffic noise levels were also calculated separately with and without the project traffic in CY 1991. The contributions of project and non-project traffic to the total noise

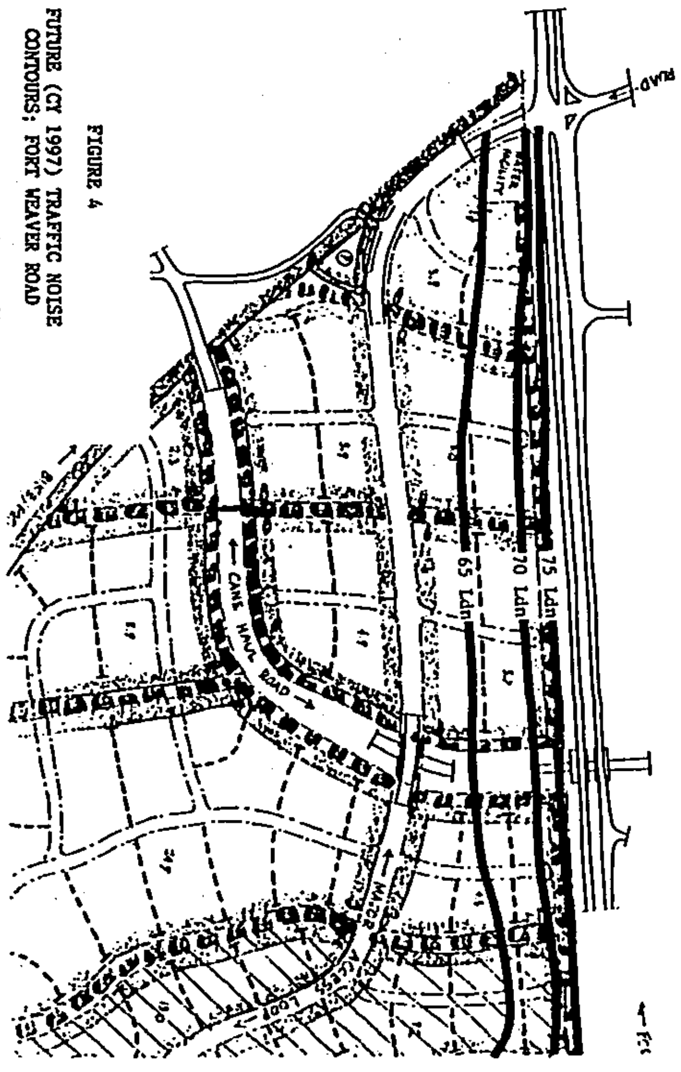

FIGURE 4

FUTURE (CY 1997) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

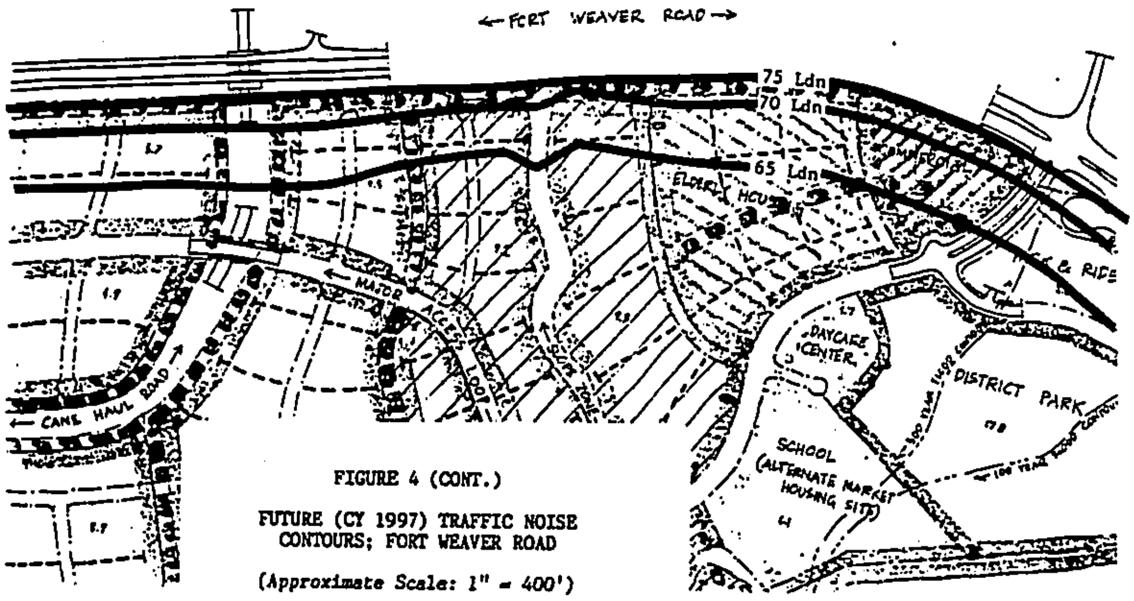

FIGURE 4 (CONT.)

FUTURE (CY 1997) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

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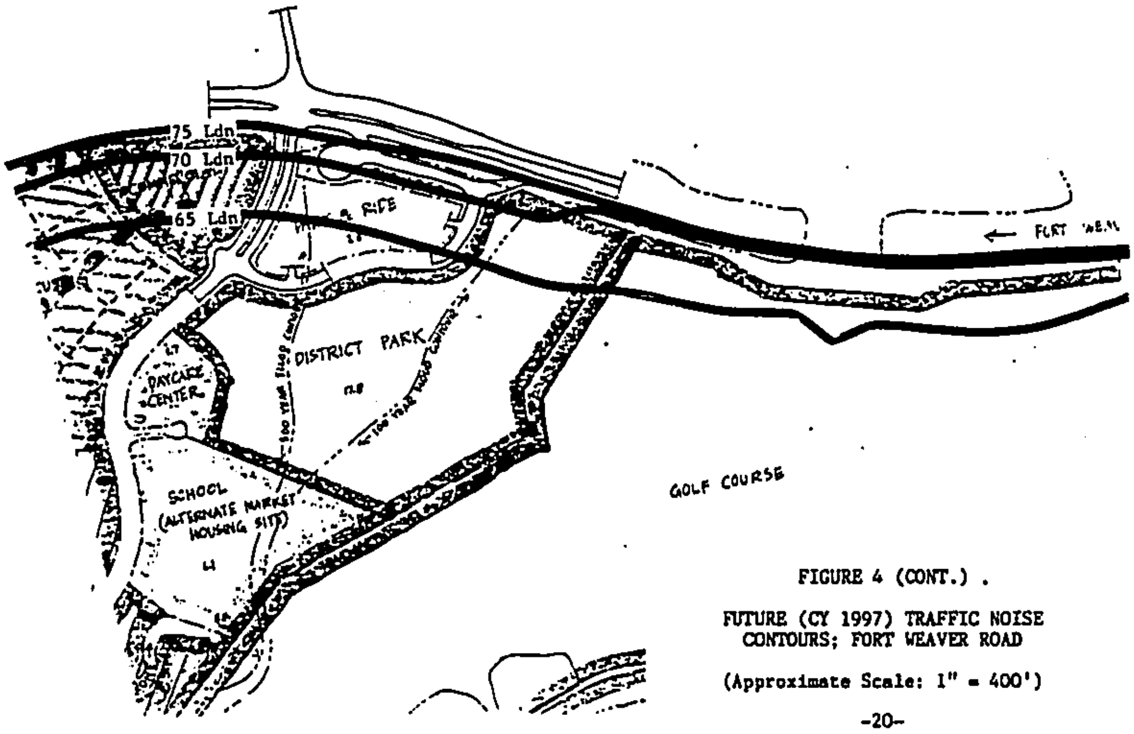

FIGURE 4 (CONT.) .

FUTURE (CY 1997) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

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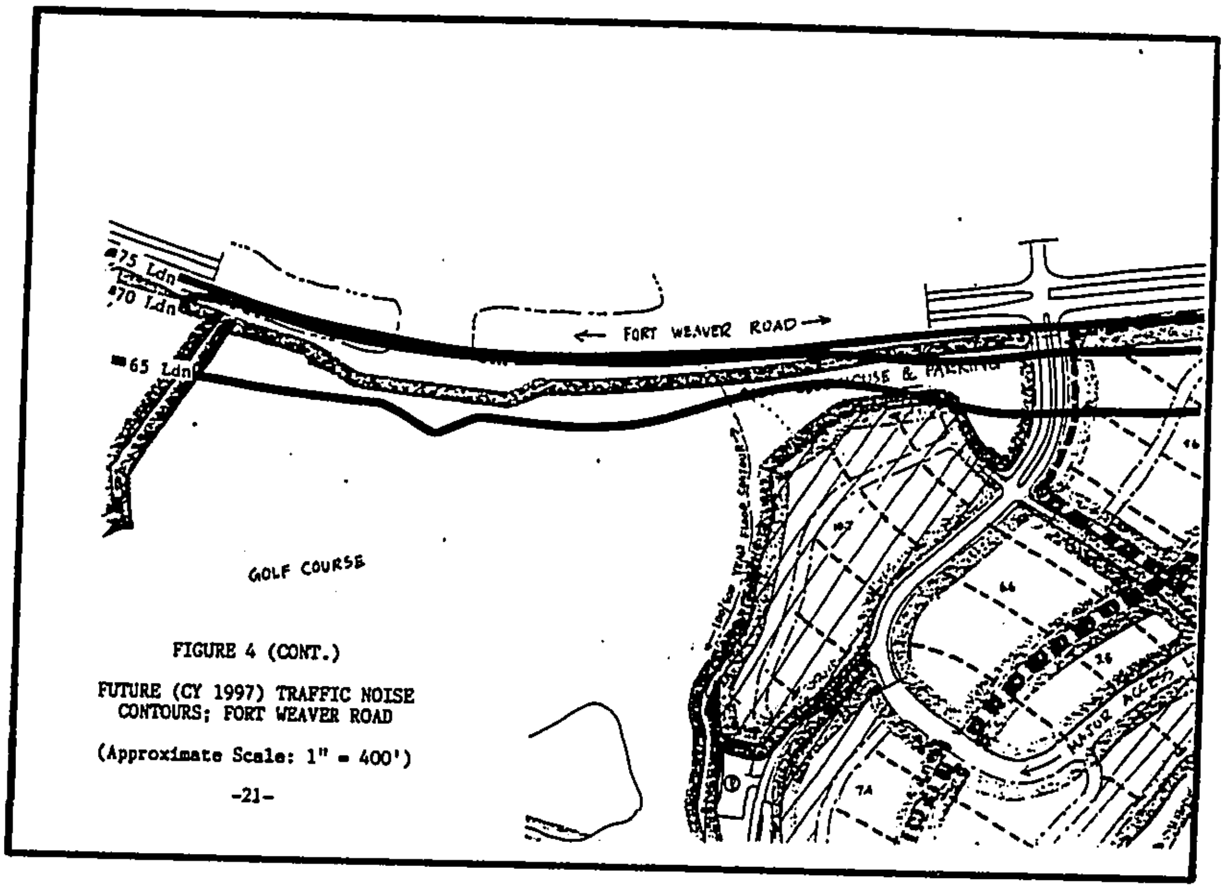

FIGURE 4 (CONT.)

FUTURE (CY 1997) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

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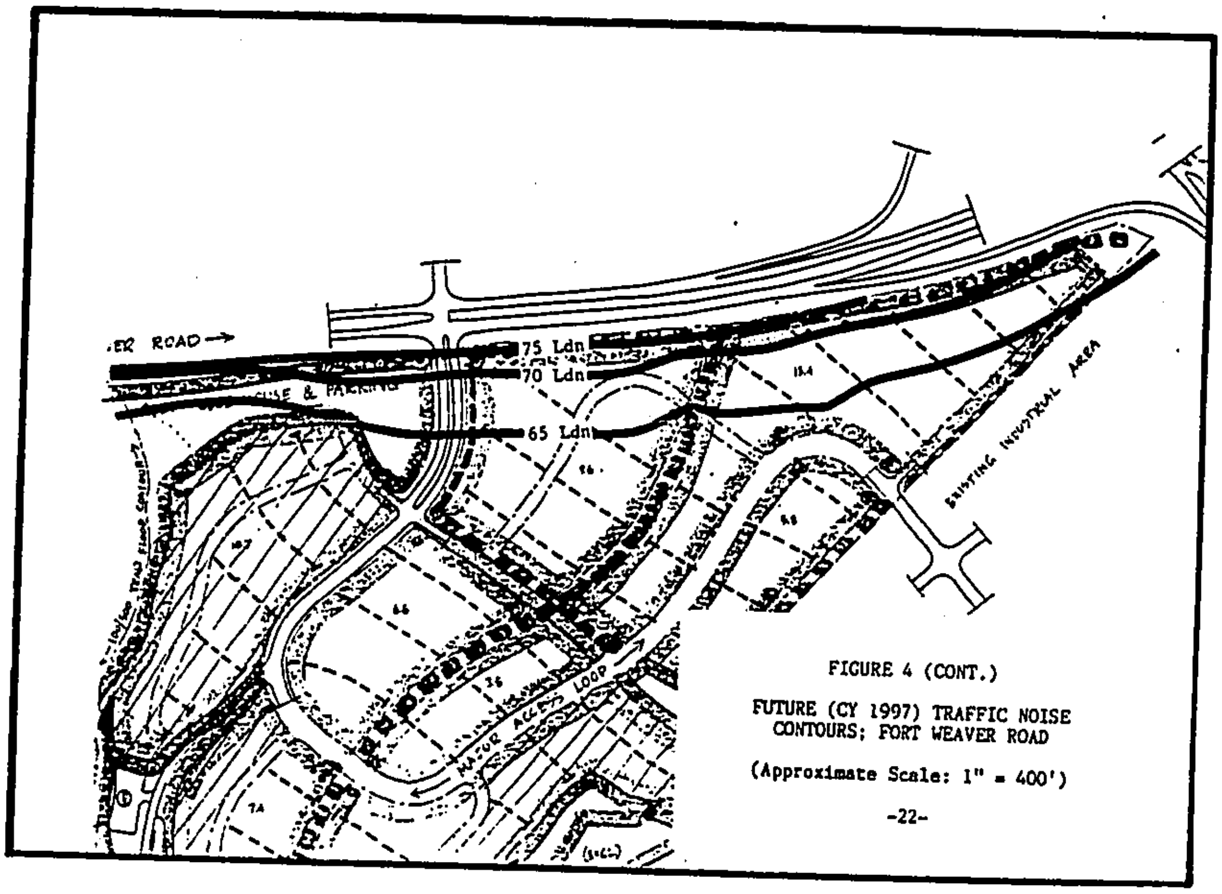

FIGURE 4 (CONT.)

FUTURE (CY 1997) TRAFFIC NOISE CONTOURS; FORT WEAVER ROAD

(Approximate Scale: 1" = 400')

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TABLE 3

COMPARISONS OF EXISTING AND FUTURE TRAFFIC NOISE LEVELS IN PROJECT ENVIRONS

LOCATION	SPEED (MPH)	VPH	*** HOURLY LEQ IN dB @ 100 FT. AUTO	MT	HT	ALL VEH.	DB INCREASE
YEAR 1987 PM PEAK HOUR TRAFFIC:							
Ft. Weaver Rd. (North)	50	2,083	66.3	60.4	64.8	69.3	
Ft. Weaver Rd. (Center)	50	2,083	66.3	60.4	64.8	69.3	
Ft. Weaver Rd. (South)	43	2,083	64.5	58.9	63.9	67.8	
Ft. Weaver Rd. (To EB)	35	1,826	61.4	56.2	62.0	65.3	
PROJECTED 1997 PM PEAK HOUR TRAFFIC:							
Ft. Weaver Rd. (North)	50	5,320	70.4	64.5	68.9	73.3	4.1
Ft. Weaver Rd. (Center)	50	5,320	70.4	64.5	68.9	73.3	4.1
Ft. Weaver Rd. (South)	43	4,995	68.3	62.7	67.7	71.6	3.8
Ft. Weaver Rd. (To EB)	35	4,837	65.6	60.4	66.2	69.5	4.2

Notes:

1. Assumed traffic mix of 96% Autos, 2% Medium Trucks, and 2% Heavy Trucks.
2. Soft ground conditions and 180 degree field-of-view assumed.
3. North Section is from Farrington Hwy. to proposed Road "A"; Center Section is from proposed Roads "A" to "B"; South Section is from proposed Road "B" to Arizona Rd., and EB Section is from Arizona Rd. toward Ewa Beach.
4. Average speeds vary from 50 MPH to 35 MPH along South Section from Road "B" to Arizona Road.

TABLE 4

EXISTING AND FUTURE DISTANCES TO 60, 65, AND 70 Ldn CONTOURS

STREET SECTION	60 Ldn SETBACK (FT) EXISTING	60 Ldn SETBACK (FT) FUTURE	65 Ldn SETBACK (FT) EXISTING	65 Ldn SETBACK (FT) FUTURE	70 Ldn SETBACK(FT) EXISTING	70 Ldn SETBACK(FT) FUTURE
Ft. Weaver Rd. (North)	505	944	235	438	109	203
Ft. Weaver Rd. (Center)	505	944	235	438	109	203
Ft. Weaver Rd. (South)	403	723	187	335	87	156
Ft. Weaver Rd. (To EB)	275	526	128	244	59	113

Notes:

1. All setback distances are to the roadway centerline.
2. Setback distances are for unobstructed line-of-sight conditions.
3. Computed Ldn equal to PM Peak Hour Leq(h) plus 1.3 dB.

TABLE 5

SUMMARY OF TRAFFIC NOISE INCREASES ASSOCIATED WITH PROJECT AND NON-PROJECT TRAFFIC
CY 1991

ROADWAY SECTION	** PM PEAK HR VOLUME (VPH) ** WITHOUT PROJECT	WITH PROJECT	**** PM PEAK HR Leq (dB) **** WITHOUT PROJECT	WITH PROJECT	*** INCREASE IN dB ** NON-PROJECT	PROJECT
Ft. Weaver Rd. (North)	3,502	4,752	71.5	72.8	2.3	1.3
Ft. Weaver Rd. (Center)	3,261	4,354	71.2	72.5	2.0	1.3
Ft. Weaver Rd. (South)	3,261	3,719	69.8	70.3	2.0	0.5
Ft. Weaver Rd. (To EB)	3,042	3,329	67.5	67.9	2.2	0.4

Notes:

1. All noise levels computed at 100 FT setback distance from centerline of Ft. Weaver Road.
2. See TABLE 3 for assumptions used in traffic noise predictions.

(project plus non-project) levels were calculated. TABLE 5 presents the anticipated increases in traffic noise levels, and the contribution of project traffic to these increases. As indicated in TABLE 5, increases in traffic noise levels associated with project traffic are predicted to range from 0.4 to 1.3 Ldn by CY 1991. The greatest increases in project related traffic noise are predicted to occur along the north portions of Fort Weaver Road, and are expected to be in the order of 1.3 Ldn. Relatively insignificant increases of 0.5 Ldn are expected along the south portions of Fort Weaver Road as a result of project traffic. Non-project traffic noise increases along the north and south sections of the roadway are predicted to be greater at 2.3 Ldn and 2.2 Ldn, respectively.

Along the internal circulation roadways of the proposed subdivision, traffic noise levels should not exceed FHWA or FHA/HUD criteria at 87 FT setback distance (from the roadway centerline) for the projected maximum PM peak hour volume of 1,028 VPH and at an average speed of 35 MPH or less. Corresponding minimum setback distances for internal streets with PM peak hour volumes of 700, 500, and 250 VPH are 67, 54 and 34 FT, respectively.

VI. DISCUSSION OF FUTURE NOISE IMPACTS

Without noise mitigation measures, future traffic noise levels are expected to be in the "Significant Exposure, Normally Unacceptable" noise exposure category along the first row of West Loch Estates house lots which front Fort Weaver Road. If development of West Loch residences within the future 65 Ldn contour (see FIGURE 4) is necessary due to the difficulties in achieving adequate setback distances, adverse noise impacts on future residents are expected to occur.

Unavoidable traffic noise impacts are predicted to occur in the form of increased traffic noise along all sections of Fort Weaver Road as a result of project and non-project traffic. By CY 1997, traffic noise levels at existing homes and at the Hale O Ulu School are predicted to increase by approximately 3.8 Ldn to 4.2 Ldn above existing levels, which are significant. Project related traffic noise contributions to these increases are anticipated range from 0.4 to 1.3 Ldn. Growth in non-project traffic are predicted to contribute 2.8 to 3.8 Ldn to the total increases in noise along Fort Weaver Road. Traffic noise increases associated with the West Loch Estates Subdivision project are predicted to represent 10% and 32% of the total increases predicted along the south and north sections, respectively, of Fort Weaver Road by CY 1997. This degree of project contribution to future increases in traffic noise are considered to be moderate to insignificant. The major contributor to the expected increases in traffic noise at existing noise sensitive properties south of the proposed "Road B" intersection is non-project traffic.

VII. POSSIBLE NOISE MITIGATION MEASURES

The results of this noise study indicate that sufficient setback distances do not exist to meet FHA/HUD noise criteria at the proposed Phase I and Phase II residential lots which front Fort Weaver Road. Minimum barrier heights of 6 to 9 FT will probably be required along the east highway Right-of-Way to reduce future traffic noise levels below 65 Ldn. If two story homes are located within 65 Ldn contour of FIGURE 4, the upper level spaces will not be adequately shielded by a 6 to 9 FT high wall, and the use of other mitigation measures, such as air conditioning of affected rooms or the installation of window sound attenuators, may be employed.

TABLE 6 is a summary of probable top elevations and locations of the required sound attenuation barrier segments. The barrier segments are located on the Diamond Head side of Fort Weaver Road, with start and end points keyed to the highway station numbers (see As-Built plans for Fort Weaver Road). For example, the first barrier segment, which is approximately parallel to the roadway from Station 94+00 to Station 95+00, should be between 160 to 155 FT ("Y-START" and "Y-END") east of the roadway centerline, and should have an average top elevation of 74.5 FT. Sections of sound attenuation barrier are required from STA 94+00 to STA 112+00, and from STA 152+00 to STA 195+00. The top elevations shown for each barrier segment were computed so as to meet the 65 Ldn FHA/HUD standard for the first row of single story homes east of the barrier. The indicated top elevations should be confirmed following completion of the lot grading plans, and prior to actual construction. Earth berms, concrete block or rock walls, or combination berms plus walls are acceptable methods of implementing the sound barriers. In order to minimize traffic noise reflections toward the west and across the highway, the sound absorption or scattering characteristics of the walls should be maximized. The use of lava rock, the avoidance of painting or sealing the pores (on the side facing the highway) of a concrete

TABLE 6

LOCATION OF POSSIBLE SOUND ATTENUATION BARRIERS
(EAST SIDE OF FORT WEAVER ROAD)

START STA. NO.	END STA. NO.	Y-START (FT)	Y-END (FT)	AVE. TOP ELEV.(FT)
94+00	95+00	-170	-165	74.5
95+00	96+00	-165	-160	74.5
96+00	97+00	-160	-155	74.8
97+00	98+00	-155	-145	75.0
98+00	99+00	-145	-135	75.3
99+00	100+00	-135	-125	75.3
100+00	101+00	-125	-125	75.8
101+00	102+00	-125	-125	75.5
102+00	103+00	-125	-125	74.8
103+00	104+00	-125	-125	73.3
104+00	105+00	-125	-125	70.0
105+00	106+00	-125	-125	67.5
106+00	107+00	-125	-125	66.5
107+00	108+00	-125	-125	66.0
108+00	109+00	-125	-125	65.5
109+00	110+00	-125	-125	64.3
110+00	111+00	-125	-125	63.0
111+00	111+50	-125	-125	62.3
111+50	112+00	-125	-125	62.3
152+00	153+00	-100	-100	27.1
153+00	154+00	-100	-100	28.4
154+00	155+00	-100	-100	29.0
155+00	156+00	-100	-100	29.2
156+00	157+00	-100	-100	29.7
157+00	158+00	-100	-100	30.5
158+00	159+00	-100	-100	30.0
159+00	160+00	-100	-100	29.6
160+00	161+00	-100	-100	29.6
161+00	162+00	-100	-100	29.3
162+00	163+00	-100	-100	29.4
163+00	164+00	-100	-100	29.4
164+00	165+00	-100	-100	29.7
165+00	166+00	-100	-100	39.4
166+00	167+00	-100	-100	56.5
167+00	168+00	-100	-100	63.5
168+00	169+00	-100	-100	61.7
169+00	170+00	-100	-100	59.6
170+00	171+00	-100	-100	57.8
171+00	172+00	-100	-100	58.5
172+00	173+00	-100	-100	57.9
173+00	174+00	-100	-100	57.8
174+00	175+00	-100	-80	57.8
175+00	176+00	-80	-80	57.6
176+00	177+00	-80	-100	61.0

TABLE 6 (CONTINUED)

LOCATION OF POSSIBLE SOUND ATTENUATION BARRIERS
(EAST SIDE OF FORT WEAVER ROAD)

START STA. NO.	END STA. NO.	Y-START (FT)	Y-END (FT)	AVE. TOP ELEV.(FT)
177+00	178+00	-100	-100	61.8
178+00	179+00	-100	-100	61.3
179+00	180+00	-100	-100	60.0
180+00	181+05	-100	-100	59.0
181+00	182+00	-100	-100	57.8
182+00	183+00	-100	-100	56.5
183+00	184+00	-100	-100	54.5
184+00	185+00	-100	-100	51.8
185+00	186+00	-100	-100	49.0
186+00	187+00	-100	-100	45.8
187+00	188+00	-100	-100	45.0
188+00	189+00	-100	-100	47.5
189+00	190+00	-100	-100	50.5
190+00	191+00	-100	-100	50.4
191+00	192+00	-100	-100	50.4
192+00	193+00	-100	-100	50.3
193+00	194+00	-100	-100	49.5
194+00	195+00	-100	-100	49.3

block wall, the use of specially constructed, sound absorbent concrete blocks, and the use of foliage to visually screen the wall from the highway are possible methods of increasing the sound absorption or scattering characteristics of the wall.

If two-story homes are constructed within the 65 to 70 Ldn contours of FIGURE 4, the use of sound attenuating windows at the upper floor is the recommended mitigation measure. The first floor should be adequately shielded by the sound barrier described previously. Examples of sound attenuation windows are at Kalakaua Homes on Oahu, and at the Skill Village and Hale Noho Subdivisions on Maui.

A. REFERENCES

(1) Barry, T. and J. Reagan; "FHWA Highway Traffic Noise Prediction Model," FHWA-RD-77-108; Federal Highway Administration; Washington, D.C.; December 1978.

(2) Existing, CY 1991, and CY 1997 PM Peak Hour traffic volumes at the Fort Weaver Road intersections in the project area; draft transmittal from Pacific Planning & Engineering, Inc.; September 9, 1987

(3) Hawaii State Department of Transportation; 24-Hour Traffic Counts; Station C-10-H, New Fort Weaver Road at Honouliuli Bridge; January 20-21, 1986.

(4) Hawaii State Department of Transportation; 24-Hour Traffic Counts; Station C-10-J, New Fort Weaver Road at Farrington Highway; January 20-21, 1986.

(5) "Guidelines for Considering Noise in Land Use Planning and Control;" Federal Interagency Committee on Urban Noise; June, 1980.

(6) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B;" U.S. Department of Housing and Urban Development; July 12, 1979.

(7) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety;" Environmental Protection Agency, EPA 550/9-74-004; March, 1974.

(8) American National Standard, "Sound Level Descriptors for Determination of Compatible Land Use;" ANSI S3.23-1980; Acoustical Society of America; May 30, 1980.

BNA

APPENDIX B — TEXT

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the L_{Cdn} with the LAdn.

Although not included in the tables, it is also recommended that "L_{PN}" and "L_{EPN}" be used as symbols for perceived noise levels and effective perceived noise level, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

> The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, L_{eq}, is designated the "equivalent sound level". For L_d, L_n, and L_{dn}, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristic of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, dBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (L_{PN} was found to be 75 dB. L_{PN} = 75 dB.) This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighted Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

TABLE I: A-Weighted Recomended Descriptor List

	Term	Symbol
1.	A-Weighted Sound Level	L_A
2.	A-Weighted Sound Power Level	L_{WA}
3.	Maximum A-Weighted Sound Level	L_{max}
4.	Peak A-Weighted Sound Level	L_{Apk}
5.	Level Exceeded x% of the time	L_x
6.	Equivalent Sound Level	L_{eq}
7.	Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8.	Day Sound Level	L_d
9.	Night Sound Level	L_n
10.	Day-Night Sound Level	L_{dn}
11.	Yearly Day-Night Sound Level	$L_{dn(y)}$
12.	Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine.)

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APPENDIX B (CONTINUED)

TABLE II: Recommended Descriptor List

	TERM	A-WEIGHTING	ALTERNATIVE(1) A-WEIGHTING	OTHER WEIGHTING (2)	UNWEIGHTED
1.	Sound (Pressure) (3) Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2.	Sound Power Level	L_{WA}		L_{WB}	L_W
3.	Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4.	Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5.	Level Exceeded x% of the time	L_x	L_{Ax}	L_{Bx}	L_{px}
6.	Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7.	Equivalent Sound Level Over Time(T) (4)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8.	Day Sound Level	L_d	L_{Ad}	L_{Bd}	L_{pd}
9.	Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10.	Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11.	Yearly Day-Night Sound Level	$L_{dn(y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12.	Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13.	Energy Average value over (non-time domain) set of observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14.	Level exceeded x% of the total set of (non-time domain) observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15.	Average L_x value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown.. Applies also to C,D,E,..... weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified as $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine)).

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HOUR	SPEED (MPH)	VPH	% AUTOS	% MT	% HT	*** HOURLY LEQ IN AUTO			100 FT. ALL VEH
0000-0100	50	215	98.0	1.0	1.0	56.5	47.6	52.0	58.2
0100-0200	50	122	98.0	1.0	1.0	54.1	45.1	49.5	55.8
0200-0300	50	84	98.0	1.0	1.0	52.5	43.5	47.9	54.1
0300-0400	50	73	98.0	1.0	1.0	51.8	42.9	47.3	53.5
0400-0500	50	237	98.0	1.0	1.0	57.0	48.0	52.4	58.7
0500-0600	50	1,134	96.0	2.0	2.0	63.7	57.8	62.2	66.6
0600-0700	50	1,766	96.0	2.0	2.0	65.6	59.7	64.1	68.5
0700-0800	50	1,874	96.0	2.0	2.0	65.9	60.0	64.4	68.8
0800-0900	50	1,151	96.0	2.0	2.0	63.7	57.9	62.3	66.7
0900-1000	50	1,339	96.0	2.0	2.0	64.4	58.5	62.9	67.3
1000-1100	50	1,318	96.0	2.0	2.0	64.3	58.4	62.8	67.3
1100-1200	50	1,317	96.0	2.0	2.0	64.3	58.4	62.8	67.3
1200-1300	50	1,371	96.0	2.0	2.0	64.5	58.6	63.0	67.4
1300-1400	50	1,418	96.0	2.0	2.0	64.6	58.8	63.2	67.6
1400-1500	50	1,650	96.0	2.0	2.0	65.3	59.4	63.8	68.2
1500-1600	50	1,903	96.0	2.0	2.0	65.9	60.0	64.4	68.9
1600-1700	50	1,686	96.0	2.0	2.0	65.4	59.5	63.9	68.3
1700-1800	50	1,591	96.0	2.0	2.0	65.1	59.3	63.7	68.1
1800-1900	50	1,379	96.0	2.0	2.0	64.5	58.6	63.0	67.5
1900-2000	50	1,025	96.0	2.0	2.0	63.2	57.4	61.8	66.2
2000-2100	50	799	96.0	2.0	2.0	62.2	56.3	60.7	65.1
2100-2200	50	699	96.0	2.0	2.0	61.6	55.7	60.1	64.5
2200-2300	50	506	98.0	1.0	1.0	60.3	51.3	55.7	61.9
2300-2400	50	360	98.0	1.0	1.0	58.8	49.8	54.2	60.5

TOTAL VPD: 25,017 LDN @ 50 FT: LDN @ 100 FT: 70.2

STA:C-10-J, NEW FORT WEAVER ROAD AT FAR. HWY, TWO-WAY TRAFFIC (1/20-21/86)

APPENDIX C. WORKSHEET #1

APPENDIX D

Air Quality Impact Report
West Loch Estates

by

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Kailua, Hawaii

September 28, 1987

AIR QUALITY IMPACT REPORT

WEST LOCH ESTATES

September 28, 1987

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WEST LOCH ESTATES

1. INTRODUCTION

West Loch Estates is a two-phase residential development being proposed for construction on some 232 acres of sugarcane lands along Fort Weaver Road in the Ewa District of Oahu. Phase I calls for the completion of 586 homes by 1991 while Phase II includes an additional 914 dwellings by 1997.

The purpose of this report is to assess the impact of the proposed development on air quality both on a local and regional basis. The overall project is clearly an "indirect source" of air pollution as defined in the federal Clean Air Act [1] since its primary association with air pollution is due to its inherent generation of mobile source, i.e., motor vehicle activity. Much of the focus of this analysis therefore is on the project's ability to generate traffic and the resultant impact on air quality. Air quality impact was evaluated for existing (1987) and future (1991 & 1997) conditions.

Residential projects such as this also has off-site impacts due to increased demand for electrical energy which must be met through the combustion of some type of fuel. Disposal of the refuse generated by the residents will also result in offsite impact as it will most probably be burned in the City's proposed resource recovery facility. Both of these combustion processes result in pollutant emissions to the air which have been addressed.

Finally, during construction of the various buildings and facilities air pollutant emissions will be generated due to vehicular movement, grading and general dust-generating construction activities. These impacts have also been addressed.

2. AIR QUALITY STANDARDS

A summary of State of Hawaii and national ambient air quality standards is presented in Table 1 [2, 3]. Note that Hawaii's standards are not divided into primary and secondary standards as are the federal standards.

Primary standards are intended to protect public health with an adequate margin of safety while secondary standards are intended to protect public welfare through the prevention of damage to soils, water, vegetation, man-made materials, animals, wildlife, visibility, climate, and economic values [4].

Some of Hawaii's standards are clearly more stringent than their federal counterparts but, like their federal counterparts, may be

exceeded once per year. It should also be noted that in April, 1986, the Governor signed amendments to Chapter 59 (Ambient Air Quality Standards) making the state's standards for particulate matter and sulfur dioxide the same as national standards. In the case of particulate matter, however, this uniformity did not last long. On July 1, 1987, the EPA revised the federal particulate standard to apply only to particles 10 microns or less in diameter (PM-10) [5], leaving the state once again with standards different than the federal ones.

In the case of the automotive pollutants [carbon monoxide (CO), oxides of nitrogen (NOx), and photochemical oxidants (Ox)], there are only primary standards. Until 1983, there was also a hydrocarbons standard which was based on the precursor role hydrocarbons play in the formation of photochemical oxidants rather than any unique toxicological effect they had at ambient levels. The hydrocarbons standard was formally eliminated in January, 1983 [6].

The U.S. Environmental Protection Agency (EPA) is mandated by Congress to periodically review and re-evaluate the federal standards in light of new research findings [7]. The last review resulted in the relaxation of the oxidant standard from 160 to 240 micrograms/cubic meter (ug/m3) [8]. The carbon monoxide (CO), particulate matter, sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) standards are currently under review, but final action has not been taken yet [9].

Finally, the State of Hawaii also has fugitive dust regulations for particulate matter (PM) emanating from construction activities [10]. There simply can be no visible emissions from fugitive dust sources.

3. EXISTING AIR QUALITY

The two nearest State Department of Health air monitoring stations to the project area are located at the Campbell Industrial Park about 6 miles to the southwest and at Pearl City, some 4 miles to the northeast. The State Department of Health has monitored air quality at the park since 1971, and a summary of the data is presented in Table 2. Total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) were all monitored on a 24-hour basis. Initially, the site was at the Barbers Point Lighthouse, but the proximity to the ocean resulted in very high TSP levels due to salt spray. The station was therefore moved to the Chevron Refinery site about 1.7 kilometers north of the lighthouse on March 17, 1972. In 1976, NO_2 monitoring was ceased. On August 7, 1979, the monitoring station was moved to a rooftop location at the same Chevron site.

It should also be noted that total suspended particulate monitoring with a high-volume sampler was ceased at the site in October, 1985. In November, 1985, a new PM-10 sampler was installed. This instrument measures respirable particulate matter under 10 microns in aerodynamic diameter. PM-10 and SO2 monitoring data for 1986 are summarized in Table 3. Table 4 lists PM-10 and TSP data at the Pearl City site for calendar year 1986.

It is evident from the data in Tables 2, 3 and 4 that both the National Ambient Air Quality Standards (NAAQS) and Hawaii Ambient Air Quality Standards (HAAQS) are being met at those monitoring sites.

Because the Campbell Industrial Park monitoring station is situated relatively close to the elevated sources, i.e., the stacks, located at the industrial park, the data collected may not be representative of the highest ambient pollutant levels resulting from the various industrial sources at the park. Computer modeling done in conjunction with the City's resource recovery facility permitting indicated maximum SO2 concentrations occurring some 1.0 to 1.5 kilometers north of the park in the flat terrain as well as on the hillsides also north of the park [11].

Unfortunately, there are no routine monitoring data for the primary automotive pollutant, i.e., carbon monoxide. The nearest CO monitoring site is at the Department of Health building in downtown Honolulu some 11 miles east-southeast of the project area. Because the area is presently at an early stage of development, it can be surmised that present CO levels are also relatively low.

A spot sampling of carbon monoxide concentrations along Fort Weaver Road was conducted during two recent a.m. peak hour traffic periods as part of this impact analysis. The results were as follows:

Location	Date/Time	NAS Barbers Point Wind Direction	NAS Barbers Point Wind Speed	1-Hour CO Concentration
10 m east of Fort Weaver Road at eastbound H-1 on-ramp of Kunia Interchange	17 Sep 87 Thursday 6 - 7 am	NE	3-5 kts	3.4 mg/m3
10 m east of Fort Weaver Road near Project Access Road "A"	22 Sep 87 Tuesday 6 - 7 am	W	2-7 kts	2.8 mg/m3

It should be noted that during the September 17, 1987 sampling the monitoring instrument was located upwind of the Fort Weaver Road traffic due to the light northeasterly winds; thus, the low CO levels being measured were due to vehicles operating on the H-1 freeway upwind (northeast) of the sampling site.

During the September 22, 1987 sampling, onsite winds were very light and at times calm. During the calm periods, CO concentrations leveled off at about 1.0 - 1.5 mg/m3.

4. CLIMATE & METEOROLOGY

Weather conditions in the project area are typical of sites located on the leeward coast of Oahu. Long-term climatic data collected at Barbers Point Naval Air Station indicate mean daily maximum and minimum temperatures of 81 and 69 degrees Fahrenheit, respectively; mean annual rainfall of 20.3 inches; and prevailing winds from the northeast at 9 knots [12]. Annual rainfall is of interest because of its role in particulate matter removal from the atmosphere, while wind speed and direction are determinants of pollutant concentration and potential receptors, respectively. Atmospheric stability is another important factor in determining the potential for air pollution problems. It is largely a function of insolation and wind speed, and an objective methodology for determining it has been developed by Turner [13].

Historical data from Honolulu International Airport were reviewed and indicated a seasonal variation in wind direction. This winter-summer disparity is clearly shown in Figures 1 and 2 which depict January and August wind roses.

Historical meteorological data from Barbers Point NAS which had been processed using the Turner method were also reviewed [14,15,16]. They confirmed the annual predominance of northeasterly trade winds, but also indicated a significant occurrence of onshore winds primarily associated with a midday seabreeze regime. A screening of the 1967 - 71 Barbers Point surface observations indicated SE to SW winds occurred 643 - 1,032 hours per year. This is equivalent to 6.5 - 11.8% of the time.

Secondly, they indicate that almost 25% of the time slightly to moderately unstable conditions exist. Such conditions are conducive to bringing smoke plumes from elevated sources, e.g., smoke stacks, down to the ground within a relatively short distance downwind. Somewhat surprisingly, the data also show a very significant percentage (45%) of stable air conditions which tend to carry plumes largely intact for great distances. Such conditions can result in high pollutant concentrations if the plume reaches hills which are at approximately the same height as the stack. Such stable conditions can also contribute to high pollutant concentrations if they coincide with peak traffic hours because automotive pollutants are emitted close to the ground.

5. MOBILE SOURCE IMPACT

5.1 Mobile Source Activity. A traffic impact report was prepared for the proposed development and served as the basis for this mobile source impact analysis [17]. Existing and projected p.m. peak-hour volumes for 1991 and 1997 at the following intersections with Fort Weaver Road were provided:

- Project Access Road "A"
- Project Access Road "B"
- Renton Road

Average daily hour-by-hour distributions for 1985 and 1997 were also provided. Morning peak-hour volumes were estimated based on the a.m. peak/ADT and p.m. peak/ADT ratios. A 6:00 - 7:00 a.m. traffic count made during the September 22, 1987 CO sampling indicated northbound traffic on Fort Weaver Road at 1327 vph and southbound at 591 vph which was consistent with the estimates.

5.2 Mobile Source Emission Factors. Carbon monoxide (CO) emission factors for vehicles were generated using the MOBILE-3 emissions model [18]. The emission factors were localized by use of the age distribution of registered vehicles in the City & County of Honolulu [19]. Fraction of vehicle miles travelled (VMT) was assumed to be directly proportional to the registration distribution. Emission factors were based on traffic speeds ranging from 10 - 40 mph depending on the volumes on each leg of the intersections. Intersections were assumed to be signalized with green/cycle ratios proportional to approach demands. Queue lengths and emission strengths at intersection approachs were determined by an EPA method [20].

5.3 Modeling Methodology. While emissions burden analysis is one means of evaluating a project's impact, it is generally more important to estimate the ambient impact since air quality standards are expressed as ambient concentrations, and it is the ambient concentrations to which living things are exposed. Computer modeling is normally employed to generate these ambient concentration estimates, most commonly with non-reactive pollutants. This is due to the complexity of modeling pollutants

which undergo chemical reactions in the atmosphere and are subject to the effects of numerous physical and chemical factors which affect reaction rates and products. For projects involving motor vehicles as the principal air air pollution source, carbon monoxide is normally selected for modeling because it has a relatively long half-life in the atmosphere (about 1 month) [21], and it comprises the largest fraction of automotive emissions.

The EPA guideline model CALINE-3 [22,23] was employed to estimate maximum 1-hour CO concentrations at receptor locations 10 - 40 meters from the intersection during the worst-case AM peak hour traffic. Worst-case meteorological conditions were selected accordingly.

Because of the time of day of the analysis (AM peak hour), the currently low level of urbanization in the area which would otherwise contribute to a "heat island" effect and increased turbulence, a stable atmosphere (Pasquill-Gifford Class "F") [24] and 1 meter per second (m/sec) wind speed were assumed as worst case meteorological conditions. A background CO level of 1.0 milligrams/cubic meter (mg/m3) was also assumed to account for the existing low level of traffic activity.

Preliminary modeling with 15, 45, 70, 80, and 90 degree wind-road angles with Fort Weaver Road indicated that the 15 degree angle would produce the maximum pollutant concentrations; thus, this angle was input to the CALINE-3 model. Specifically, due to the traffic volumes and predicted queuing, north-northwest winds direction were used for the "worst-case" analysis. In subsequent runs, north-northeast winds (yielding similar wind/road angles) were used because of their greater frequency.

5.4 Results: 1-Hour Concentrations. The results of the modeling for existing conditions are presented in Figures 3 - 5 for the three intersections under study. It is evident that both state and federal 1-hour CO standards appear to be met even under "worst-case" conditions of traffic, meteorology, and receptor location. The modeling results are also of the same magnitude as the CO sampling data collected on September 17 and 22, 1987 during a.m. peak-hour traffic.

Figures 6 through 8 depict the predicted CO concentrations at the intersections in 1991 if the proposed project were not built. The results suggest that the State's 1-hour CO standard of 10 mg/m3 may be exceeded, but the federal standard (40 mg/m3) would not. Note that the possible exceedance occurs within 10 meters of the roadway, and that concentrations drop off rather sharply with distance from the intersection.

The modeling results for the 1991 "with project" scenario are presented in Figures 9 through 11. The possibility of exceedances of the State standard out to 40 meters from the intersection is indicated. Again, however, the federal standard still appears to be met.

In 1997 with the project, predicted CO levels again show possible exceedances of the State standard, but only at the Road "A" and Road "B" intersections (Figures 12 and 13). Concentrations in the Renton Road area appear to have dropped back below the standard (Figure 14).

5.5 Results: 8-Hour Concentrations. Estimates of 8-hour concentrations can be derived by applying a "persistence" factor of 0.6 to the 1-hour concentrations. This "persistence" factor is recommended in an EPA publication on indirect source analysis [24] and has been further corroborated by analysis of carbon monoxide monitoring data in Honolulu which yielded the same 8-hour-to-1-hour ratio [25]. When using this approach any 1-hour CO concentration greater than 8.4 mg/m3 would indicate exceedance of the State's 8-hour standard. Similarly, any 1-hour concentration over 16.7 mg/m3 would indicate exceedance of the federal 8-hour standard.

Applying this factor to the 1-hour results indicates compliance with federal (10 mg/m3) and state (5 mg/m3) 8-hour standards under existing conditions. Violations of the State's standard, however, are indicated for 1991 and 1997 both with and without the project. For the "with project" scenarios in 1991 and 1997, exceedance of the federal standard also appears possible.

5.6 Correlation with Meteorological Data. In light of the high CO levels predicted for the intersections under study, a more detailed analysis of the Barbers Point meteorological data was undertaken in order to estimate the frequency of occurrence of those high concentrations. First, five years (1967-71) of meteorological data were screened for the occurrence of "worst-case" conditions, i.e., NNW (330 - 360 degrees) winds at 1 m/sec in a stable atmosphere (Pasquill-Gifford Category "F"), during the 6:00 - 8:00 a.m. period. None were found. A total of three hours out of the five years had similar conditions except 1.5 m/sec wind speed.

Next, the highest 1-hour CO scenario (Figure 10) was rerun with less stable conditions (Categories "E" and "D") in order to see if standards exceedances still showed up. The results of this modeling are depicted in Figures 15 and 16. The predicted concentrations are less than the "worst-case" levels but still indicate exceedance of the State 1- and 8-hour standards.

The meteorological data were again screened, this time for the frequency of 1 m/sec NNW winds and "E" and "D" stability. In two

of the five years, there were two hours for "E" stability and one hour for "D" during the specified morning hours. Again, the frequency of occurrence was very low.

Given knowledge of the greater frequency of NE winds in Hawaii, a modeling run was made with 1 m/sec NE (45 degrees) winds and "F" stability. The results in Figure 17 indicate exceedance of the State 1-hour standard and imply exceedance of the State and federal 8-hour standards. The high concentrations, however, do not appear to extend as far from the roadway as under the NNW wind conditions.

A screening of the 1971 and 1984 Barbers Point wind data indicated the following frequencies of 1 m/sec NE (30 - 60 degrees) winds and "F" stability:

	1971		1984	
Hour	Number of Occurrences	Annual Frequency	Number of Occurrences	Annual Frequency
6:00 am	10	2.74%	23	6.3%
7:00 am	10	2.74	14	3.8
8:00 am	3	0.82	0	0.0
Total:	23	6.3%	37	10.1%

Finally, wind data for the September - December, 1984 and January - February, 1985 period were manually screened in an effort to identify the "worst-case" 8-hour period. These months were selected because of the predominance of trade winds during the other months of the year and the greater likelihood of lower wind velocities during the Fall and Winter seasons. Because of the hourly traffic volume distribution along Fort Weaver Road, the screening focused on the 6:00 a.m. to 2:00 p.m. period. The screening criteria included:

- low wind speed
- consistent wind direction
- atmospheric stability

Three days (4 Sep 84, 26 Nov 84, and 4 Jan 85) were selected as offering the greatest promise of maximum 8-hour CO concentrations. All three days tended to have low velocity, predominantly NE winds with high stability (Class "F") in the early hours followed by neutral stability (Class "D") during the rest of the period. Most of the rejected days had either changes in wind direction in mid-morning due to onset of the seabreeze regime or simply higher wind speeds.

The hourly meteorological and traffic data for these three 8-hour periods was combined with the "worst-case" year (1991) and intersection (Road "B") and run in the CALINE-3 model. The results are presented in Table 5. The highest concentration, 7.3 mg/m3, indicates exceedance of the state but not the federal 8-hour standard.

5.7 In-Vehicle CO Levels. It should also be noted that operators and passengers can be exposed to levels of carbon monoxide inside vehicles significantly higher than that indicated by the microscale ambient air quality impact analysis. This exposure is, of course, exacerbated as congestion increases. When volume capacity ratios reach the 0.90 - 1.0 range and service levels drop to E and F, this occurs. With vehicles at idle or very low speed, CO emissions increase sharply and the occupants of vehicles are delayed in traffic; thus, for both reasons their CO exposure increases sharply. Unfortunately, there is currently no standardized modeling technique to estimate this exposure. In this particular instance, these conditions might occur during portions of a commute trip to Honolulu.

Carbon monoxide measurements were made during one such commute on September 22, 1987. The trip originated in the vicinity of Road "A" along Fort Weaver Road, proceeded to the H-1 eastbound on-ramp, then east on the H-1 to the Vineyard Street off-ramp, and terminated in the vicinity of the Cultural Plaza on North Kukui Street. The commute began at 7:30 a.m. and thus was near the end of the normal peak traffic period. The total trip time was 33 minutes and the average CO level in the vehicle was 12.8 mg/m3. This is comparable to levels found during a previous study of a.m. peak hour commutes along the Pali Highway [26].

6. STATIONARY SOURCE IMPACT

6.1 Electrical Generation. The estimated 10.8 million kilowatt hours of annual electrical demand by the ultimate development will necessitate the generation of electricity by power plants. Currently, most of Oahu's electrical energy is generated at Hawaiian Electric Company's Kahe Power Station located near Nanakuli on the leeward coast. This is currently a six-unit, approximately 650-megawatt facility firing low-sulfur fuel oil. A seventh 150-megawat unit has been recently proposed [27], and in the future some units may fire a coal-derived fuel, but for

the purposes of this analysis, oil-firing was assumed. Estimates of annual emissions were computed based on EPA emission factors and the fuel required to meet a 10.8 million KWhr demand. The results are presented in Table 6.

6.2 Solid Waste Disposal. The refuse generated by the residents of the 1,500 new homes in West Loch Estates will require disposal. Presently, about 80% of Oahu's refuse is being landfilled with the remaining 20% being burned at the Waipahu Incinerator [28]. In the future, most refuse will be burned at the City's proposed resource recovery facility. Estimates of annual emissions attributable to the combustion of West Loch Estates refuse at that facility are included in Table 6.

7. OTHER LONG-TERM IMPACTS

7.1 Agricultural Burning. Burning of sugar cane fields prior to harvest is a long-standing practice in Hawaii's sugar industry. Unfortunately for industry, however, as urbanization closes in around agricultural operations, it is inevitable that complaints about air pollution will arise. Cane fires result in the emission of particulates, carbon monoxide, and trace amounts of other organics. This was most recently demonstrated in an EPA study of cane burning on Maui [29]. Concentrations of particulates can reach high levels within about one mile of the fires [30]. A complete quantitative characterization of cane smoke, however, has yet to be performed. Fortunately, fires are generally infrequent and only last about 20 - 30 minutes.

7.2 Campbell Industrial Park. The industrial sources at Campbell Industrial Park obviously affect air quality in the Ewa area. The maximum concentrations of total suspended particulates (TSP) and sulfur dioxide, however, are in compliance with existing federal and state air quality standards. Neither monitoring nor computer modeling show violations of the current standards. Historically, there has been a problem meeting the State's TSP standard, and even with adoption of the less stringent federal standards, this may continue to be a problem as levels in the past have on occasion even exceeded those standards. As noted in Section 2, the state and federal particulate standards are once again different and while recent monitoring data indicate that the federal PM-10 standard is being met, the state TSP standard continues to be threatened.

SO2 standards are being gradually approached as new sources come in and existing sources expand. The impending construction of the City's resource recovery facility and the future construction of other as yet unidentified sources in the industrial park will all contribute additional increments of regulated and unregulated pollutants to the Ewa air. The responsible government agencies will have to watch the situation closely to insure that standards continue to be complied with.

8. SHORT-TERM IMPACT

The principal source of short-term air quality impact will be construction activity. Construction vehicle activity will increase automotive pollutant concentrations along Port Weaver road as well as in the vicinity of the project site itself. Because of the moderate existing off-peak traffic volumes, the additional construction vehicle traffic should not exceed road capacities although the presence of large trucks can reduce a roadway's capacity as well as lower average travel speeds.

The site preparation and earth moving will create particulate emissions as will building and on-site road construction. Construction vehicles movement on unpaved on-site roads will also generate particulate emissions. EPA studies on fugitive dust emissions from construction sites indicate that about 1.2 tons/acre per month of activity may be expected under conditions of medium activity, moderate soil silt content (30%), and a precipitation/evaporation (P/E) index of 50 [31,32].

The principal soil type in the project area is a Honouliuli clay with a silt content of about 30%. The precipitation/evaporation (P/E) Index for the area is 39. Compared to the EPA estimates and conditions, it would appear that there is a somewhat greater potential for fugitive dust due to the drier local climate, i.e., P/E Index of 39 versus 50.

9. DISCUSSION AND CONCLUSIONS

9.1 Mobile Source Impacts.

The presence of project-generated traffic will clearly increase the probability that state 1-hour and 8-hour CO standards will be exceeded within 40 meters of Port Weaver Road by 1991 and later. Due to the federal motor vehicle control program [33], ambient levels could decline by 1997 and beyond unless offset by additional traffic generated by more residential development.

Exceedance of the federal 1-hour CO standard does not seem likely, but there appears to be a non-zero probability that the 8-hour standard could be exceeded in close proximity (within 20 meters) of Port Weaver Road. Whether or not there will be a simultaneous occurrence of human exposure within that distance and timeframe will depend on the nature of development in the area.

9.2 Stationary Source Impacts.

The emissions estimates may be compared to the 1980 county emissions inventory in Table 7 in order to provide some perspective on their significance. The project's contribution to county emissions appears to be less than 1%.

9.3 Other Long-Term Impacts. As noted in Section 7, there will be at times exposure to the smoke from agricultural field burning. Until urbanization entirely replaces sugar cane cultivation in the Ewa District, this will result in some human exposure and complaints about cane fire smoke. The State Department of Health and federal EPA have indicated that they are continuing efforts to better characterize the exposure and potential health effects [34]. Depending on the results of those efforts, the smoke exposure may be reduced or eliminated before cane cultivation ceases in Ewa.

In the case of industrial air pollution sources at Campbell Industrial Park, the likelihood of those sources significantly affecting West Loch Estates seems rather low given the distance (about 7 miles) and low frequency of winds which would carry source emissions toward the development. A screening of the 1967-71 wind data from Barbers Point indicated about 0.5 - 1% of the time winds were heading from the industrial park towards West Loch Estates.

9.4 Short-Term Impacts. Since as noted in Section 8, there is a potential for fugitive dust due to the dry climate and fine soils, it will be important for adequate dust control measures to be employed during the construction period. Dust control could be accomplished through frequent watering of unpaved roads and areas of exposed soil. The EPA estimates that twice daily watering can reduce fugitive dust emissions by as much as 50%. The soonest possible landscaping of completed areas will also help.

9.5 Conclusions. Based on the foregoing analysis, the following conclusions may be drawn:

- The proposed project will result in increased air pollutant emissions due to its inherent traffic generation ability, and its requirement for electrical power and solid waste disposal;

- The addition of project-related traffic will increase the probability of exceedances of state 1-hour and 8-hour carbon monoxide standards within 40 meters of Port Weaver Road by 1991 and later;

- Project-related traffic will also contribute to the small probability that the federal 8-hour carbon monoxide standard will be exceeded within 20 meters of Fort Weaver Road;
- Annual emissions of criteria pollutants due to electrical generation and solid waste disposal attributable to West Loch Estates will increase county emissions by less than 0.1%; and
- Due to the relatively dry climate and fine soils in the area, dust control measures during construction will be important to prevent violations of state fugitive dust standards.

9.6 Mitigation Measures. The principal means available to reduce the predicted CO concentrations are:

- improve intersections to increase capacity
- increase bus service to area
- encourage car-pooling
- modify business/school starting hours
- develop mass transit system
- restrict residential development

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T A B L E S

TABLE 1

SUMMARY OF STATE OF HAWAII AND FEDERAL
AMBIENT AIR QUALITY STANDARDS

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

TABLE 2

AIR MONITORING DATA
CAMPBELL INDUSTRIAL PARK
1971-85

	TSP			SO_2			NO_2		
YEAR	RANGE	MEAN	>AQS	RANGE	MEAN	>AQS	RANGE	MEAN	>AQS
1971	18-471	125	54	<5-16	<5	0	<20-49	29	0
1972	24-155	55	4	<5- 7	<5	0	<20-49	21	0
1973	14-129	50	1	<5-5	<5	0	<20-33	<20	0
1974	23-132	47	1	<5-10	<5	0	<20-40	25	0
1975	13-137	52	1	<5-11	<5	0	< 5-25	11	0
1976	12-101	40	1	<5-7	<5	0	< 5-29	14	0
1977	25-134	54	1	<5-18	<5	0	------	--	-
1978	22-127	48	1	<5-40	<5	0	------	--	-
1979	23-223	76	10	<5-27	<5	0	------	--	-
1980	29-158	53	2	<5-10	<5	0	------	--	-
1981	26-188	51	2	<5-40	<5	0	------	--	-
1982	15- 63	41	0	<5-12	<5	0	------	--	-
1983	28-193	--	2	<5-95	--	1	------	--	-
1984	17-112	50	1	<5-<5	<5	0	------	--	-
1985	24-138	57	3	<5-25	<5	0	------	--	-

NOTES:
1. TSP = total suspended particulates
2. SO2 = sulfur dioxide
3. NO2 = nitrogen dioxide
4. >AQS = number of violations of state air quality standard
5. All concentrations are in micrograms per cubic meter of air.
6. Sampling station was moved from Barbers Point Lighthouse to the Chevron Refinery site due to salt spray from the ocean on 17 March 1972.
7. The samplers were elevated to a rooftop on 7 August 1979.
8. Source: State Department of Health

TABLE 3

TSP & SO2 MONITORING DATA
BARBERS POINT, OAHU
1986

	Particulate Matter-10u (PM-10) 24-Hour Concentrations (ug/m3)				Sulfur Dioxide (SO2) 24-Hour Concentrations (ug/m3)			
MONTH	SAMPLES	MIN.	MAX.	MEAN	SAMPLES	MIN.	MAX.	MEAN
Jan 86	5	13	31	19	4	<5	<5	<5
Feb 86	4	21	40	27	4	<5	10	5
Mar 86	4	16	28	20	2	<5	<5	<5
Apr 86	4	27	31	28	5	<5	7	<5
May 86	5	19	20	24	5	<5	6	<5
Jun 86	3	18	42	31	5	<5	<5	<5
Jul 86	5	12	26	19	6	<5	<5	<5
Aug 86	3	24	35	29	5	<5	<5	<5
Sep 86	5	21	31	27	5	<5	<5	<5
Oct 86	5	17	43	28	5	<5	<5	<5
Nov 86	5	19	66	33	5	<5	<5	<5
Dec 86	4	7	40	24	5	<5	<5	<5
ANNUAL	52	7	66	26	56	<5	10	<5

SOURCE: Department of Health

TABLE 4

PM-10 & TSP MONITORING DATA
PEARL CITY, OAHU
1986

	Total Suspended Particulates (TSP) 24-Hour Concentrations (ug/m3)				Particulate Matter-10u (PM-10) 24-Hour Concentrations (ug/m3)			
MONTH	SAMPLES	MIN.	MAX.	MEAN	SAMPLES	MIN.	MAX.	MEAN
Jan 86	5	22	46	32	5	10	22	14
Feb 86	5	30	65	43	5	12	32	20
Mar 86	5	19	46	30	5	10	22	15
Apr 86	5	23	41	30	5	14	23	18
May 86	5	27	38	33	5	16	22	18
Jun 86	5	23	30	26	5	12	18	15
Jul 86	5	17	28	22	5	9	15	12
Aug 86	5	22	32	27	5	11	19	15
Sep 86	5	22	44	34	5	13	22	17
Oct 86	5	24	32	27	5	10	17	13
Nov 86	5	23	35	27	5	12	20	17
Dec 86	5	18	35	27	5	10	20	15
ANNUAL	60	17	65	30	60	9	32	16

SOURCE: Department of Health

TABLE 5

Estimates of Maximum 8-Hour Carbon Monoxide
Concentrations in the Vicinity of the Fort
Weaver Road - Road "B" Intersection
1991

Hours/ Receptor	Hourly CO Concentrations (mg/m3) 6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	8-hr Mean CO (mg/m3)
1	11.9	5.6	3.1	5.9	2.7	2.4	2.4	2.5	5.2*
2	8.5	3.2	2.2	4.5	2.1	1.8	2.4	2.4	3.9
3	5.6	2.6	1.7	3.8	1.7	1.6	2.3	2.4	3.1
4	3.8	2.5	1.6	3.1	1.5	1.4	2.0	2.3	2.6
5	13.9	8.1	4.1	6.1	3.7	2.9	1.9	2.1	6.1*
6	11.9	5.4	3.0	4.9	2.6	2.2	1.9	2.0	4.8
7	9.5	3.4	2.3	4.4	2.1	1.8	2.1	1.9	3.9
8	6.9	2.6	1.7	3.6	1.8	1.6	1.9	2.0	3.2
9	12.8	9.7	4.6	6.1	4.1	2.6	1.6	1.9	6.2*
10	12.5	7.6	3.6	5.1	3.2	2.5	1.7	1.7	5.4*
11	11.0	5.3	2.9	4.4	2.7	2.1	1.8	1.6	4.5
12	9.5	3.7	2.3	3.9	2.1	1.8	1.6	1.6	3.8

Meteorological data: 4 Jan 85

Hours/ Receptor	Hourly CO Concentrations (mg/m3) 6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	8-hr Mean CO (mg/m3)
1	7.2	4.5	4.7	5.0	3.8	3.4	1.0	3.4	4.7
2	4.2	3.4	3.4	3.6	2.8	2.3	1.0	2.6	3.3
3	3.1	3.3	2.7	2.8	2.3	1.9	1.0	2.1	2.7
4	3.0	3.2	2.1	2.5	1.9	1.7	1.0	1.8	2.5
5	10.9	6.3	5.5	5.7	3.9	3.8	1.0	3.5	5.8*
6	7.0	3.9	4.3	4.5	3.4	3.1	1.0	2.8	4.3
7	4.4	3.3	3.3	3.3	2.8	2.4	1.0	2.3	3.3
8	3.3	3.2	2.8	2.8	2.5	1.9	1.0	2.1	2.8
9	13.1	9.6	5.9	6.4	3.7	3.5	1.0	3.3	6.6*
10	10.1	5.3	4.7	5.0	3.5	3.2	1.0	2.8	5.1*
11	7.1	3.7	3.7	4.0	3.1	2.8	1.0	2.6	4.0
12	4.9	3.1	2.9	3.1	2.7	2.3	1.0	2.2	3.2

Meteorological data: 26 Nov 84

TABLE 5 (Con't)

Hours/ Receptor	Hourly CO Concentrations (mg/m3) 6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	8-hr Mean CO (mg/m3)
1	10.1	9.5	1.5	2.7	4.5	1.7	3.8	3.0	5.3*
2	5.6	5.3	1.4	2.1	3.8	1.4	3.7	2.4	3.7
3	4.2	4.1	1.3	1.9	3.2	1.4	3.7	2.1	3.1
4	3.9	3.9	1.2	1.5	3.1	1.4	3.7	1.7	2.9
5	15.5	14.5	1.5	2.8	4.0	2.1	3.1	2.7	6.6*
6	9.7	9.3	1.3	2.5	3.5	1.6	2.7	2.5	4.7
7	5.9	5.6	1.3	2.2	3.2	1.3	2.7	2.3	3.5
8	4.5	4.3	1.2	1.9	2.8	1.4	2.7	2.0	3.0
9	18.7	17.6	1.5	2.8	3.1	2.2	2.9	2.2	7.3*
10	14.2	13.4	1.3	2.4	2.9	1.8	2.5	2.3	5.8*
11	10.0	9.6	1.3	2.4	2.6	1.5	2.3	2.2	4.6
12	6.5	6.2	1.2	2.2	2.6	1.2	2.2	2.0	3.4

Meteorological data: 4 Sep 84

TABLE 6

Estimates of Annual Emissions Due to
Electrical Generation and Solid Waste Disposal
West Loch Estates, 1991-97

Pollutant	Emissions (T/Yr) Electrical Generation	Solid Waste Disposal
Sulfur dioxide	29.8	1.9
Nitrogen oxides	39.4	9.1
Particulate Matter	3.0	0.8
Carbon monoxide	1.9	8.0
Hydrocarbons	0.4	0.5

TABLE 7

1980 EMISSIONS INVENTORY

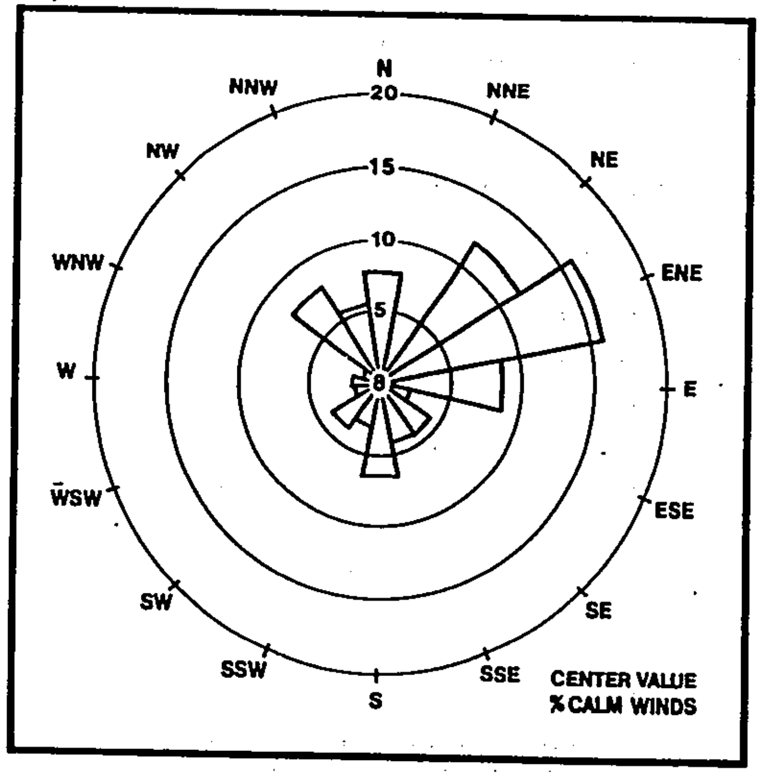
CITY & COUNTY OF HONOLULU

SOURCE CATEGORY	EMISSIONS (Tons/Year) TSP	SOx	NOx	CO	HC
Steam Electric Power Plants	2092.0	36736.5	12454.9	1065.5	184.5
Gas Utilities	14.1	0.0	199.0	0.0	0.0
Fuel Combustion in Agricultural Industry	1088.4	579.3	358.1	0.0	30.8
Refinery Industry	621.9	7096.3	2148.8	266.4	2583.7
Petroleum Storage	0.0	0.0	0.0	0.0	1261.1
Metallurgical Industries	28.3	96.5	39.8	0.0	0.0
Mineral Products Industry	6883.7	1882.7	596.9	0.0	30.8
Municipal Incineration	42.4	144.8	2029.4	0.0	184.5
Motor Vehicles	1413.5	1013.8	17269.7	239197.6	22853.2
Construction, Farm and Industrial Vehicles	183.8	193.1	2506.9	3729.1	338.3
Aircraft	381.6	144.8	1750.8	5593.7	1476.4
Vessels	42.4	386.2	437.7	532.7	123.0
Agricultural Field Burning	1399.4	0.0	0.0	15982.0	1691.7
TOTAL IN TONS PER YEAR:	14,192	48,274	39,792	266,367	30,758

F I G U R E S

FIGURE 1

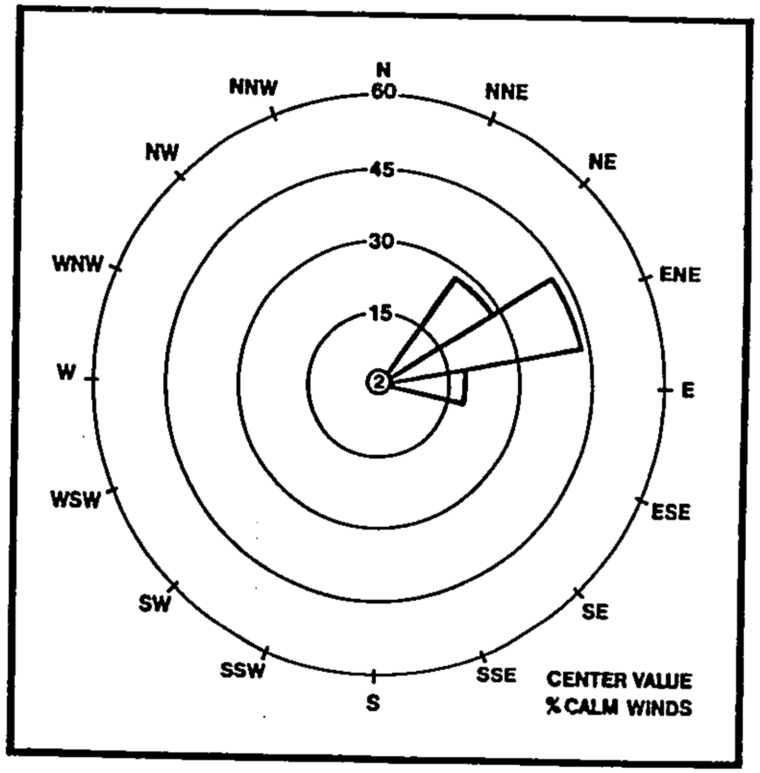
FREQUENCY DISTRIBUTION OF WIND DIRECTION IN PERCENTAGE
MONTH OF JANUARY
HONOLULU INTERNATIONAL AIRPORT



SOURCE: NATIONAL WEATHER SERVICE
RECORDS (1940-67)

FIGURE 2

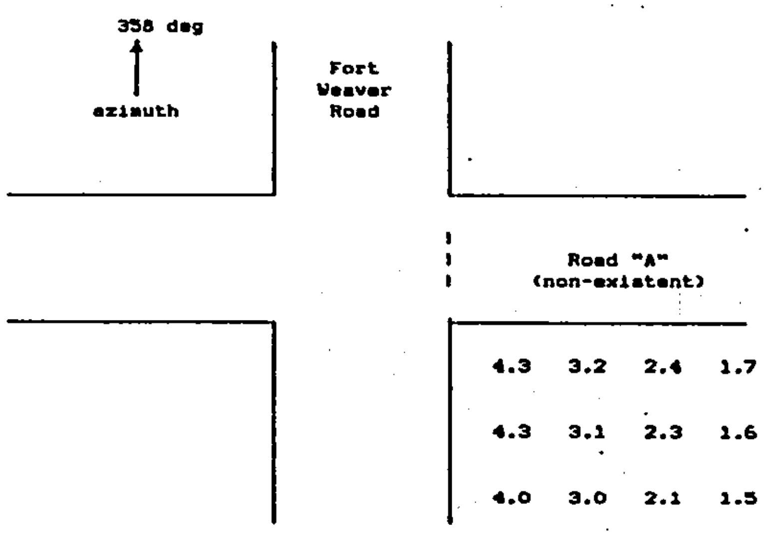
FREQUENCY DISTRIBUTION OF WIND DIRECTION IN PERCENTAGE
MONTH OF AUGUST
HONOLULU INTERNATIONAL AIRPORT



SOURCE: NATIONAL WEATHER SERVICE
RECORDS (1939-48, 1950-68)

FIGURE 3
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "A" (1987)

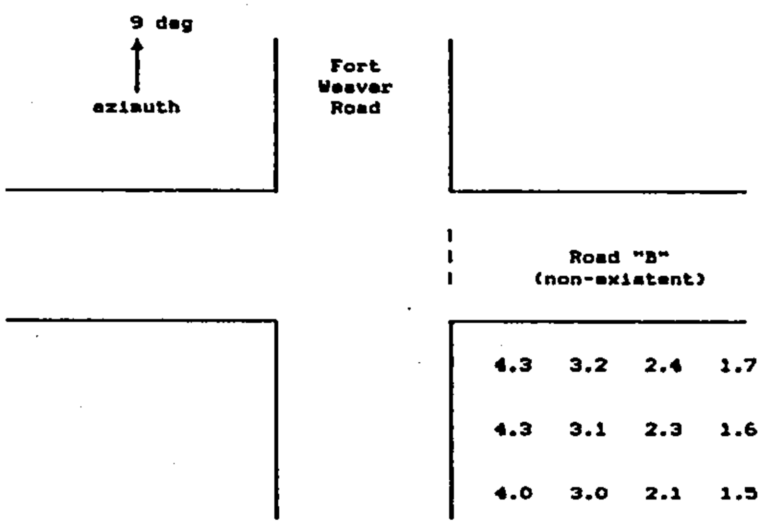


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 343 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 4
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "B" (1987)

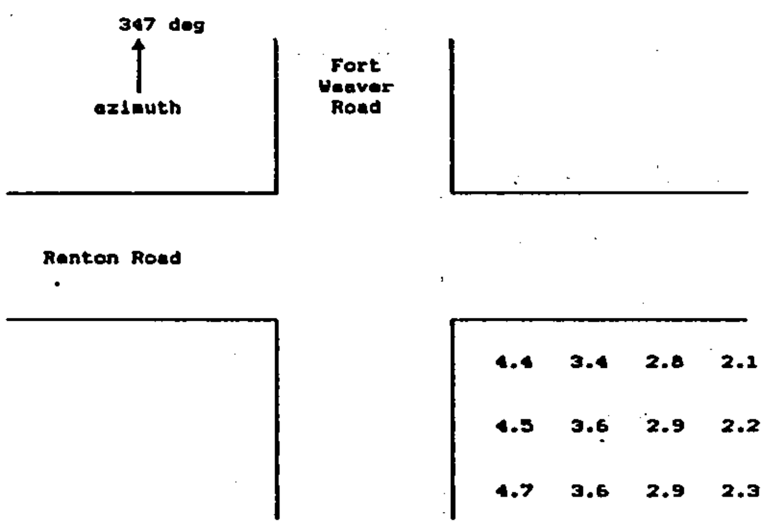


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 5
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT RENTON ROAD
AM-PEAK HOUR - RENTON ROAD (1987)

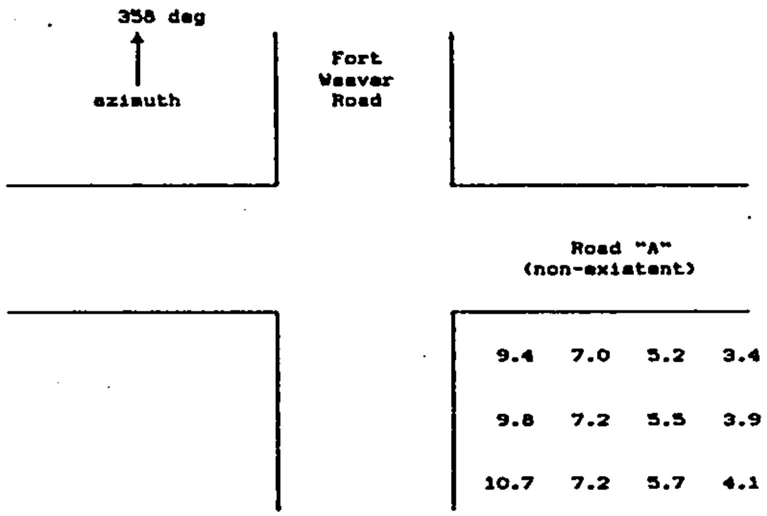


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 332 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 6
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "A" (1991 WITHOUT PROJECT)

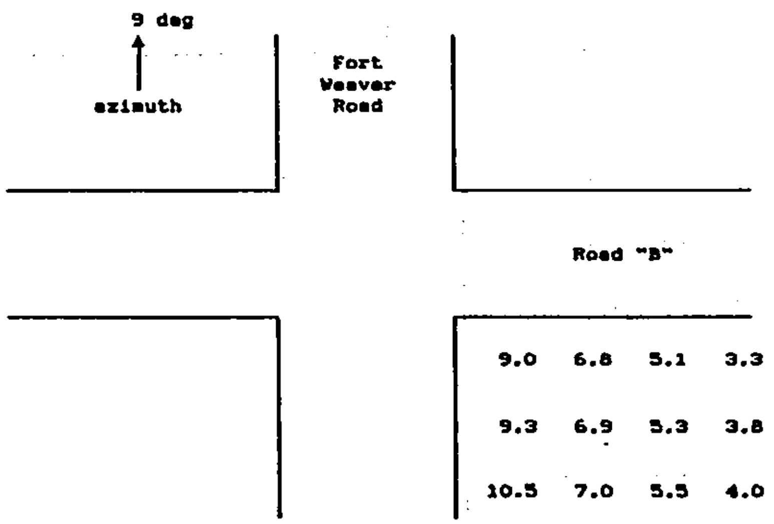


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 343 deg
Wind speed = 1 meter per seconxd (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 7
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "B" (1991 WITHOUT PROJECT)

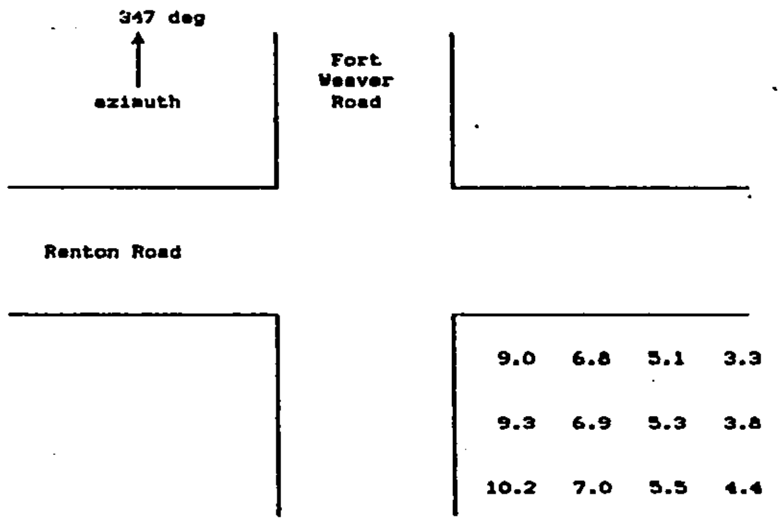


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 8
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT RENTON ROAD
AM-PEAK HOUR (1991 WITHOUT PROJECT)

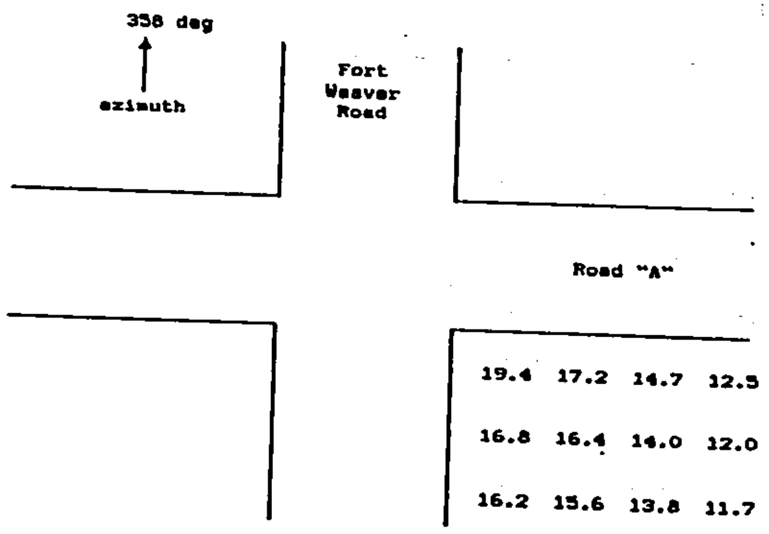


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 332 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 9
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "A" (1991 WITH PROJECT)

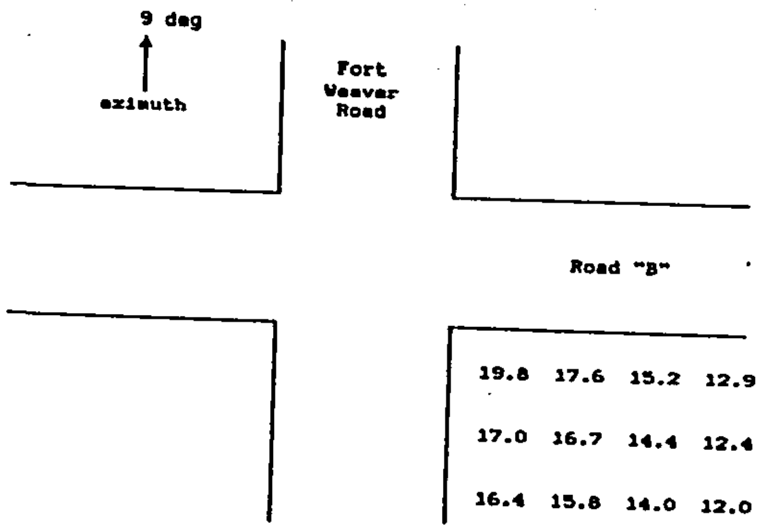


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 343 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 10
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "B" (1991 WITH PROJECT)

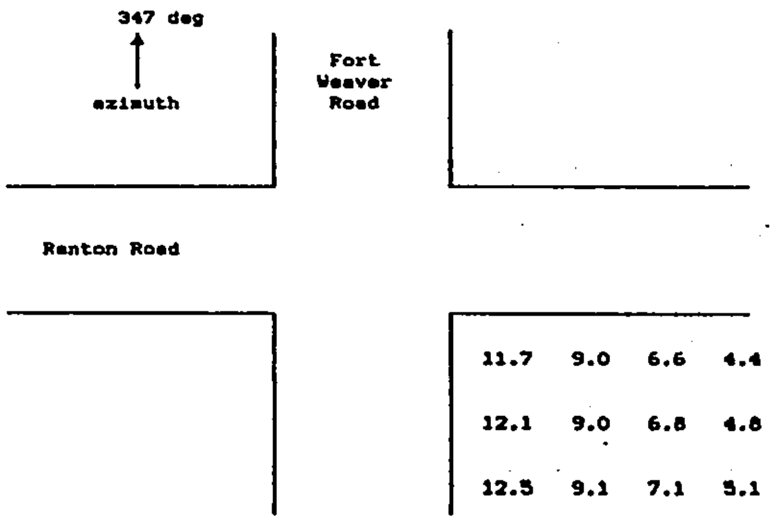


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 11
ESTIMATES OF MAXIMUM 1-HOUR CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT RENTON ROAD
AM-PEAK HOUR (1991 WITH PROJECT)

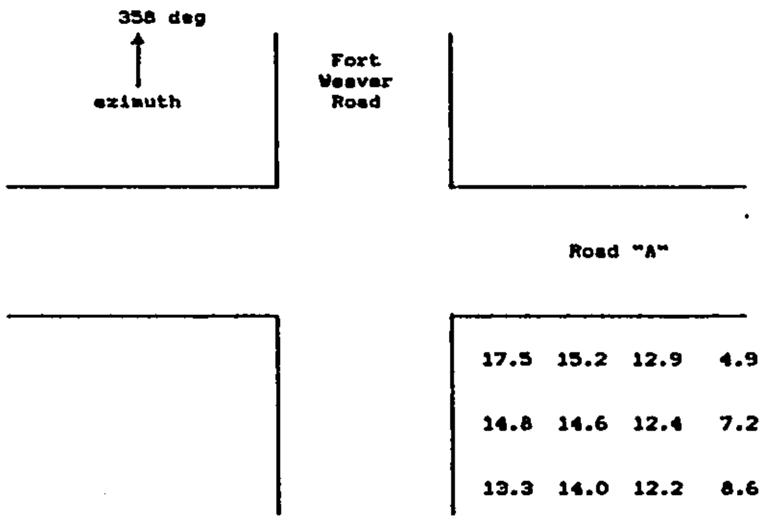


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 332 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 12
ESTIMATES OF MAXIMUM 1-HOUR CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "A" (1997 WITH PROJECT)

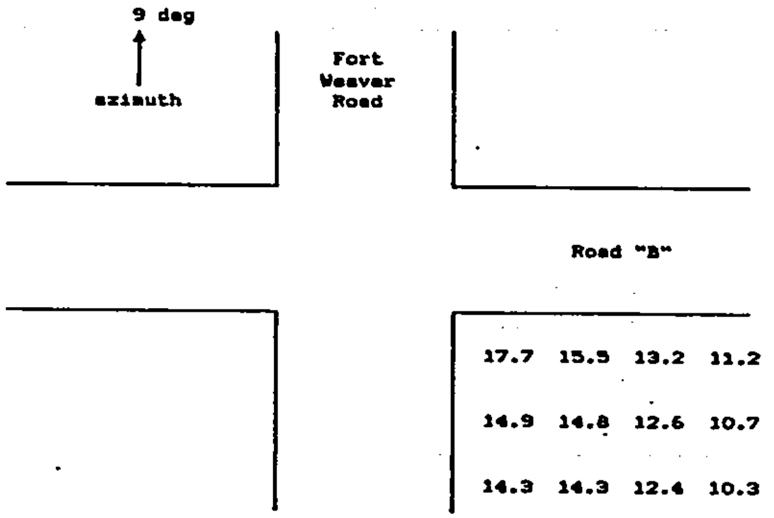


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 343 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 13
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR - ROAD "B" (1997 WITH PROJECT)

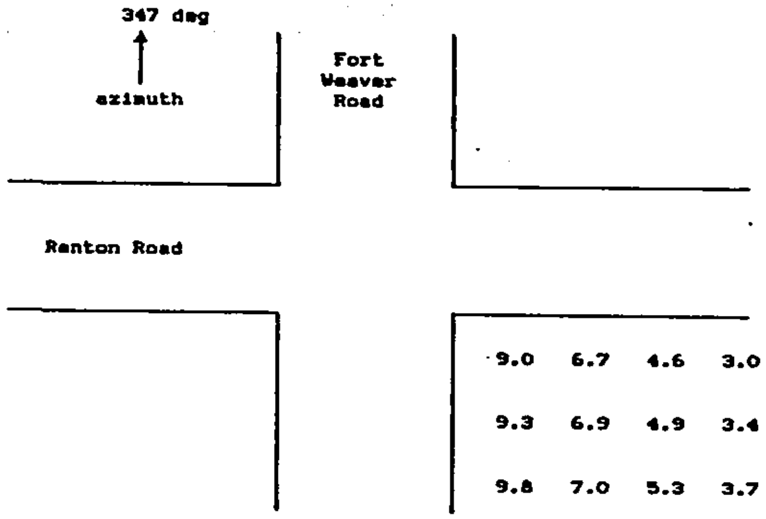


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 14
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT RENTON ROAD
AM-PEAK HOUR (1997 WITH PROJECT)

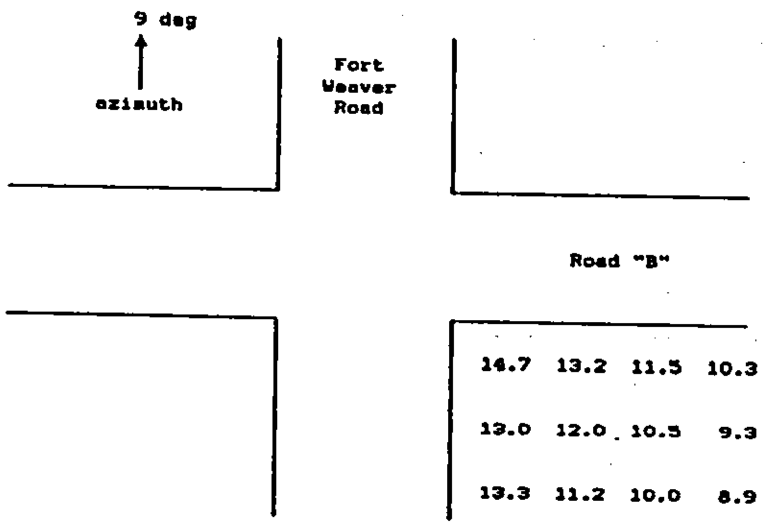


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 332 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 15
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR (1991 WITH PROJECT)
(STABILITY "E")

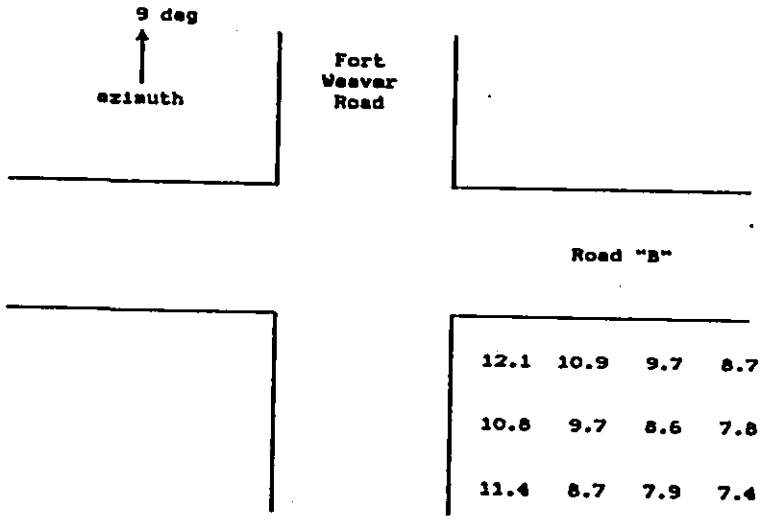


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "E" (P-G Class 5)
Background CO concentration = 1.0 mg/m3
Diffusibn model: CALINE-3
Emissions model: MOBILE-3

FIGURE 16
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR (1991 WITH PROJECT)
(STABILITY "D")

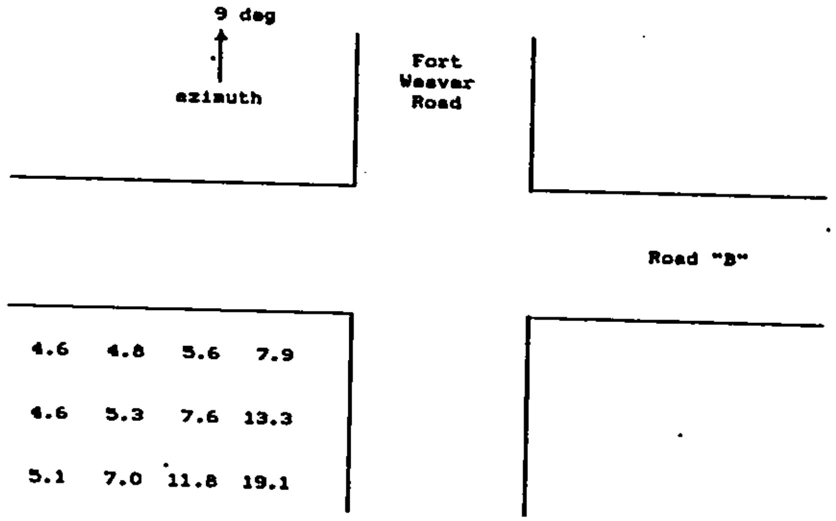


NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 354 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "D" (P-G Class 4)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

FIGURE 17
ESTIMATES OF MAXIMUM 1-HOUR
CARBON MONOXIDE CONCENTRATIONS

FORT WEAVER ROAD AT WEST LOCH ESTATES
AM-PEAK HOUR (1991 WITH PROJECT)
(NORTHEAST WIND)



NOTES

CO concentrations = milligrams per cubic meter (mg/m3)
Receptor spacing = 10 meters
Wind direction = 54 deg
Wind speed = 1 meter per second (m/s)
Atmospheric stability = "F" (P-G Class 6)
Background CO concentration = 1.0 mg/m3
Diffusion model: CALINE-3
Emissions model: MOBILE-3

<u>APPENDIX E</u>

Environmental Aspects of Storm Water Runoff
West Loch Estates
West Loch, Ewa, Oahu, Hawaii

By:

Gordon L. Dugan, Ph.D
Environmental Consultant

ENVIRONMENTAL ASPECTS OF STORM WATER RUNOFF

WEST LOCH ESTATES,
WEST LOCH, EWA, OAHU, HAWAII

November, 1987

by

Gordon L. Dugan, Ph.D.
Environmental Consultant

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INTRODUCTION

The proposed West Loch Estates Project, located adjacent to West Loch, Pearl Harbor, as shown in Figure 1, consists of four major components; two residential phases, a golf course and a shoreline park. Although all four components are proposed the municipal golf course and shoreline park are implicitly dependent upon the development of the residential components.

The separate components of the proposed project, as outlined in Figure 2, are positioned along Fort Weaver Road between its intersection with Farrington Highway to the north (mauka) and Fernandez Village to the south (ewa). The Waipahu Industrial area is located on the northeastern side of the Phase I Residential component.

The four major components cover an area of approximately 461 acres, of which 86 and 161 acres are Residential Phases 1 and 2, respectively, while 175 and 39 acres are respectively allocated to the municipal golf course and shoreline park. Residential Phase 1, the first portion of the proposed project to be developed, consists of 600 housing units and an 8 acre greenbelt area, while Residential Phase 2 includes 900 housing units, recreational space (23 acres); buffer areas and set backs (14 acres), a small commercial area (3.5 acres), and slightly more than 10 acres of land set aside for an elementary school, daycare center, and a ride and park area.

The land of the project site has been extensively modified during the past century, with sugarcane cultivation being the

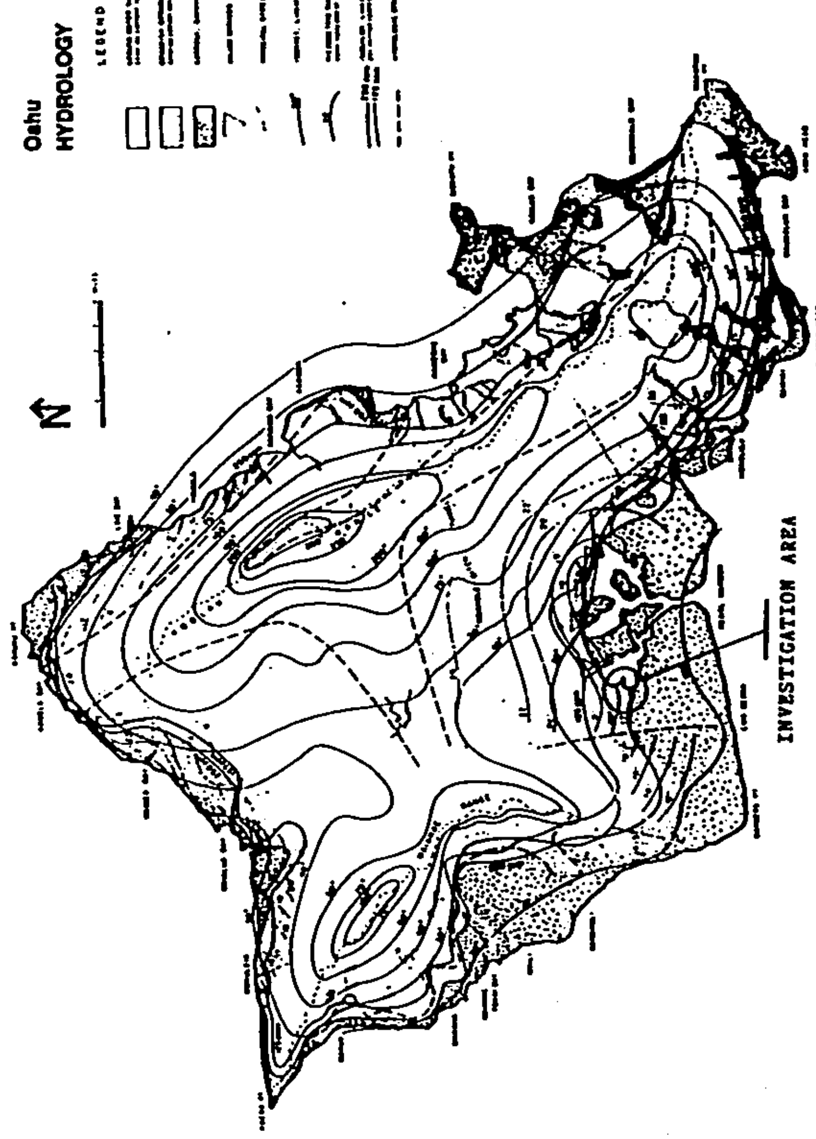

Figure 1. Hydrologic and Geologic Characteristics of Oahu

(Source: "2020 Plan," Board of Water Supply, City and County of Honolulu, 1971, page 13)

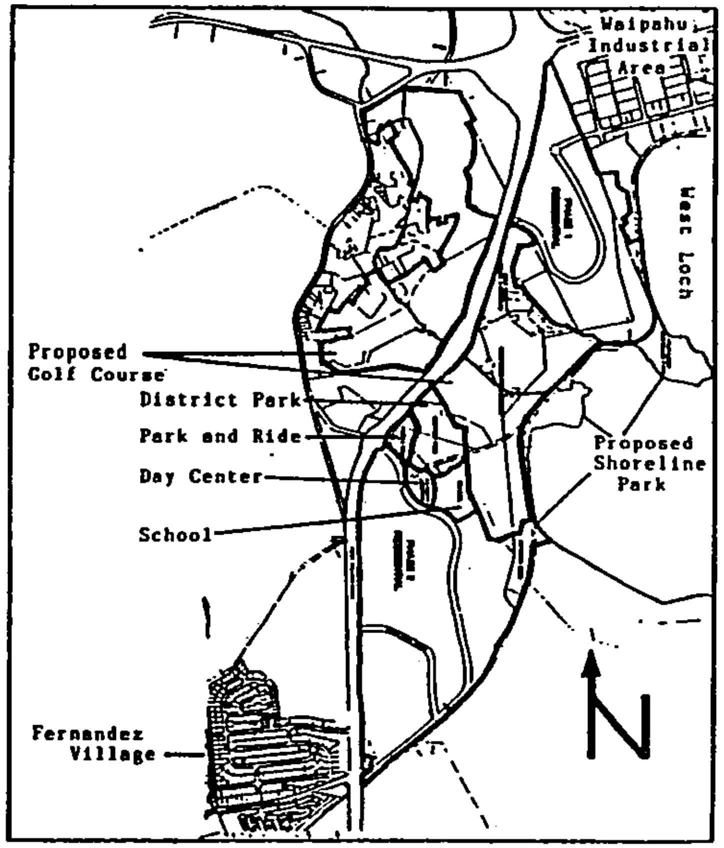

Figure 2. West Loch Estates Site Plan, West Loch, Ewa, Oahu

Source: Modified from Fig. 3, pg II-5 (Department of Housing and Community Planning, 1987) most prominent in recent years (Department of Housing and Community Planning). At the present time 135 acres of sugarcane are being cultivated* in the designated Phase 1 Residential area, but this is scheduled to be fallowed in 1990.

Fallow sugarcane land, with attendant weeds and some brush and small trees typify Phase 1 Residential land and the northern portion of the golf course on the mauka side of Fort Weaver Road, while the majority of the golf course is located in a drainage swale between Residential Phases 1 and 2. The intermittent Honouliuli Stream drains the swale and discharges through a marsh-type area before flowing into the West Loch of Pearl Harbor. At the present time drainage from the project site is directed to Honouliuli Stream/flood plain or into West Loch by means of existing drainage systems (Department of Housing and Community Planning 1987). The swale area, apparently subjected to various past land uses, is presently covered by a heavy growth of grasses (typically California grass and some wild sugarcane), brush, and trees.

The major portion of the swale area is classified as Zone A in terms of flood hazard, as identified by the Federal Insurance Administration Flood Insurance Rate Map (National Flood Insurance Program). This implies that the land could be inundated by the 100 year flood, but no base flood elevations or flood hazard factors have been ascertained. The remaining project site area, principally the residential areas and a portion

* Personal communication with Hugh Morita, Oahu Sugar Company, October 30, 1987.

of the golf course and shoreline beach park are classified as Zone C and D; which respectively denotes areas of minimal flooding and areas of undetermined, but possible flood hazard (City and County of Honolulu, 1980). Onsite drainage from the residential developments will be collected and channeled to the proposed municipal golf course. The golf course will be designed with the capacity to effectively retain not only the residential and golf course generated storm water runoff, but also the flow from the drainage areas mauka of the project, before eventually draining, after setting, percolation, and evaporation, into West Loch. The elevation of the project site area varies from about 65 feet near the intersection of Farrington Highway/Fort Weaver Road (Phase 1 Residential) to essentially sea level at the shore of West Loch (Department of Housing and Community Planning, 1987).

The median annual rainfall at the proposed project site is approximately 23 in., which for Oahu standards is relatively dry. The site is underlaid by the water restricting caprock, as indicated in Figure 1. The 250 mg/L isochlor (chloride) line (although it can change over time) cuts through the lower portion of the Project (Figure 1). The 250 mg/L chloride concentration level is considered to be the desired upper limit for drinking water.

Seven soil series are encompassed within the project site (Foote et al., 1972) in addition to approximately 40 acres of fill land and about 16 acres of essentially open water surfaces. Nearly 80% of the project's soils are considered to be poorly drained types, or stated otherwise, they would produce a higher percentage of surface water runoff. The relationship of these soils, however, to storm water runoff, will be discussed in a subsequent section of this report.

A development project as the one being herein proposed generally produce alterations in surface water runoff as a result of modifying existing ground conditions. Interest in these runoff changes is generally a result of concern over two factors; one, public safety, and two, environmental impact. The first factor requires the identification of changes in peak discharge rates, the magnitudes of which are necessary for designing adequate drainage structures to prevent flooding, while the second concern requires identification of changes in total runoff volume, as well as sediment, nutrient, and other constituent loads, and the effects these will have on the ecosystem of the natural resource serving as the "sink". It is this second concern, environmental impact resulting from increased runoff volume and sediment and nutrient loads, and its probable effect on subsequent receiving waters (West Loch of Pearl Harbor) that is under study in the present investigation as herein reported.

PURPOSE AND SCOPE

The purpose of this study is to evaluate the environmental impact of the proposed 461 acre West Loch Estates Development as it relates to surface water runoff. From an assembledge of baseline hydrologic and water quality data, an estimate of the existing and projected volume and quality characteristics of surface water runoff will be made, along with an assessment of the environmental impact resulting from this runoff, in the form of written comments.

METHODOLOGY

The methodology used in this study consisted of assembling, analyzing, and interpreting existing data from federal, state, and county agencies, as well as from on-site surveys of field conditions.

Inasmuch as the scope of work consisted of estimating the alterations in volume and quality of surface water runoff resulting from the proposed project, it was necessary to identify those factors that affect runoff generation and runoff quality for both pre-and post-development conditions.

Methods currently available to estimate the surface water runoff volume from a specific storm event requires the determination of reasonable rainfall-runoff coefficients for varying magnitude and duration storms, and for different land management, vegetation, soil, and soil moisture conditions, to name but a few hydrologic factors. In most practical situations, it is not considered feasible, due to the numerous influencing factors, to determine varying rainfall-runoff coefficients; rather, it is more practical for design and evaluation purposes to use a single coefficient for a particular land-use over a given rainfall intensity range. However, in order to circumvent a major portion of the unavoidable error created by using a constant rainfall-runoff coefficient, methods developed by the Hawaii Environmental Simulation Laboratory (HESL) of the University of Hawaii, (Lopez, 1984; Lopez and Dugan, 1978) and the U.S. Soil Conservation Service (SCS)(1986), were utilized

to determine representative storm water volumes under varying conditions.

The HESL method is based on the use of soil maps (Foote et al., 1972) and the incorporation of curve numbers from the U.S. SCS which were obtained from empirical data, including precipitation, soil and changing soil moisture conditions, and vegetative cover information from the classification of thousands of soils throughout the nation. These soils were classified into four groups, labeled A,B,C, and D, with Class A having the highest water intake rates and Class D soils the lowest. Four of the seven soils series for the project, Honouliuli, Pearl Harbor, Keaau, and Kaloko, which cover approximately 78% of the land area, are classified as "D". The other soil series are Helemano, Class "C", and Waipahu and Haleiwa, Class "B". For conservative reasons the fill land area was included in the Class "C" designation. The 16 acres of open water surface was, for obvious reasons, not included in the storm water runoff determinations. Under these assumptions, Class "C" comprised 15%, and Class "B" 4% of the project site area, with open surface water amounting approximately 3%. The HESL method also included the use of data derived from Hawaii (Cooley and Leonard, 1980) and the rainfall-frequency for given recurrence and duration storms (Giambella et al., 1984). The rainfall recurrence interval storms chosen for evaluation purposes were 2, 10, 50, and 100 yr with 1 and 24 hr durations.

Once the increase in surface water runoff volume had been established, it was necessary to determine the runoff quality for pre-and-post-development conditions.

The quality parameters of stormwater runoff considered the most representative to identify potential changes under different land management practices (i.e. pre-and-post development conditions) are: total nitrogen; total phosphorus; and suspended solids (sediments). Unfortunately, there is no water quality data from the intermittent Honouliuli Stream that drains the project site area.

To circumvent the problem of determining representative nitrogen and phosphorus values in surface runoff, for comparative purposes, nitrogen and phosphorus values of 3.0 and 0.3 lb/acre-yr, respectively, were selected to represent pre-project (1987) development conditions. These values were derived from a compilation of data relating to nutrient outputs from rural and agricultural lands throughout the nation that were reported by Loehr (1972). To convert the output loads to concentration values the nitrogen and phophorus values of 3.0 and 0.3 lb/acre-yr, respectively, were divided by the median annual rainfall of 23 in. and a rainfall-runoff coefficient of 0.35 to result in concentration values of 1.35 and 0.14 mg/L, respectively, for pre-project development conditions.

Representative suspended solids values in storm water runoff from the presently developed (1987) project site area are again difficult to determine, inasmuch as it is commonly presumed, by mainly indirect methods, that the majority of the annual suspended solid load is carried by the heavy storm

water runoff events which tend to occur on an infrequent basis. For the present study the concentration of suspended solids was based on composite measured and estimated suspended solids load per unit area from various Oahu streams, including those out of the entire Kaneohe Bay Drainage Basin, as reported by Jones et al., (1971). Following this reasoning the suspended solids concentration value for predeveloped conditions for comparative purposes was set at 1000 mg/L.

Quality data for stormwater runoff from developed areas are sparce, both locally and nationally. Loehr (1974) compiled urban stormwater runoff quality data collected from throughout the United States, as well as from a few international locations. As expected, the data are diverse. Locally, Fujiwara (1973) reported urban water quality data collected from storm drains in different land use drainage areas of Honolulu (residential, commercial and industrial), as shown in Table 1. These values compare favorably with similar situations from the continental U.S.

For the present study, the quality results of storm waters from the Honolulu residential area of Table 1 for nitrogen, phophorus, and suspended solids of 0.60, 0.57, and 250 mg/L, respectively, were used for the proposed project's full development conditions, except for the nitrogen concentration of storm water runoff for the golf course, which was assumed to be doubled (1.2 mg/L). The reason for doubling the nitrogen value for the golf course, was because of the emphasis given to fertilization, although it is applied under professional supervision with attention given to the application rate as well as

Table 1

Representative Storm Water Quality Data for Honolulu [a] (Fujiwara,1973)

	Residential[b]	Commercial[c]	Industrial[d]
Total Solids	511	278	246
Suspended Solids	252	142	12
COD	142	209	40
BOD	10	19	7
Dissolved Oxygen	7.1	5.7	6.7
NO_3-N	0.211	0.045	1.1
TKN	0.381	0.272	2.70
Total P	0.57	0.53	2.17
Ortho P	0.27	0.19	1.27
Grease	2.8	1919	2.2
Lead	0.407	0.987	1.657
Chromium	0.013	0.021	0.013
Zinc	0.512	0.792	0.729
Copper	0.036	0.036	0.021
Iron	0.377	0.295	0.049
Total Coliform	83,300	33,500	11,500
Fecal Coliform	1,965	463	580
Fecal Strep	6,393	7,900	7,350

[a] All units in mg/l except total coliform, fecal coliform, and fecal strep which are listed as No./100 ml

[b] Storm water samples collected on Aupuni Street near Nuhelewai Stream

[c] Storm water samples collected at Beretania Street between Maunakea

[d] Storm water samples collected near Iwilei and Pacific Streets

abstaining from fertilization during periods of probable heavy rainfall, for economic as well as environmental reasons. Attention is likewise drawn to the heavy metal content of residential storm water runoff.

The aforementioned stormwater runoff constituent concentrations for nitrogen, phosphorus, and suspended solids for pre-development (1987) can then be applied to the pre-and-post run-off volumes to determine the projected sediment and nutrient loads from the project site.

SURFACE WATER RUNOFF ALTERATIONS

Quantity

The estimated storm water runoff and constituent changes due to the proposed 461 acre West Loch Estates Development Project are shown in Table 2. The values presented, it must be emphasized, are for comparative purposes only, and are not intended to be representative of the accuracy implied by the practice of reporting results to one decimal place. This was done primarily for convenience of calculations and balancing. No attempt was made to compare these changes with contributions from its surrounding, or parent watershed areas, which would significantly negate apparent changes caused by the land use change within the project site.

As can be readily observed in Table 2, the storm water runoff volume for the West Loch Estates Development Project for the 2 yr, 1-hr duration storm for post (full) development conditions is about 3½ times greater than pre-developed (1987) conditions; however, as the storm duration and recurrence interval increases, this difference reduces down to approximately 16% times greater for the 100-yr, 24-hr storm which was the greatest calculated incremental storm water runoff volume, as expected. At higher rainfall intensities and durations, soil saturation increases, thus more runoff occurs.

The calculated increased runoff from the project area correspondingly indicates less groundwater recharge within the site of the project; however, since the golf course will be designed to serve as a holding basin for excess storm water

Table 2

Estimated Storm Water Runoff and Constituent Changes due to the Proposed West Loch Estates Development, West Loch, Ewa, Oahu

Storm[a]			Storm Water Runoff											
Dur-ation	Recur-rence Interval	Quan-tity	Hydraulic			Nitrogen[b]			Phosphorus[c]			Suspended Solids[d]		
			Development 1987	Development Full	Δ	Development 1987	Development Full	Δ	Development 1987	Development Full	Δ	Development 1987	Development Full	Δ
hr	yr	in.	AF/event	AF/event	AF/event	lb/event	lb/event	lb/event	lb/event	lb/event	lb/event	ton/event	ton/event	ton/event
1	2	1.1	2.7	9.5	+ 6.8	9.7	7.7	- 2.0	1.0	14.8	+ 13.8	3.60	3.24	- 0.36
1	10	1.7	10.4	23.3	+ 12.9	38.2	27.2	- 11.0	4.0	36.1	+ 32.1	14.14	7.92	- 6.22
1	50	2.2	19.6	36.8	+ 17.2	72.0	49.4	- 22.6	7.5	57.1	+ 49.6	26.66	12.53	- 14.13
1	100	2.4	23.8	42.6	+ 18.8	87.4	59.3	- 28.1	9.1	66.1	+ 57.0	32.35	14.49	- 17.86
24	2	3.9	61.5	89.7	+ 28.2	225.6	147.2	- 78.4	23.4	139.1	+ 115.7	83.57	30.50	- 53.07
24	10	7.5	173.3	214.1	+ 40.8	636.2	402.2	- 234.0	66.0	332.0	+ 266.0	235.62	72.81	- 162.81
24	50	10.4	271.9	318.3	+ 46.4	998.5	624.7	- 373.8	103.5	493.5	+ 390.0	369.80	108.22	- 261.58
24	100	11.3	303.3	350.9	+ 47.6	1113.6	695.2	- 418.4	115.5	544.1	+ 428.6	412.45	119.32	- 293.13

a) From "Rainfall Frequency for Oahu" (Giambelluca, et al., 1984).

b) Based on a nitrogen value of 1.35 mg/L for 1987 conditions and 60 mg/L for full development of Residential Phases 1 and 2 and Shoreline Park, and 1.20 mg/L for the Golf Course.

c) Based on a phosphorus value of 0.14 mg/L for 1987 conditions and 0.57 mg/L for full development.

d) Based on a suspended solids value of 1000 mg/L for 1987 conditions and 250 mg/L for full development.

runoff prior to discharge into West Loch the potential for additional recharge at the golf course area will be enhanced.

These runoff values (acre-ft/event) represent a volume of water and should not be confused with peak discharge rates which represent the maximum volume of storm water runoff discharge per unit of time (e.g., cfs). Peak discharge rates are required for engineering design of proposed drainage facilities and ascertaining the capacity of existing facilities, while total runoff volume provides a more realistic estimate of impact on water quality. Calculated peak discharge rates and the resulting flooded area for the streams or drainage courses within the project boundaries are usually determined from the City and County of Honolulu's Drainage Standards procedure (City and County of Honolulu, 1969), with consideration given to the previously discussed designated 100 year flood area classifications under the National Flood Insurance Program (City and County of Honolulu, 1980).

Quality

Besides the changes in volume of storm water runoff, the quality of the various constituents being transported is of equal, if not more importance. However, estimates of water quality constituents resulting from significant storm water runoff that occurs at the most, only a few times a year, is very perplexing, especially since information on this subject essentially only became available at both the local and national level in the 1970's.

The summation of nitrogen, phosphorus, and suspended solids loads from both present (1987) and projected (full)

development for storms of 1- and 24-hr duration at recurrent intervals of 2-, 10-, 50-, and 100-years are shown in Table 2, along with the correspondingly previously discussed expected volumes for specific storms. The incremental changes per storm event for the present and projected development conditions for the various duration and recurrence interval storms indicate that from the least to the greatest amount of rainfall: nitrogen and suspended solids loads decrease and phosphoruses increases for all levels of storms. Any potential impact of the phosphorus load should be significantly lessened by the designed golf course holding basin.

The hydrologic and water quality aspects of the surface water runoff were only considered for the present and projected conditions. However, increases in constituent loads could result from construction activities, especially if a significant storm occurs during the interim period between earth moving operations or exposed soil conditions and soil stabilization completion. The impact of construction activities can be minimized by adhering to strict erosion control measures, such as those outlined in the City and County of Honolulu (1972) ordinance relating to grading, grubbing, and stockpiling and/or the U.S. SCS's Erosion and Sediment Control Guide for Hawaii (Soil Conservation Service, 1981).

Other water quality constituents of general concern include biocides and heavy metals. Typically, the biocides in general use tend to break down more readily in comparison to the more long lasting types of a few years ago; consequently, except for agricultural runoff, the types and concentrations are usually considered insignificant.

Heavy metals, on the other hand, do apparently increase somewhat as a result of urbanization, however, for a comparison basis, although it is not directly applicable for storm water runoff, only lead and iron (by a slight margin) actually exceed the primary (Department of Health, 1981) and secondary (U.S. Environmental Protection Agency, 1979) drinking water standards, respectively. Inasmuch as essentially all new automobiles have switched over to unleaded gasolines since the mid-1970's it would be expected that the concentration of lead in residential storm water runoff would be steadily decreasing. Iron's concern in drinking water is due to its potential for staining fixtures and producing tastes.

The possible long-term effect, if any, that the apparent slightly increased heavy metals have upon the biological life of the receiving waters (West Loch of Pearl Harbor) at the concentrations and especially at the very low loading rates expected is not presently well defined. However, a biological study of Pearl Harbor, conducted by the U.S. Navy in the early 1970's concluded that the heavy metal burden in Pearl Harbor was below the level of concern (even though that several heavy metal sources that were discharging into Pearl Harbor at that time have since been eliminated) and that the major detriment to marine environment appeared to be silt (Evans et al., 1972). As previously noted in Table 2, the suspended solids load for all storm events are calculated to

decrease significantly. Additionally, the designed golf course holding basin would be expected to settle a portion of the suspended solids and nutrient content of the storm water runoff prior to discharge into West Loch.

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APPENDIX F

Baseline Marine Surveys
Pearl Harbor, Oahu, Hawaii

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SECTION 1.0 INTRODUCTION

This report presents the results of marine water quality and biological surveys conducted in the Honouliuli Region of upper West Loch, Pearl Harbor, Oahu, Hawaii, between September 25, 1987 and October 2, 1987 (Figure 1). The purpose of the study was to define baseline marine environmental conditions that occur in the vicinity of the proposed West Loch Housing and Golf Course Project and to gain an understanding of the marine resources that could potentially be affected by construction of the proposed project and subsequent human use of the area.

The scope of work for the studies encompassed herein was defined with the assistance of Mr. Chester Koga, R. M. Towill Corporation. The results of the investigations presented herein should be interpreted as a "snapshot" reflecting physical and chemical measurements and biological observations made during the aforementioned survey period and do not necessarily reflect conditions that may be encountered during other times of the year.

SECTION 2.0 METHODS

2.1 Physical-Chemical Measurements

Salinity and temperature measurements were made with a Yellow Springs Instrument Company (YSI) S-C-T meter equipped with a YSI Model 3300 nickel-platinum conductivity/temperature probe. Dissolved oxygen measurements were obtained utilizing a YSI Model 51B dissolved oxygen meter equipped with a membrane-covered, pressure-compensated, polarographic sensor. The dissolved oxygen meter was calibrated according to factory guidelines in a water vapor-saturated chamber. With the exception of most inshore sampling stations (10-50 feet from shore), all measurements were based on *in situ* readings (generally from a small inflatable boat). Based on manufacturer-supplied specifications, worst-case possible instrument/probe (combined) errors are as follows: temperature, ±0.7 degrees Centigrade (C.); salinity, ±0.2 parts per thousand (ppt); dissolved oxygen, ±0.2 parts per million (ppm). However, considering the conditions encountered in the field (wind and wave chop against a small inflatable boat), actual instrument/probe error was probably higher than suggested by the above specifications. With few exceptions, most readings were made by "averaging" meter oscillation at any given station.

Three sites located between Waipahu Town and the Honouliuli Unit of the Pearl Harbor National Wildlife Refuge were selected for water quality analyses (Figure 2). Site selection was

constrained by the presence of dense mangrove stands and respect for private property rights. However, an adequate cross-section of nearshore environments was sampled to provide an overview of the subject area. Sampling stations at each selected site were layed out using a 100-meter transect line which was aligned perpendicular to shore. Small wooden dowels with fluorescent orange tape attached to the top were embedded in the substratum to mark each station. In some cases, the dowels were lost and distances from shore were estimated. Water depths never exceeded 1.5 meters at any sampling station during any tidal period.

2.2 Biological Surveys

Underwater biological surveys were conducted during morning low tide periods on September 25-26, 1987. Despite repeated visits to the study area through October 2, 1987, the September 25-26 interval was the only time turbidity levels permitted underwater observations. A total of approximately five hours were spent either underwater or making observations from the surface. Surface observations were conducted when water depths were too shallow to permit underwater viewing. The diver reconnoitered the study sites by random swimming encompassing both inshore (immediately outside the mangrove stands) and offshore areas (edge of the slope). All observations were recorded on waterproof Polypaper sheets and, when possible, supplemented by underwater photography utilizing a Nikonos II camera.

Benthic macroinvertebrate identification and enumeration was generally limited to specimens exceeding 2.0 centimeters (cm.) in longest dimension, though certain especially numerous, albeit smaller, invertebrates were recorded. Where appropriate, counts or estimates of population densities of certain benthic invertebrates were made with an aluminum meter stick which was utilized to lay out crude one-square meter or 0.25-square meter quadrats. These efforts were largely unsuccessful because of the silt suspended by the movement of the diver and the meter stick. Rocks, refuse and related debris were occasionally turned over or sifted to locate burrowing and cryptic species. Particular attention was focused on pier pilings, mangrove prop roots, and other solid substrates which offered a foothold for epibenthic organisms.

Fish identification and estimates of abundance were made by the diver recording all species sighted during the underwater surveys. Underwater visibility was generally limited to no more than six feet on 9/25/87 and 9/26/87. In an attempt to better define the represented fish fauna, the catch of four separate seine-netting efforts by local fishermen was examined. These efforts were successful in accounting for several species that were not recorded during the underwater surveys. However, seine-net fishermen utilized 2-inch (stretch) mesh, which would not account for small fishes that might be present.

SECTION 3.0 RESULTS

3.1 Water Quality

The approximate location of water quality sampling stations is shown in Figure 2. Tables 1-3 show the results of temperature, salinity and dissolved oxygen measurements conducted on September 25th and 26th, and October 2, 1987. As briefly noted in each of the tables, weather conditions during the sampling periods ranged from absolutely windless conditions during the morning of 9/25 and 9/26, to tradewind conditions (which began at 0955 hrs. on 9/26 and characterized all of the 10/2/87 sampling period). Wind conditions were significant inasmuch as they directly affected turbidity levels in the shallow waters which characterized all study areas. Tables 4-6 depict the tidal conditions during the water quality surveys.

Water temperatures ranged from a high of 30.5 degrees C. in shallow waters at Site #1 (Table 2) to a low of 28.0 degrees C. at the same site on the preceding day (Table 1). A general pattern of cooler inshore waters and warmer offshore waters characterized all study sites during all survey periods. Cooler inshore waters were likely the result of subsurface fresh or brackish water discharges (this interpretation appears to be supported by the salinity data). There was no discernible temperature stratification apparent at any sampling station.

Salinites ranged from a low of 18.3 ppt at a low-tide nearshore station at site #2 (Table 1) to a high of 29.4 ppt at a high-tide offshore station at study sites #1 and #2 (Table 3). Normal oceanic salinity for offshore Hawaiian waters averages approximately 35 ppt. These data indicate the influence of both subsurface and surface freshwater discharges on water quality within the upper West Loch basin. There was no discernible density stratification apparent at any sampling station.

Dissolved oxygen values demonstrated similar variability and ranged from a low of 4.05 ppm in murky inshore waters at site #1 (Table 1) to a high of 6.25 ppm at an offshore station during high tide (Table 3; site #1). These values correspond to 67 percent and 101 percent of saturation, respectively. Dissolved oxygen values were significantly lower at all sampling stations on 9/25/87; a period of virtually no detectable wind. The

influence of tradewinds on dissolved oxygen levels was most apparent on 9/26/87 (Table 2; Site 1). As noted in Table 2, dissolved oxygen levels rose approximately 1 ppm within minutes after the tradewinds reached the study site. This change is not considered unusual given the prevailing shallow waters which characterized all three study sites.

3.2 Biological Surveys

3.2.1 Algae

Other than filamentous blue-green algae (cyanophytes) which were a conspicuous component of the epifaunal community on nearly all submerged surfaces, there was no macrothallic algae or coralline algae of any taxonomic group observed during underwater surveys.

3.2.2 Corals

Living or dead corals were not encountered at any site within the upper West Loch basin.

3.2.3 Macroinvertebrates

The macroinvertebrates characterizing the benthic estuarine mudflat community in the upper West Loch basin can best be described as an oyster-sponge-crab community, reflecting the dominant faunal components. The American oyster (*Crassostrea virginica*), several species of unidentified sponges (family *Demospongiae*), and the portunid (stone) crab, *Thalamita integra*, were represented in all areas surveyed. Although no distinct zonation patterns were apparent, oysters were generally present in higher densities in offshore areas; whereas *Thalamita* was most abundant in nearshore waters, often in or adjacent to the dense proproots of shoreline mangrove (*Rhizophora mangle*) stands. Although sponges appeared to increase in abundance in offshore areas, most of the colonies were not attached to the substratum. The latter observation may in part be based on the frequency of seine-net fishing in the area and the tendency of the weighted nets to dislodge benthic organisms.

Several other crustaceans appear to represent important components of the benthic mudflat community. The Samoan (mangrove) crab *Scylla serrata* and the xanthid crabs *Pilumnus oahuensis* and *Lophozozymus* sp. were seen on several occasions, though their population size is significantly less than *Thalamita*. These species are occasionally caught incidental to subsistence dip-net fishing efforts directed at *Thalamita*. Five juvenile Samoan crabs (carapace width 4-6 cm.) and one adult Samoan crab (carapace width 24 cm.) were counted offshore of study area 1 (the latter specimen was subsequently captured in a seine net by local fishermen). This crab was the largest invertebrate observed in West Loch. Two species of burrowing shrimp (*Alpheus*) were observed in an offshore oyster bed near study area 2.

The remainder of the mudflat fauna was dominated by the mollusks *Dendropoma platypus*, *Anomia nobilis*, and *Hiatella hawaiensis*. Both *D. platypus* and *A. nobilis* were of uncommon occurrence; the tiny *H. hawaiensis* had a patchy distribution and was generally found in offshore areas with noticeable water currents.

A second major group of benthic organisms, generally characterized as components of the epifaunal or "fouling" community, were considered separate and distinct enough in terms of habitat to be described separately. This community occurred on virtually any type of solid substrate, including mangrove prop roots, pier pilings, and virtually any type of manmade debris or natural structure. The majority of the organisms in this group are generally considered a part of the intertidal community. Aside from both live and dead *C. virginica*, the barnacle *Balanus amphitrite* was the most common and conspicuous member of the fouling community with population densities often exceeding 300 per square meter. The slipper limpet, *Crepidula aculeata*, and two species of serpulid worms (*Hydroides elegans* and *Hydroides* sp.) were often found in association with *Balanus*. *C. aculeata* was only found on vertical to near-vertical surfaces. *H. elegans* appeared to represent the primary pioneer species on recently submerged substrates. Several recently dumped concrete cinder-blocks were colonized with thousands of small calcareous tubes secreted by this tube-dwelling worm. These organisms were less prominent on structures that had obviously been in the water for some time.

The subtidal portion of the fouling community was characterized by two species of ascidians (the compound tunicate, *Diplosoma macdonaldi*, and an unidentified (*Styela*-like) solitary tunicate), several species of encrusting and erect-branching sponges, and at least one unidentified colonial hydrozoan (possibly *Obelia dichotoma*). The subtidal infaunal community is composed of numerous species of small crustaceans (amphipods, etc.) which live in the dense, silty, and seemingly anoxic microenvironment provided by larger fouling organisms. The two largest constituents of this infaunal community were the polychaete worms, *Nereis* sp. and *Perinereis* sp. Live specimens of the hiatellid clam *H. hawaiensis* were occasionally found within this microenvironment. Evidence of the

past presence of marine boring organisms was found in many dilapidated wooden pier pilings, but no live specimens were found at any location.

Small numbers of the native Hawaiian oyster, *Ostrea sandwichensis*, were observed on mangrove prop roots in study areas 1 and 2.

3.2.4 Fishes

A total of ten species of fish were identified during the baseline environmental surveys conducted in upper West Loch basin (an eleventh species, a blenny, could not be identified to the genus or species level) (Table 8).

The common tilapia, *Oreochromis mossambicus*, and the striped mullet, *Mugil cephalus*, dominated the icthyofauna throughout all areas surveyed. Large roving schools of adult tilapia were encountered at every study site and were generally more abundant in offshore waters. Juvenile tilapia appeared to favor inshore waters and were often found within the mangrove proproot zone.

Equalling or perhaps surpassing tilapia in terms of total biomass were massive schools of juvenile mullet, generally of the same age/size class, which dominated inshore waters, particularly in vicinity of study area 1. These schools were frequently ravaged by large (unidentified) predatory fish.

Juvenile milkfish (*Chanos chanos*), up to 20 cm. in length, were occasionally observed in study areas 1 and 2, but their population size was insignificant in comparison to tilapia and mullet populations.

The omilu (papio; *Caranx melampygus*) was not observed during underwater surveys but was well represented in the catch of four separate seine-net fishing efforts conducted by local fishermen offshore of study areas 1 and 2. On a weight basis, this species typically comprised less than approximately 5 percent of the total seine-net catch (the remainder being composed largely of adult tilapia). The omilu averaged approximately one pound in weight.

Two small schools of juvenile scalloped hammerhead sharks (*Aphyrna lewini*) were observed approximately 500 meters north of study area 1 on September 26th and a single school of approximately 8 sharks was observed on October 2nd in waters less than 20 cm. deep between study areas 1 and 2. On October 2nd, two seine-net fishermen working as a team between study area 1 and 2 reported catching "about a dozen" small hammerheads in a catch otherwise dominated by tilapia. Dead juvenile hammerheads were frequently seen washed up on the shoreline in several mangrove clearings within the study area boundaries. It is not known whether these individuals were killed by fishermen or were the result of natural mortality. Measurements of several dead specimens indicated an average length of approximately 40 cm. (15 inches).

Halfbeaks (*Hemiramphus depauperatus*) and aholehole (*Kuhlia sandvicensis*) were next in overall abundance with fewer than a dozen individuals of each species recorded. Aholehole were always found within or adjacent to the dense proproot system of shoreline mangrove stands; halfbeaks were generally associated with more open offshore areas.

The remaining species, including a large eagle ray (*Aetobatus narinari*), barracuda (*Sphyraena barracuda*), and moray eel (*Gymnothorax undulatus*), were limited to one or two sightings each.

The fish fauna of upper West Loch is probably more extensive than the survey data indicate, but prevailing high water turbidities hindered efforts to provide a more quantitative baseline assessment. Similarly, the seine-net data, while providing an indication of the abundance of tilapia, and accounted for two species that may not have otherwise been recorded (omilu and one barracuda), would not have accounted for juvenile fishes.

SECTION 4.0 DISCUSSION

4.1 Overview

The upper West Loch basin can be defined as a shallow estuarine ecosystem, dominated by a generally monotonous mudflat (soft-bottom) biological community and a less expansive, but somewhat more diverse, epifaunal community. This estuarine ecosystem has been significantly altered by drainage from upland agricultural lands, domestic sewage and cane-processing discharges, and urbanization. In 1968, following the establishment of water quality standards for the State of Hawaii, Pearl Harbor was designated as the highest priority pollution problem in the state (FWPCA, 1969). Silt from terrigenous sources remains a major pollutant along all of the western side of upper West Loch.

Despite a history of long-term and generally manmade abuse, upper West Loch remains an area of apparent high biological productivity, as witnessed by the extant biomass of certain both

desirable and less-desirable fish, crustaceans and shellfish. Upper West Loch also remains as one of the least-studied areas within the greater Pearl Harbor Basin, a factor that is in part the result of privately-owned lands, limited shoreline access (dictated by near circumferential mangrove stands), and an absence of U.S. Navy facilities. Despite shoreline access limitations, upper West Loch appears to provide a small but significant sport and subsistence fishery for tilapia, various crustaceans, and oysters (the latter being harvested frequently, but contrary to Department of Health and Department of Land and Natural Resources regulations). The basin also appears to constitute a major spawning area and nursery for several important commercial and sport fishes, and a pupping area for at least one species of shark. Despite its apparent high biological productivity, overall biological diversity is low in comparison to other coastal areas and embayments within Pearl Harbor and around Oahu (Evans, 1974).

4.2 Water Quality

Water quality data presented herein are in general agreement with other investigators. Evans (1974) reported a mean monthly surface water temperature for the September-October period in upper West Loch of 28.0 degree C.; a mean monthly salinity of 32 ppt; and a mean monthly dissolved oxygen level of 5 ppm. These values reflect offshore measurements which undoubtedly account for the higher salinity values than were recorded during the recent baseline survey. Kawamoto and Sakuda (1973) reported temperatures ranging from 25-28.0 degrees C. and salinities of 31-32 ppt during the months of September-October over eight oyster beds in upper West Loch. The salinity values are approximately 10 percent higher than the data reported herein but are within the range of what might be expected as a function of the tidal period. Fecal coliform levels ranging from 4 - 1,100 MPN were reported from water column sampling in the same area (DLNR, 1971). Table 9 shows the ranges of various water quality parameters reported by other researchers in the upper West Loch basin.

4.3 Siltation and Sedimentation

Silt and sediment runoff resulting from upland agricultural practices and urbanization appear to be exerting the singlemost adverse environmental influence within the upper West Loch. At least three perennial and intermittent streams are apparently responsible for silt and sediment deposition (Figure 1).

Waikele Stream drains approximately 45.7 square miles of the Central Oahu Basin and receives runoff from high mountain areas as well as significant runoff from lands under sugar cane and pineapple cultivation. Until relatively recently the stream received an average of nearly 4.0 million gallons per day (mgd) of partially treated sewage (FWPCA, 1969). The mean flow of Waikele Stream is approximately 1.1 cubic meters/second with a maximum recorded flow of 385 cubic meters/second (U.S. Geological Survey, 1971). In 1969, Waikele Stream discharged an average of 9,900 pounds of solids into West Loch daily or approximately 1,875 tons annually. Over half of these solids were settleable (FWPCA, 1969).

The Honouliuli and Kapakahi Streams are regarded as intermittent streams (U.S. Army Engineer District, 1979). Honouliuli Stream drains mauka cane lands and urbanized areas on the west side of upper West Loch; Kapakahi Stream meanders less than a mile before discharging into West Loch several hundred meters east of the mouth of Waikele Stream. West Loch receives approximately 30 percent of Pearl Harbor's total surface water flow (Evans, 1974). Sugar cane cultivation (and processing) on Waipio Peninsula is also believed to be a major silt contributor though in recent years the development of settling ponds for cane-process waters discharged from the Oahu Sugar Company mill has significantly reduced daily silt and sediment loading. Collectively, these sources of silt and sediment are responsible for major shoaling throughout upper West Loch. Silt deposits in excess of 8 feet have been reported between Laulaunui Island and Waikele Stream (FWPCA, 1969). Other reports have indicated "...recently accumulated silt up to 8 feet thick..." in the upper reaches of several Pearl Harbor lochs and sedimentation rates in excess of 0.1 meter/year have been recorded near the mouth of Waimanu Stream in East Loch (U.S. Army Engineering District, 1979; Evans, 1974). Considering that stream flows for Waimanu Stream average less than one-fifth of the flow from Waikele Stream, the sedimentation potential of Waikele Stream is rather apparent. Not surprisingly, sediment analyses have indicated that upper West Loch is characterized by "silt and clay" particles with 95.8-98.1 percent less than 1/16 millimeter in diameter (U.S. Naval Civil Engineering Laboratory, 1973a).

Cross-loch tradewinds and an absence of strong tidal currents also appear to contribute to the apparent high sedimentation on the Honouliuli (west) side of upper West Loch (FWPCA, 1969). Inflowing (ocean) waters tend to concentrate on the eastern banks of West Loch and lower salinity outflowing waters along the western banks. Water currents have been described as clockwise in motion within upper West Loch (DLNR, 1971). Wind-driven upwelling is often associated with the eastern sides of East, Middle and West Lochs (Evans, 1974). Given the often high turbidity of the surface water-derived outflowing water, the

water current-limited shallow waters along the west side of upper West Loch would appear to provide an excellent settling basin; an observation that is supported in the recent studies reported herein.

The introduced American mangrove (*Rhizophora mangle*), which lines most of West Loch., may be contributing to sediment buildup because of their dense proproot systems which tend to trap and settle suspended silt and sediments which might otherwise be flushed out of the loch. Several studies conducted between 1963 and 1973 in the upper West Loch oyster beds provide a baseline which suggests that the rate of mangrove encroachment in the loch is preceding at an unprecedented rate (Sparks, 1963; DLNR, 1971; Kawamoto & Sakuda, 1973). Sparks' (1963) photographic record reveals an open, generally mangrove-free shoreline in the Honouliuli region. Kawamoto and Sakuda (1973) provided a map which indicates that the Matsuyama Fishpond was once a major open water pond. Mangroves now constitute a nearly solid coastal barrier averaging approximately 40 meters wide around most of the Honouliuli sector of upper West Loch (R.M. Towill aerial photo map #8507-9, 1:200 scale, dated August 7, 1987). The former Matsuyama fishpond, which once extended approximately 150 meters seaward into West Loch, is now a solid 150-meter wide mangrove swamp.

4.4 The American Oyster

West Loch once harbored extensive natural beds of the introduced American oyster, *Crassostrea virginica* (Figure 3). Sparks (1963) estimated that West Loch contained 19 major oyster beds harboring approximately 36 million live oysters (the majority found in the Honouliuli sector). A re-survey of the same beds in 1971 revealed an estimated 3 percent decrease in the number of live oysters but with represented oysters generally of a larger size than in the 1963 survey (DLNR, 1971). An estimated 99 percent of the 1971 estimate of 34.6 million oysters perished in 1972 as a result of a parasitic fungus infection (Kawamoto & Sakuda, 1973). However, deterioration of the bed as a result of siltation was apparent before 1972 (U.S. Army Engineer District, 1979).

Recent baseline studies indicated that the once confluent, nearly monotypic, oyster beds which previously lined the west side of upper West Loch have further deteriorated to the extent that recognizable intertidal or subtidal "beds" are no longer apparent. The combined effects of mangrove encroachment and siltation have nearly eliminated oysters from most inshore and many offshore areas. Although densities of 15-25 oysters/square meter were occasionally noted in localized areas off study areas

1 and 2 (and occasionally as a component of the epifaunal community on various types of solid substrates), these were generally the exception rather than the rule. However, dense accumulations of dead oysters were frequently found beneath several inches of silt in several nearshore and offshore locations. Although still constituting an important component of the benthic mudflat community, this species has apparently been unable to re-establish its former population size when faced with mangrove encroachment, chronic siltation, microbial infection, and perhaps other environmental stresses.

4.5 General Biological Considerations

Other than the occurrence of juvenile hammerhead sharks, there were no species observed in upper West Loch that would not be expected to be found in any shallow estuarine environment in Hawaii.

Pearl Harbor and Kaneohe Bay have long been known as pupping grounds for hammerhead sharks with the summer months, particularly September, being associated with maximum reproductive activity (Naughton, personal communication, 1987). Sharks up to approximately 8-feet in length are frequently caught in seine-nets throughout Pearl Harbor and in the vicinity of Iroquois Point (Grovhoug, personal communication, 1987).

Absent from the survey data record was the Hawaiian anchovy or nehu (*Stolephorus purpureus*). Pearl Harbor has, historically, been heavily fished for nehu which comprises the most important baitfish for the Hawaiian aku (skipjack tuna) industry. Baiting has tapered off in recent years as a result of the decline in the size of the aku fleet. Most baiting in West Loch was generally associated with deeper waters in lower West Loch (Evans, 1974). Au (1965) reported an absence of nehu eggs and larvae over the shallow mudflats in upper West Loch.

Two major groups of organisms were conspicuously absent from the baseline surveys: macrothallic algae and echinoderms. Any one of the three most common species of *Ulva* (*Ulva fasciata*, *U. lactuca* and *U. reticulata*) could be expected to occur within the low saline, turbid waters of upper West Loch; however, none was observed at any survey station. Herbivorous fish may be responsible for cropping this species down to its holdfast, where it would be indistinguishable from the heavily silted benthic substratum. The prevailing high water turbidity may also limit the light necessary for algal growth.

Echinoderms were strikingly absent from the survey data. Common echinoids (sea urchins) such as *Diadema* would be expected to

be found in association with the fouling community or as a part of the benthic fauna on solid substrates. Similarly, holothurians (sea cucumbers) would be expected to be found in association with the benthic mudflat community. Four species of echinoids and 2 species of holothurians are known to occur within Pearl Harbor (Evans, 1974). Other investigators have commented that echinoderms in general and holothurians in particular are "...remarkably absent from inner Pearl Harbor" (Evans, 1974). The factor(s) responsible for the absence of these species in what appears to be otherwise ideal habitat is unknown.

4.6 Environmental Impacts

4.6.1 Construction Impacts

With the exception of minor construction-induced short-term siltation and sedimentation associated with mauka earthmoving activities, impacts to estuarine biota in the upper West Loch basin resulting from the proposed project are expected to be inconsequential. The relatively flat topography of the project site (particularly in the immediate coastal area) should insure that even these minor impacts can be mitigated through judicious use of various erosion control measures, particularly along the Honouliuli Stream and within the surrounding watershed. The prevailing flat coastal plain, numerous abandoned ponds, and dense mangrove stands which border the shoreline would appear to provide for silt and sediment containment under the most severe weather conditions.

Erosion may be more difficult to control around Hoaeae Point, a site that has been designated for a future shoreline park. Shoreline mangroves have been cleared in several locations around the peninsula, thus siltation of inshore waters associated with runoff is likely to be more extensive, though largely controllable. Given the location of this peninsula in relation to the mouth of Waikele Stream, it is difficult to envision construction-generated silt and sediment levels exceeding that found naturally in inshore waters, particularly during periods of heavy storm water runoff.

The fish and benthic invertebrate populations found within upper West Loch are those that are generally found in association with any shallow estuarine or mudflat habitat within the state. These species are adapted to changing salinities, high ambient turbidity levels, and unconsolidated bottom sediments. Any short-term or long-term increase in turbidity levels resulting from increased silt and sediment loading or re-suspension of existing bottom sediments would not be expected to affect most represented estuarine species, but may be expected to exert a continuing stress to oysters, as well as other filter-feeding organisms. This type of stress characterizes the pre-development (1987) conditions and would continue to occur with or without the proposed project. Dugan's (1987) calculations indicate that the level of suspended solids associated with storm water runoff will decrease with full development of the project.

A change in land use from the existing mauka cane lands to housing and golf course complex would likely reduce silt and sediment deposition at the mouth of Honouliuli Stream (Dugan, 1987). Existing high storm water runoff and associated sedimentation may in part be responsible for the aggressive advancement of the mangrove vegetation in the former Matsuyama Fishpond (the mouth of Honouliuli Stream). Dugan (1987) calculated that storm water runoff volume for the 2-year, 1-hour duration storm for post (full) development conditions is about 3.5 times greater than pre-developed (1987) conditions; however, as the storm duration and recurrence interval increases, this difference reduces down to approximately 16% times greater for the 100-year, 24-hour storm. At higher rainfall intensities and durations, soil saturation increases, thus more runoff occurs. The calculated increased runoff from the project area correspondingly indicates less groundwater recharge within the project site; however, since the proposed golf course will be designed to serve as a holding basin for excess storm water runoff prior to discharge into West Loch the potential for additional recharge at the golf course area will be enhanced (Dugan, 1987). Given the estuarine character of upper West Loch, the projected runoff values are not expected to produce any adverse affects to resident biota.

Nitrogen, phosphorus, and suspended solids loads from both present (1987) and projected (full) development, based on various duration and recurrence interval storms, indicate that from the least to the greatest amount of rainfall: nitrogen and suspended solids loads decrease and phosphorus (all forms) increases for all levels of storms. Any potential impact of the phosphorus load should be significantly lessened by the proposed golf course holding basin(s). Increases in constituent loads could result from construction activities, especially if a significant storm occurs during the interim period between earthmoving operations or exposed soil conditions and soil stabilization completion (Dugan, 1987).

Biocides and heavy metals represent other areas of general concern. Typically, the biocides in general use tend to break down more readily in comparison to the long-lasting types of a few years ago; consequently, except for agricultural runoff, the types and concentrations are usually considered insignificant

(Dugan, 1987).

Heavy metals generally increase somewhat in storm runoff waters as a result of urbanization. The possible long-term effect, if any, that heavy metals have upon the biota of the receiving waters at the concentrations and low loading rates expected is not presently well defined. Evans (1974) concluded that the heavy metal burden in Pearl Harbor sediments was below the level of concern and that the major detriment to the marine environment appeared to be silt. As previously noted, the suspended solids load for all storm events is calculated to decrease significantly with full development of the project site. The golf course holding basin(s) would be expected to settle a portion of the suspended solids and nutrient content of storm water runoff prior to discharge into upper West Loch.

Removal of shoreline mangroves is not expected to produce any significant adverse impacts other than a short-term rise in turbidity levels, minor habitat losses, and the loss or dislocation of a meager inshore fauna of low species diversity. *Rhizophora mangle* is an exotic species originally introduced into Hawaii from Florida in 1902 to reduce shoreline erosion on Molokai's reef flats (Walsh, 1967). This species (and three other species imported from the Philippines in 1922) has subsequently invaded sheltered bays, estuaries, coastal and anchialine ponds statewide, often displacing indigenous vegetation (Walsh, 1967; Maciolek and Brock, 1974). Unlike other insular areas in the Pacific where mangroves are indigenous, Hawaiian mangrove swamps do not appear to harbor any distinctive floral or faunal assemblages, nor do they appear to constitute important nursery grounds for indigenous marine or brackish water fauna (Walsh, 1967). Removal of mangrove stands may improve water quality in localized areas by enhancing water circulation and flushing.

4.6.2 Impacts Associated with Increased Human Use of the Shoreline and Offshore Waters

Urbanization and the corresponding increased population density associated with the proposed housing complex, combined with expanded opportunities for shoreline recreation in the Honouliuli region would offer the potential for greater utilization of marine resources in the upper West Loch Basin. Present information, based largely on short-term field observations, suggests that these resources are presently underutilized.

Increased utilization of both fish and benthic invertebrates (shellfish, crustaceans, etc.) would not come without some attendant human risks associated with the sanitary quality of upper West Loch. The poor sanitary quality of most of the lochs within Pearl Harbor has been documented in several studies, though recent information on the sanitary quality of West Loch waters is not available. Although openly harvested, oyster stocks in West Loch have been restricted for human consumption for many years by regulation of the Department of Land and Natural Resources and the Department of Health. Even with the abandonment of several sewer outfalls that once discharged into West Loch, polluted waters eminating from Waikele Stream and occasional discharges of cane processing water from the Oahu Sugar Company's Waipio Peninsula settling ponds are likely to pose a continuing risk to water contact recreation and consumption of marine resources from West Loch.

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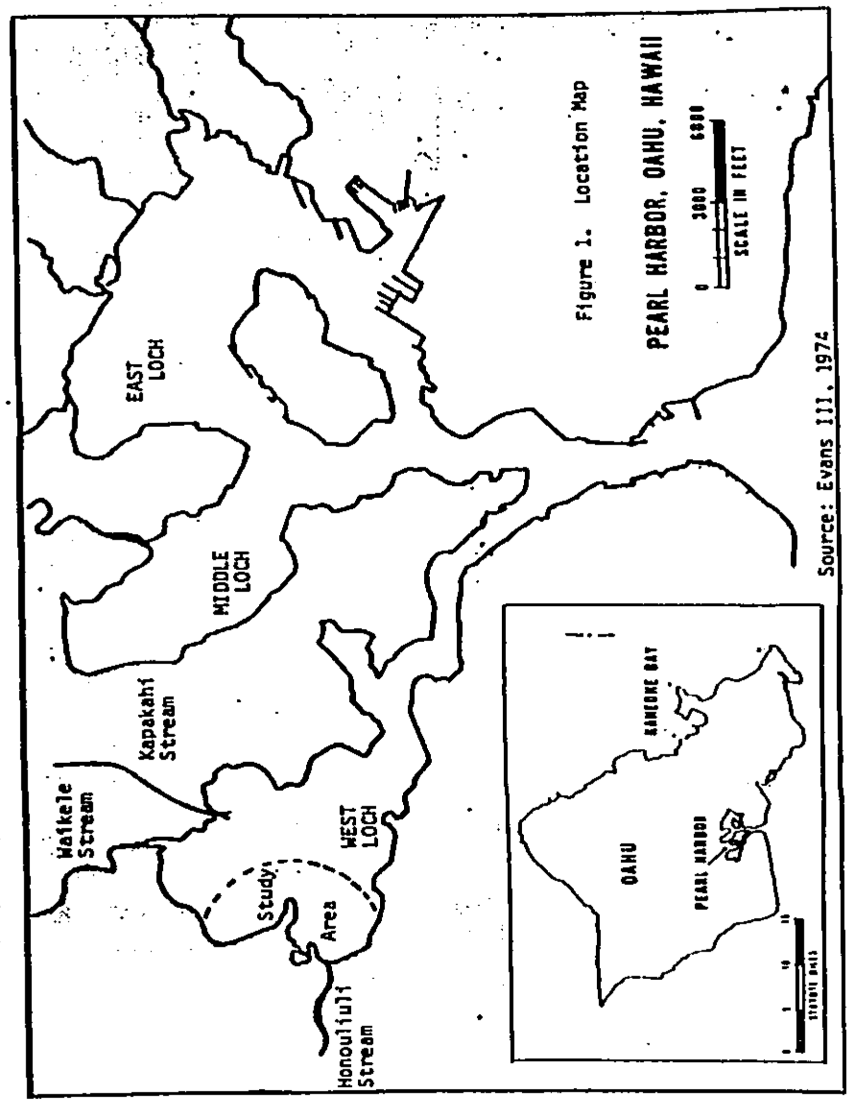


Figure 1. Location Map

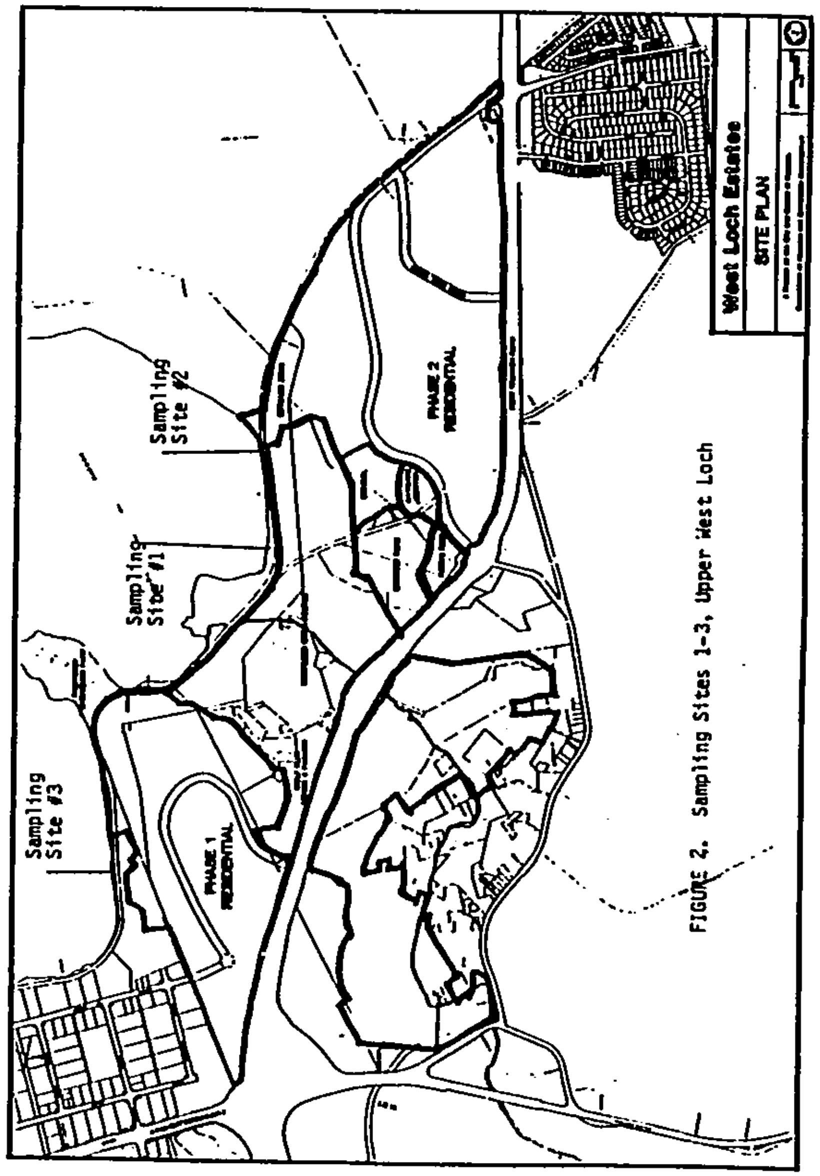
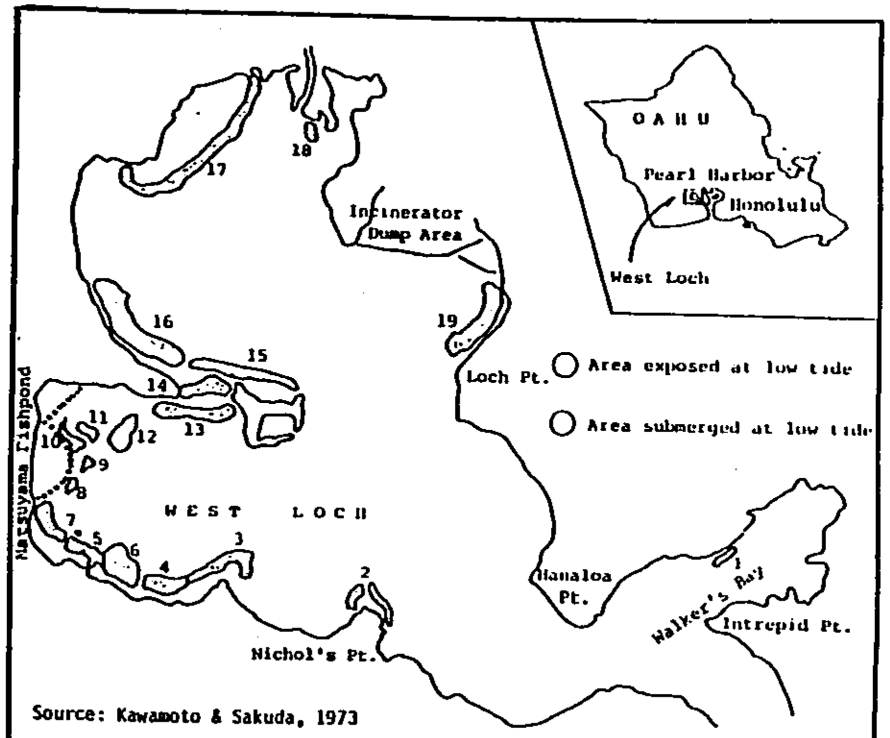


FIGURE 2. Sampling Sites 1-3, Upper West Loch



Source: Kawamoto & Sakuda, 1973

1. Walker's Bay Bed
2. One Rock Bed
3. Three Rock Bed
4. Salt Bed
5. Gilbert's Bed
6. Gilbert's Little Bed
7. Honouliuli Station Bed
8. South Gate Bed
9. Matsuyama Fishpond Bed
10. North Gate Bed
11. Matsuyama Little Bed
12. Matsuyama Submerged Bed
13. Honouliuli Parallel Bed
14. Honouliuli Mid-Channel Bed
15. Laulauniu Bed
16. Yoshida Bed
17. Hoaeae-Waikele Bed
18. Waikele Point Bed
19. Loch Point Bed

Figure 3. Major Oyster Beds, 1971

TABLE 1.

WATER QUALITY DATA - WEST LOCH

September 25, 1987

Time	Site	Temp.	Sal.	D.O.	Notes*
Site 1.					
0950	10' from shore	28.0	19.8	5.10	No wind, water clear,
0952	50' from shore	28.5	20.0	4.42	falling tide
0954	100' from shore	28.6	21.7	4.40	"
0959	200' from shore	28.8	23.8	4.05	"
1011	300' from shore	28.8	24.1	4.85	"
1016	500' from shore	28.7	24.2	4.75	"
1021	1000' from shore	28.8	26.6	5.20	edge of slope, 10 cm
1022	1000' from shore	28.9	27.9	5.10	edge of slope, 50 cm
Site 2.					
1045	20' from shore	28.1	18.3	4.85	No wind, water clear,
1047	50' from shore	28.0	21.4	4.45	falling tide
1050	100' from shore	28.4	21.3	4.50	"
1053	300' from shore	28.6	22.4	4.60	"
1057	500' from shore	28.7	24.9	5.10	"
1105	750' from shore	28.8	25.4	4.90	"
1105	800' from shore	28.9	27.1	5.20	edge of slope, 10 cm
1106	800' from shore	28.9	28.0	5.00	edge of slope, 50 cm
Site 3.					
1145	20' from shore	28.7	22.4	4.80	No wind, water clear,
1147	100' from shore	28.5	26.0	5.10	low tide
1150	200' from shore	28.9	26.6	5.50	"
1152	300' from shore	29.4	26.4	5.45	"
1155	400' from shore	29.8	27.4	5.40	edge of slope, 5 cm
1155	400' from shore	29.9	28.3	5.20	edge of slope, 30 cm

* Unless noted otherwise, all samples based on probe depth of approximately 15 cm.

TABLE 2.

WATER QUALITY DATA - WEST LOCH

September 26, 1987

Time	Site	Temp.	Sal.	D.O.	Notes*
Site 1.					
0940	10' from shore	30.5	27.0	4.45	No wind, clear water
0945	50' from shore	29.2	26.8	4.40	"
0947	100' from shore	28.5	27.2	4.50	"
0949	200' from shore	29.9	27.7	4.60	"
0957	300' from shore	29.4	28.1	5.10	Sustained winds**,
1002	500' from shore	29.8	28.8	5.45	water cloudy
1007	1000' from shore	29.8	28.8	5.60	"
1007	1000' from shore	29.8	28.8	6.05	"
1011	500' from shore	29.8	28.8	5.70	"
1015	50' from shore	29.9	28.6	5.45	"
1018	10' from shore	29.8	28.8	5.40	"
Site 2.					
1038	20' from shore	29.9	28.7	5.65	Sustained wind,
1039	50' from shore	28.9	28.7	5.35	water cloudy
1042	100' from shore	29.0	28.8	5.55	"
1045	300' from shore	29.2	28.2	5.25	"
1049	500' from shore	29.7	28.6	5.40	"
1053	800' from shore	28.9	29.0	6.05	edge of slope, 10 cm
1053	800' from shore	28.9	28.9	5.40	edge of slope, 50 cm
Site 3.					
1121	20' from shore	28.9	27.8	5.50	Sustained wind
1126	100' from shore	29.2	28.4	5.50	"
1136	200' from shore	29.3	28.8	5.65	"
1138	300' from shore	29.2	28.6	5.45	"
1142	400' from shore	29.2	28.6	5.40	edge of slope, 10 cm
1143	400' from shore	29.2	28.8	5.50	edge of slope, 40 cm

* Unless noted otherwise, all samples based on probe depth of approximately 15 cm.

** Strong and persistent wind began at 0955 hours and continued throughout remainder of day

TABLE 3

WATER QUALITY DATA - WEST LOCH

October 2, 1987

Time	Site	Temp.	Sal.	D.O.	Notes*
Site 1.					
1023	10' from shore	28.4	22.4	4.25	windy, dirty water, rising tide
1030	50' from shore	28.4	22.5	4.90	
1033	100' from shore	28.6	22.5	5.15	
1036	200' from shore	28.7	24.9	5.25	"
1038	300' from shore	28.6	24.5	5.45	"
1039	500' from shore	28.8	25.7	5.25	"
1042	1000' from shore	28.9	25.9	5.55	"
1235	10' from shore	29.0	25.0	5.25	high tide
1237	50' from shore	29.0	25.3	6.20	"
1240	100' from shore	29.0	25.2	6.00	"
1242	200' from shore	28.9	27.1	5.85	"
1244	300' from shore	28.9	27.5	5.65	"
1248	500' from shore	29.7	28.3	6.25	"
1253	1000' from shore	29.7	29.4	6.00	"
Site 2.					
1057	20' from shore	28.7	25.8	5.15	rising tide
1059	50' from shore	28.5	27.2	4.90	"
1102	100' from shore	28.9	27.9	5.25	"
1107	300' from shore	28.9	25.5	5.00	"
1110	500' from shore	28.9	27.4	5.60	"
1113	800' from shore	28.8	27.7	5.15	"
1302	20' from shore	29.2	29.1	5.40	high tide
1305	50' from shore	29.0	28.8	5.55	"
1309	100' from shore	29.0	29.2	5.25	"
1313	300' from shore	28.9	29.1	5.00	"
1317	500' from shore	29.2	29.4	5.65	"
1319	800' from shore	28.9	29.4	5.45	"

TABLE 3, CONTINUED

Time	Site	Temp.	Sal.	D.O.	Notes*
Site 3.					
1141	20' from shore	28.4	21.8	4.65	rising tide
1144	100' from shore	28.4	22.1	5.45	"
1147	200' from shore	28.8	24.7	5.50	"
1151	300' from shore	29.0	24.7	5.50	"
1156	400' from shore	28.9	24.7	5.25	"
1331	20' from shore	29.0	26.7	5.00	high tide
1334	100' from shore	29.0	26.9	5.00	"
1338	200' from shore	28.8	26.9	5.20	"
1341	300' from shore	29.0	26.8	5.20	"
1344	400' from shore	28.9	26.9	5.45	"

* Unless otherwise noted, all samples based on probe depth of approximately 15 cm.

TABLE 4

TIDAL DATA, SEPTEMBER 25, 1987*

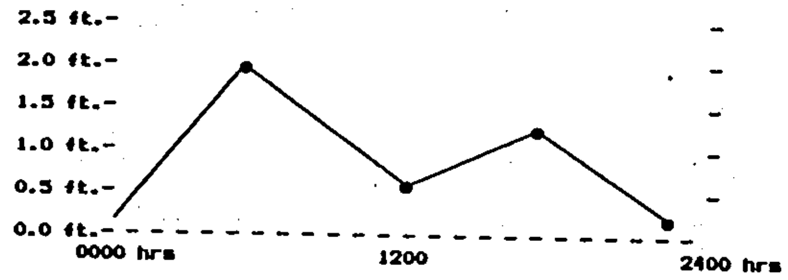
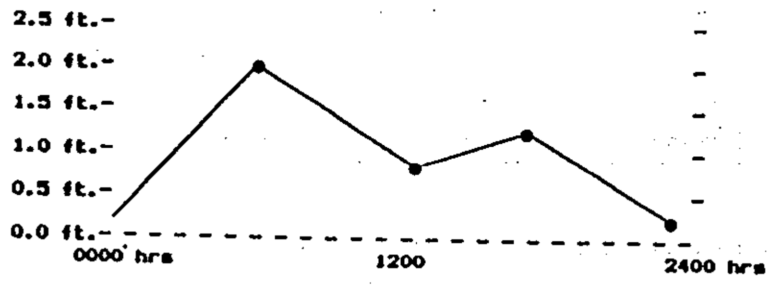


TABLE 5

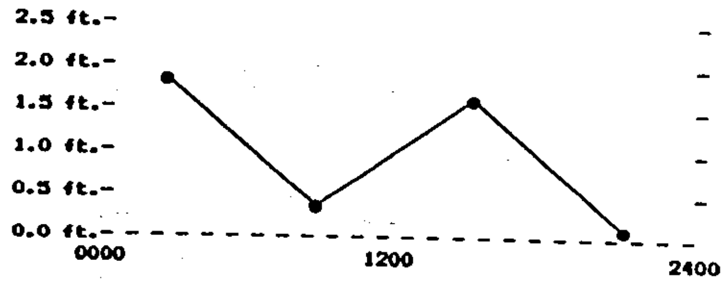
TIDAL DATA, SEPTEMBER 26, 1987*



* Source: Honolulu Star Bulletin, 9/26/85 (for Honolulu Harbor)

TABLE 6

TIDAL DATA, OCTOBER 2, 1987*



* Source: Honolulu Star Bulletin, October 2, 1987 (for Honolulu Harbor)

TABLE 7

CHECKLIST OF BENTHIC FAUNA, HONOULIULI REGION, WEST LOCH

TAXONOMIC GROUP/SPECIES	HABITAT*	ABUNDANCE RATINGS**
PORIFERA (SPONGES)		
Demospongiae		
Unident. sponge, red encrust.	M	C
Unident. sponge, brown branching	M	C
Unident. sponge, blue-green	M	U
CNIDARIA		
Hydrozoa		
Unident. hydrozoan	P	A
ANNELIDA		
Polychaeta		
Errantia		
Nereis sp.	M	U
Perinereis sp.	P	U
Sedentaria		
Serpulidae		
Hydroides elegans	P	C
Hyrdoides sp.	P	C
ARTHROPODA		
Crustacea		
Cirripedia		
Balanidae		
Balanus amphitrite	P	A
Decapoda/Natantia		
Alpheus sp. 1	M	U
Alpheus sp. 2	M	U
Decapoda/Reptantia		
Portunidae		
Thalamita integra	M	A
Scylla serrata	M	R
Xanthidae		
Lophozozymus sp.	M	U
Pilumnus oahuensis	P	U
MOLLUSCA		
Gastropoda		
Vermetidae		
Dendropoma platypus	M	U
Calyptraeidae		
Crepidula aculeata	P	C
Bivalvia		
Ostreidae		
Crassostrea virginica	M	A
Ostrea sandwichensis	M/P	U
Anomiidae		
Anomia nobilis	P	U
Hiatellidae		
Hiatella hawaiensis	M/P	C
CHORDATA		
Urochordata		
Ascidiacea		
Diplosoma macdonaldi	P	U
unident. solitary tunicate	P	U

* Codes: M = mudflats/rubble; P = pilings/underwater solid substrates/mangrove prop roots, etc.

** Codes: A = abundant; C = common; U = uncommon; R = rare (only one or two observed).

TABLE 8

CHECKLIST OF FISHES, HONOULIULI REGION, WEST LOCH

TAXONOMIC GROUP/SPECIES	ABUNDANCE RATING*
CHONDRICHTHYES (SHARKS & RAYS)	
Sphyrnidae (Scalloped Hammerhead; Mano kihikihi)	
Aphyrna lewini Griffith & Smith	U
Myliobatidae (Eagle Ray; Hihimanu)	
Aetobatus narinari Euphrasen	R
OSTEICHTHYES (BONEY FISHES)	
Hemiramphidae (Halfbeaks; Iheihe, Me'e-me'e)	
Hemiramphus depauperatus Lay & Bennett	U
Kuhliidae (Flagtail; Aholehole)	
Kuhlia sandvicensis Steindachner	U
Carangidae (Jacks; Papio, Omilu)	
Caranx melampygus Cuvier & Valenciennes	C
Cichlidae (Tilapia)	
Oreochromis mossambica	A
Mugilidae (Mullets; Ama-ama)	
Mugil cephalus Linnaeus	A
Syphraenidae (Barracuda; Kaku)	
Sphyraena barracuda Walbaum	R
Blenniidae (Blenny; Pao'o)	
Unident. blenny	R
Chanidae (Milkfish; Awa)	
Chanos chanos Forskal	C
Muraenidae (Moray Eel; Puhi Laumilo)	
Gymnothorax undulatus Lacepede	R

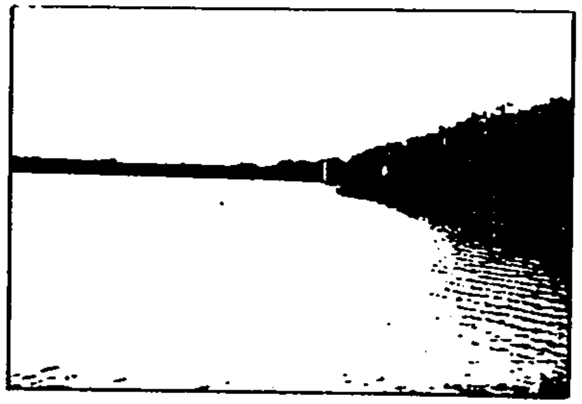
Code: A = Abundant; C = Common; U = Uncommon; R = Rare (only one or two observed)

TABLE 9

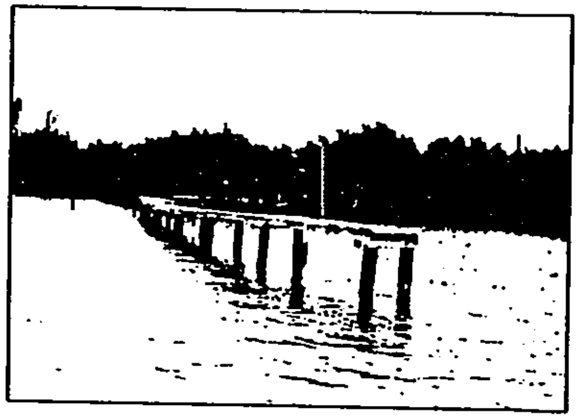
REPORTED RANGES FOR VARIOUS WATER QUALITY PARAMETERS
UPPER WEST LOCH BASIN

Parameter	No. Samples	Mean	Range	Site	Sources*
Temperature (C.)	16	22.7	16.9-27.0	Honouliuli	2
	-		26.0-27.0	West Loch	3
	17	-	23.5-27.0	West Loch	4
	-	28.0	-	Honouliuli	6
Salinity (ppt)	-	-	14.1-35.10	West Loch	2
	-	-	30.0-32.8	West Loch	3
	15	-	4.5-22.0	West Loch	4
	-	-	24.0-32.48	Honouliuli	6
Diss. Oxygen (ppm)	14	4.0	2.48-5.52	Honouliuli	1
	33	7.2	5.80-7.90	Honouliuli	1
	26	7.5	6.60-8.40	Laulaunui I.	1
	-	-	3.70-9.20	Honouliuli	2
	-	-	0.10-6.40	Honouliuli	2
	14	-	1.10-6.30	Honouliuli	2
pH (units)	16	-	7.10-7.90	Honouliuli	2
	-	-	6.80-7.80	Waikele Str	2
Turbidity (JTU)	17	33.7	2.5-175.0	Honouliuli	2
	13	22.4	3.5-150.0	Waikele Str	2
Total Coliform/100 ml	11	-	0-2,400	West Loch	3
	21	-620	-2,400,000	West Loch	4
	-	-	3,000-33,500	West Loch	5
Fecal Coliform/100 ml	21	-	0-23,000	West Loch	4
	-	-	0-1,100	West Loch	3
	20	-	45-240,000	West Loch	5

*1 = Naval Civil Engineering Laboratory, 1973a; 2 = Naval Civil Engineering Laboratory, 1973b; 3 = DLNR, 1971; 4 = Sparks, 1963; 5 = FWPCA, 1969; 6 = Au, 1965.



Photograph 1. Typical view of mangrove-mudflat community.



Photograph 2. Typical piling substrate for epifaunal community

Photograph 3. Mangrove proproot zone.

Photograph 4. Adult Samoan crab.

APPENDIX G

Traffic Impact Assessment Report
For the Proposed West Loch Estates Subdivision
Ewa, Oahu, Hawaii

by

PACIFIC PLANNING & ENGINEERING, INC.

September 1987

TRAFFIC IMPACT ASSESSMENT REPORT

FOR THE PROPOSED WEST LOCH ESTATES SUBDIVISION

Ewa, Oahu, Hawaii

September 1987

Pacific Planning & Engineering, Inc.

Prepared for:

City and County of Honolulu
Department of Housing and Community Development

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APPENDICES

LIST OF FIGURES

INTRODUCTION

The Department of Housing and Community Development (DHCD) of the City and County of Honolulu is proposing to construct a residential development composed of 1,500 residential single-family housing units and 150 elderly housing units in the West Waipahu area.

The development is divided into two phases. Phase I consists of 586 single-family units, an 18-hole golf course, and a Nature Conservation park along the shoreline of Pearl Harbor. Phase II consists of 764 single-family units, 150 elderly units, a commercial business area, a district park, a park and ride facility, an elementary school site and child care facility.

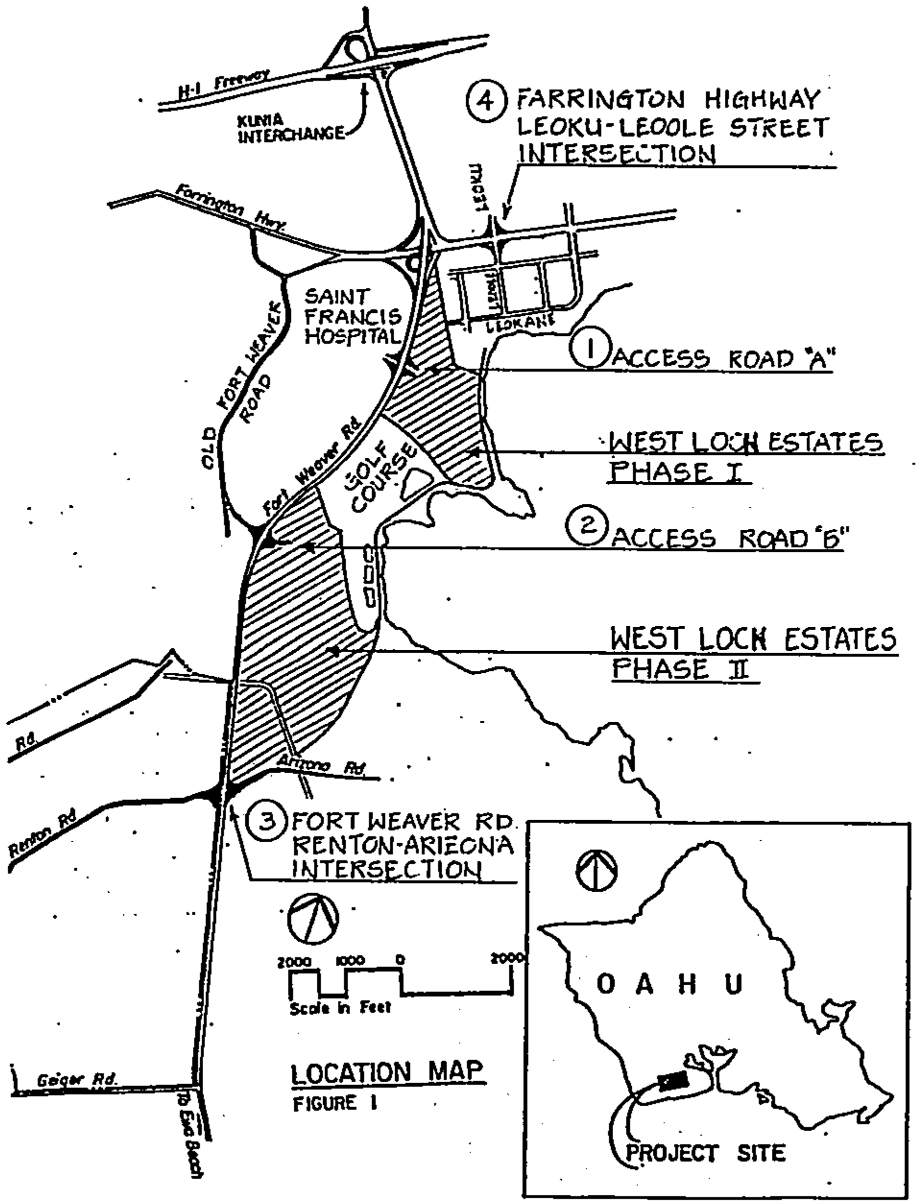
The project site is located along Fort Weaver Road in the area commonly referred to as West Loch, near Waipahu. Figure 1 shows the general project location. The project is bordered by Waipahu to the North, Fort Weaver Road to the West, Arizona Road to the South and Pearl Harbor to the East. Phase I of the development will be located across Fort Weaver Road from the new Saint Francis Hospital West, which is presently under construction.

The proposed project will have two access permitted locations, access Roads "A" and "B", which will provide the major access to Phases I and II, respectively. Secondary accesses to the proposed development will be through Leokane Street in the Waipahu industrial lots and another with Arizona Road. The 18-hole golf course will be located on both sides of Fort Weaver Road with a golf cart underpass providing access across the highway. The park and ride facility will provide a bus pick-up and drop-off area, a bus turn-around area, and a 350-space parking lot for bus riders.

This traffic study report identifies and evaluates the expected impact of forecast traffic generated by the proposed development in the year 1991. The analysis will also consider present and future developments along Fort Weaver Road and the overall impact on traffic on nearby roadways. The report includes a description of existing conditions and projected future conditions when the proposed developments are completed.

This report addresses impacts in the afternoon (pm) peak hour (3:30 - 4:30 PM), when

recent traffic counts indicate the pm peak hour traffic volume averaged about ten percent greater than the morning (am) peak hour traffic volumes. The proposed project is expected to generate more traffic during the pm peak hour due to the residential nature of the development.



LOCATION MAP
FIGURE 1

EXISTING CONDITIONS

Area Conditions and Roadway System

The general area is undeveloped or under cane cultivation, with some twenty or so homes on the project site. The nearest residential area, Honouliuli, is located west and across of Fort Weaver Road. There are no major developments planned for the immediate area. Major new residential areas are planned for the area south of Renton Road. The traffic impacts of these are addressed in a later chapter.

Fort Weaver Road provides the primary access to the proposed development and serves as a major arterial roadway between H-1 Freeway and the existing Ewa Beach Community. The roadway is a four-lane divided highway with a wide grassed medial that provides roadway width for left-turn storage lanes into the proposed subdivision.

There are no sight distance or other physical roadway constraints which would result in unusual traffic safety concerns or conditions at the proposed intersections with Fort Weaver Road. The speed limits are 35 and 45 miles per hour. There is a designated bikeway on the east side of the roadway. There are no driveway access points. All access is controlled by the State Department of Transportation, Highways Division.

Intersection improvements for the St. Francis Hospital West, presently under construction, will provide deceleration and left turn storage lane for northbound Fort Weaver Road traffic turning left into the hospital site. In addition, a traffic signal system was recommended at the intersection to improve egress during the afternoon peak hour.

Arizona Road is located along the Southern portion of the project and will serve as the secondary access for Phase II. It is an extension of Renton Road and is signalized at the intersection with Fort Weaver Road. It is presently an unpaved road servicing the West Loch U.S. Naval Magazine installation.

Leokane Street is located along the Northern portion of the project and serves as the secondary access for Phase I. Leokane Street is intersected by Leoole Street which accesses Farrington Highway in Waipahu. These streets serve the industrial area located northeast of the proposed project.

Existing Traffic Conditions

Existing traffic volumes along Fort Weaver Road and Farrington Highway were documented using recent data from the Highways Division of the State Department of Transportation (DOT) and the Department of Transportation Services of the City and County of Honolulu. Additional data on turning movements during the pm peak hour at the Fort Weaver Road/Renton Road intersection and Farrington Highway/Leoole street intersection in Waipahu were obtained by PPE, Inc. on Wednesday, August 19, 1987. Figures 2 and 3 are schematic depictions of these two intersections. This day was specifically selected. Days closer to the weekend show greater differences than the "norm". There were no special events or unusual road conditions such as accidents or rainy weather. However, road construction on Fort Weaver Road, South of Renton Road was underway.

Existing traffic counts conducted by DOT in 1985 and PPE in 1987 are summarized in Table 1 for each highway by direction. Fort Weaver Road and Farrington Highway consistently carry higher two-way hourly traffic volumes during the pm peak hour between 3:30 and 4:30 pm.

The results of the manual count of the turning movements at the two intersections (See Table 1) show that Fort Weaver Road, at the Renton Road intersection, carried 1,142 vehicles southbound towards Ewa Beach and 769 vehicles in the Northbound direction towards Kunia. Farrington Highway, at the Leoole Street intersection, carried 1,691 vehicles westbound towards Waianae and 1,867 vehicles eastbound towards Honolulu.

Existing turning volumes during the pm peak hour at the intersections of Fort Weaver Road and Renton/Arizona Road, and Farrington Highway and Leoole/Leoku Streets are shown in Figure 4. These values are used in the evaluation of present (1987) traffic flow quality and future (1991) intersection capacity checks. This is described fully in the next chapter as Traffic Forecasts.

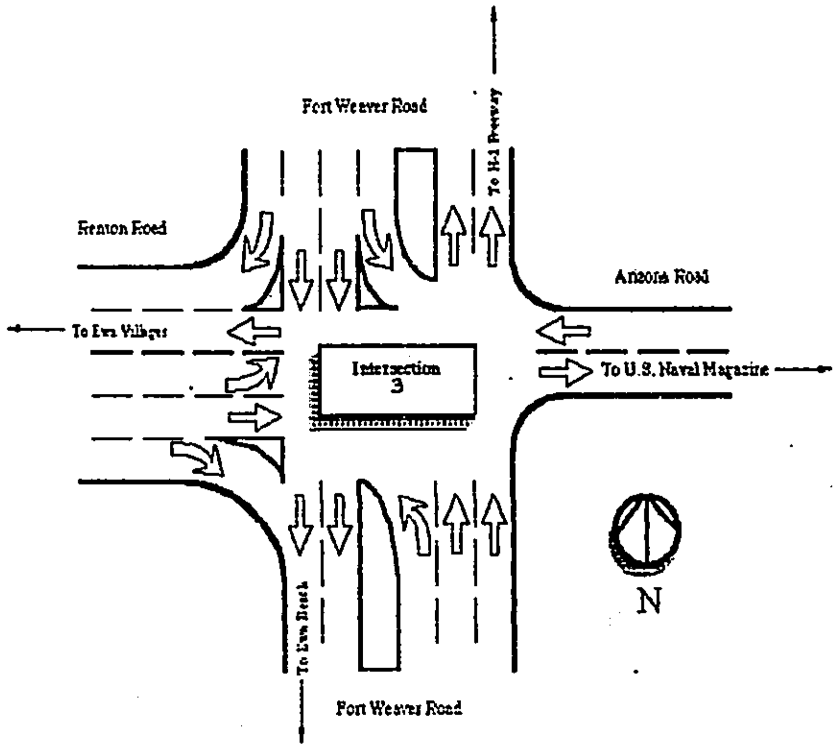


Figure 2. Intersection of Fort Weaver Road & Renton/Arizona Road

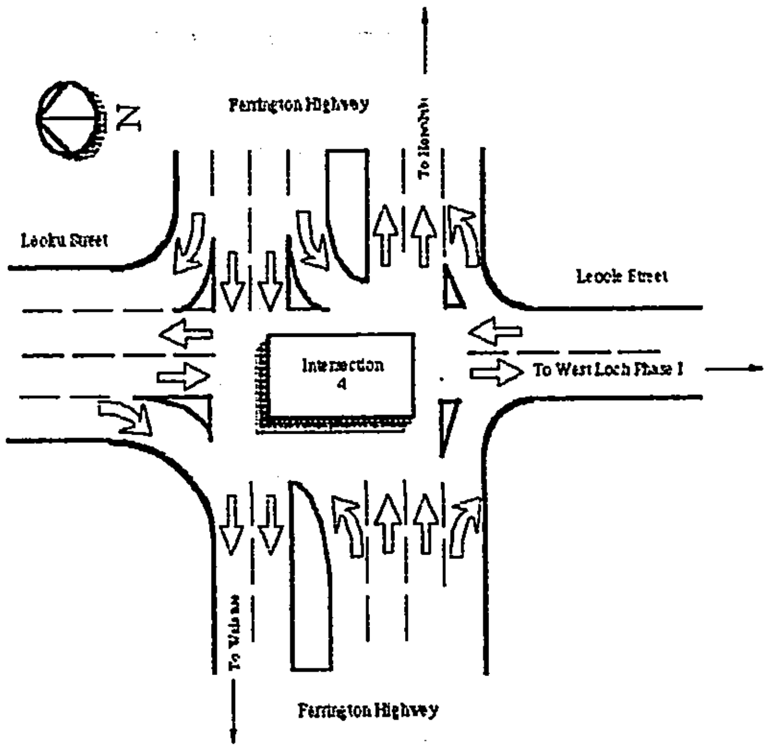


Figure 3. Intersection of Farrington Highway & Leoole/Leoku Street

Table 1. Intersection Traffic Counts

Traffic Count	Fort Weaver Road Northbound	Fort Weaver Road Southbound	Farrington Highway Eastbound	Farrington Highway Westbound
State DOT (Mechanical Count)				
Dec 18-19, 1985 (24-Hour)	12,414	12,651	-	-
AM Peak Hour (12/19/85)	1,141	746	-	-
Pm Peak Hour (12/18/85)	832	1,286	-	-
Aug 14-15, 1985 (24-Hour)	-	-	13,741	12,809
AM Peak Hour (8/15/85)	-	-	907	854
PM Peak Hour (8/14/85)	-	-	1,218	1,038
PPE (Manual Count)				
PM Peak Hour (8/19/87)	769	1,142	1,867	1,691

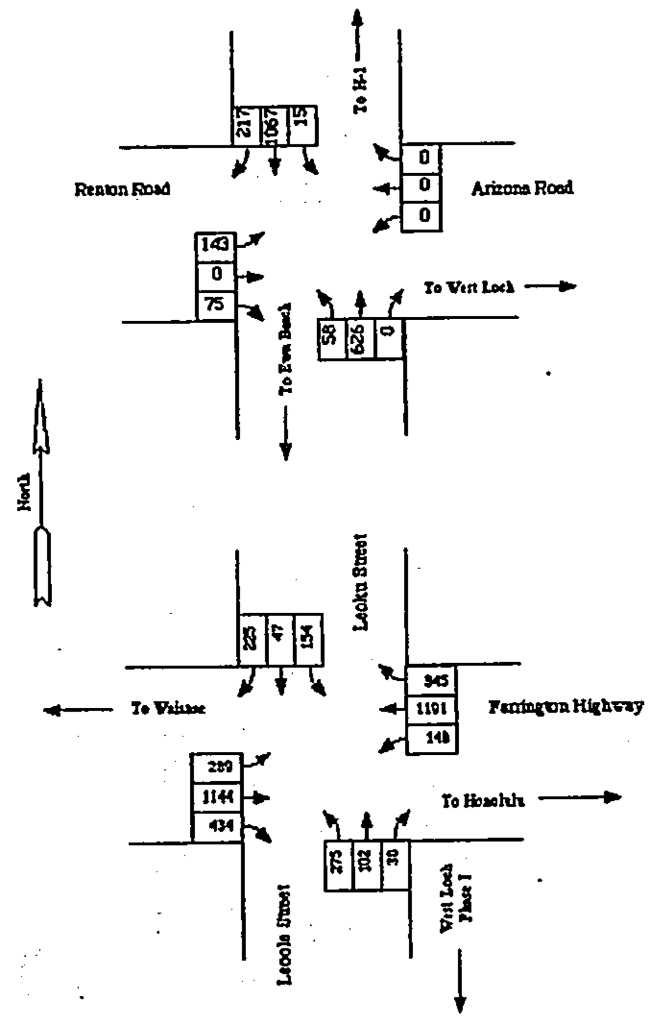


Figure 4. 1987 PM Peak Hour Traffic Volumes.

TRAFFIC FORECASTS

Future traffic were estimated for the year 1991 for two conditions--with and without West Loch Estates. All other variables such as the number of lanes on Fort Weaver were assumed to be the same until that time. Intersection changes are addressed in the chapter entitled Traffic Impacts. Future traffic generated by developments south of Renton Road were estimated. The year 1991 was selected for analysis as it was deemed to be the year when the project would be completed and occupied.

Trip Generation

The methodology used to determine number of trips generated by proposed or new projects is based upon trip rates established in the Institute of Transportation Engineers Trip Generation Report (Third Edition) 1982. These vehicle trip rates are based on average conditions and were reviewed for possible adjustment for local conditions.

The rates are used to calculate vehicles entering and exiting the project during the pm peak hour. The analysis accounts for the two-phases being physically separated. Two zones were created to account for the separation and necessary assignment to the Fort Weaver intersections.

Phase I development include 586 single family residential units, a Nature Conservation Park and an 18-hole golf course with clubhouse and parking area. Phase II consists of 764 single family dwelling units, 150 elderly housing units, a district park, a commercial development with 40,000-50,000 gross square feet of space, a civic center consisting of a day care center for 250 pre-schoolers, a park and ride area with 350 parking stalls and an area reserved for future Elementary School.

These land use activities are expected to generate trips in and out of the project. Certain uses will contribute negligible trips during the afternoon peak hour. For example, school traffic will be negligible after 3:30 pm. The analysis also accounts for internal trips within the project during the pm peak hour, as well as a potential reduction in the number of trips as a result of the park and ride facility.

The analysis estimates vehicle trips during the pm peak hour for the residential areas and the commercial center in Phase I and II. Table 2 lists the land use (parameter) and the

trip generation rates, while Table 3 list the number of trips generated by the land use activities.

Trip Distribution

Trip distribution determines the predicted origins and destinations of traffic generated by new projects. The trips distribution used in this study is based on completion of Phase I and II of West Loch Estates. The trips were distributed in three directions representing the major areas of Oahu that would have vehicles travelling between them and this area of Ewa. The directions are north to H-1 Freeway or Waipahu, south to Ewa Beach, and west to Ewa Village from West Loch Estates and new developments in the area, serviced by Fort Weaver Road.

Distribution tables based on population, employment, and dwelling units from various references were analyzed. In addition, as recommended by travel forecasting publications from the Institute of Traffic Engineers, trip distribution tables from the local urban transportation planning process were reviewed. Trip tables from the most recent forecasting effort, HALI 2000, by the Oahu Metropolitan Planning Organization were obtained and assessed for application in forecasting trip interchanges. The distribution results from these tables were modified based on dwelling unit and job distributions to account for the differences between the specific study zone boundaries and the data summarized for areas within the Ewa Development Area.

Traffic Assignment

Trip interchanges between zone pairs were estimated, and assigned to the roadways serving the future development. Turning movements at each intersection were estimated for the estimated traffic for each of the land use activities identified in Tables 2 and 3.

Analyses included the estimation of vehicle trips in the pm peak hour for the park and ride lot. Trips exiting and entering the lot include buses as well as vehicles. Bus frequencies were investigated and a frequency of 10 buses during the peak hour was utilized. Passengers loading and off-loading were estimated based on service to other areas. An average car occupancy of 1.5 was used for exiting vehicles. For simplicity, it was assumed that vehicles would be from West Loch and areas south of the project. (Usage levels beyond 1991 were not investigated, and no conclusions should be drawn

Table 2. Trip Generation Rates

Land Use (Parameters)	Daily (vpd)[1] Enter & Exit	AM Peak Hour (vph)[2]		PM Peak Hour (vph)	
		Enter	Exit	Enter	Exit
Phase I					
Residential					
Single Family	10.00/unit	0.21	0.55	0.63	0.37
Recreation					
Golf Course	6.90/acre	0.20	0.05	0.05	0.20
Nature Conser. Park	3.60/acre	-	-	-	-
Phase II					
Residential					
Single Family	10.00/unit	0.21	0.55	0.63	0.37
Elderly Housing	3.30/unit	-	-	-	-
Recreation					
District Park	3.60/acre	-	-	-	-
Civic					
Elementary School	1.02/student	-	-	-	-
Day Care Facility	1.02/child	-	-	-	-
Park and Ride	2.00/acre	-	-	-	-
Commercial					
Neighborhood Center	0.1179/s.f.	2.07	2.03	6.84	7.03

[1]Vehicles per day
[2]Vehicles per hour

Table 3. Trip Generation

Land Use (Parameters)	Daily (vpd)[1] Enter & Exit	AM Peak Hour (vph)[2]		PM Peak Hour (vph)	
		Enter	Exit	Enter	Exit
Phase I					
Residential					
586 Single Family	5,860	123	322	369	217
Recreation					
155 Ac. Golf Course	1,070	31	8	8	31
20 Ac. Nature Park	72	-	-	N[3]	N
Total Trip Ends Phase I	7,002	154	330	377	248
Phase II					
Residential					
764 Single Family	7640	160	420	481	283
150 Elderly Housing	495	-	-	15	15
Recreation					
17.8 Ac. District Park	64	-	-	N	N
Civic					
600 Student Elem	612	-	-	N	N
250 Child Day Care	255	-	-	N	N
350 Space Park & Ride	700	-	-	40	150
Commercial					
40-50,000 Sq Ft Neighborhood Center	5,305	43	91	308	316
Total Trip Ends Phase II	15,071	253	511	789	599

[1]Vehicles per day
[2]Vehicles per hour
[3]Negligible

based on these near-term estimates of transit service. Future changes and higher frequencies are subject to fleet size, operational considerations, and other factors.)

The general method used consists of adding the traffic volumes during the pm peak hour for the present conditions or 1987, the traffic volumes on the roadways generated by new residential units south of Renton Road, and the expected traffic volumes generated by West Loch Estates. Present year volumes are shown in Figure 2. Volumes for other intersections not shown are based on DOT tube counts. The 1991 traffic forecast results for the conditions "with West Loch" and "without West Loch" are presented in Appendix B. These worksheets are provided for more detailed information on specific turning movements at the intersections with Fort Weaver Road.

TRAFFIC IMPACTS

Impacts are usually measured by the change in level-of-service (LOS) for a given intersection or series of traffic movements. These terms are defined in Appendix A and provide the reader with a basis for interpreting the results of the following capacity analysis.

Impacts may be measured in terms of capacity level at signalized intersections. "Planning Analysis" of an intersection is an evaluation of the capacity of an intersection without considering the details of signalization contained in the Highway Capacity Manual. It is a basic assessment of whether capacity is likely to be exceeded for a given set of traffic volumes and intersection geometrics.

As part of the analysis requirements, the study assumes the major intersections are either signalized or will be signalized, and the traffic lights synchronized to obtain maximum green time along Fort Weaver Road, between the proposed access connection to Phase I West Loch Estates development project and Renton Road intersection.

Intersection analysis was conducted for the following intersections:

1. Fort Weaver Road and Road "A" (Primary Access to Phase I),
2. Fort Weaver Road and Road "B" (Primary Access to Phase II),
3. Fort Weaver Road and Renton-Arizona Road (Secondary Access to Phase II), and
4. Farrington Highway and Leoku-Leoole Street (Secondary Access to Phase I).

The Critical Movement Analysis Planning Application (Planning Analysis) from the revised (1985) Highway Capacity Manual (HCM) was used to estimate the capacity for the above intersections. It was assumed that those intersections not now signalized would be in 1991 for the purpose of analysis.

The 1991 volume forecasts for Phase I and II were assigned to the intersections to estimate pm peak hour turning movements at each of the four intersections. These were added to existing volumes and future traffic forecasts generated by other residential development to be occupied prior to 1991.

The method to analyze the level of intersectional capacity attainment consists of comparing the higher sum of conflicting straight and left turn movements for one roadway and adding the greater to its complement for the other roadway. An example of the Worksheet is provided in Appendix C. The analysis was made for the four intersections for 1987, 1991 without West Loch, and 1991 with West Loch.

The results of the intersection analysis are presented in Table 4. It presents the critical volumes for the named intersections. The following ranges are given by the HCM as general indicators of intersection capacity:

-Less than 1,200 vehicles per hour indicates "under-capacity" conditions at the intersection.

-Between 1,200 and 1,400 indicates "near-capacity" conditions.

- Exceeding 1,400 indicate "over-capacity" and may require additional lanes, or other intersection improvements.

Table 4 shows that only the Farrington/Leoole Street intersection is now operating near capacity. It indicates that during the pm peak hour level in 1991 none of the intersections would be operating at or over capacity. With the West Loch project, the intersections of Ft. Weaver Road with Phase I and Phase II would operate near capacity in 1991.

Table 4. Critical Volumes for 1991 Forecasts

Intersection	1987	C.L.[a]	w/o West Loch	C.L.	w/ West Loch	C.L.
1	650	Under	1145	Under	1321	Near
2	650	Under	987	Under	1280	Near
3	735	Under	1074	Under	1142	Under
4	1206	Under	1327	Near	1387	Near

[a]Without West Loch

1 Ft Weaver Road & Access Road "A"

2 Ft Weaver Road & Access Road "B"

3 Ft Weaver Road & Renton-Arizona Road

4 Farrington Highway & Leoole-Leoku Street

CONCLUSIONS AND RECOMMENDATIONS

The result of the 1991 forecasts show that the proposed West Loch Estates project will increase traffic volumes along Fort Weaver Road during the pm peak period. The critical traffic flows are expected to occur during the afternoon peak hour, when both the ambient traffic and projected traffic are at a peak. Based on the capacity analysis results, it is concluded that West Loch traffic will not bring an intersection to over-capacity levels.

With the anticipated growth in future years, it is recommended that turning lanes on Fort Weaver Road be considered for the Phase I and II intersections. Such improvements will contribute to better flow and less delay at the intersections, as well smoother merges onto Fort Weaver Road.

During Phase I development, it is recommended that the contemplated traffic signal operation of Fort Weaver Road and the access Road "A" intersection be upgraded to provide for a protected left turn for southbound traffic turning left into Phase I of West Loch Estates. Provision should be made for a left turn storage lane on Fort Weaver Road for that movement.

Access from the Phase I development through the Waipahu Industrial Lots will increase traffic volumes slightly along Leokane and Leoole Streets. To provide increased traffic capacity at the signalized intersection of Leoole Street and Farrington Highway, a possible action would be to modify the existing pavement markings on the south leg to two northbound lanes and one southbound lane. Given the proportion of turning movements on the northbound approach, the right lane should be made to allow left, straight and right turns. The left lane should be an exclusive left turn lane.

Traffic signal warrants for interruption of traffic flow are likely to be met for the Access Road "B" intersection with Fort Weaver Road which serves the Phase II development plans for West Loch. Signals should be considered and plans developed based on future traffic patterns. It is recommended that new developments south of Renton Road be included in the traffic signal timing plans.

Access for the Phase II development on Arizona and Ft. Weaver Roads will not require any significant remedial action since the signalized intersection is expected to operate under

capacity with completion of Phase II. Improvements on Arizona Road are being contemplated for serving internal access needs.

APPENDIX A

APPENDIX A
DEFINITION OF LEVEL-OF-SERVICE

The concept of levels of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

Level-of-Service definitions--In general, the various levels of service are defined as follows for uninterrupted flow facilities:

Level-of-service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

Level-of-service B is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

Level-of-service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

Level-of-service D represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

Level-of-service E represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuver. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

Level-of-service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go wave, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of the vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

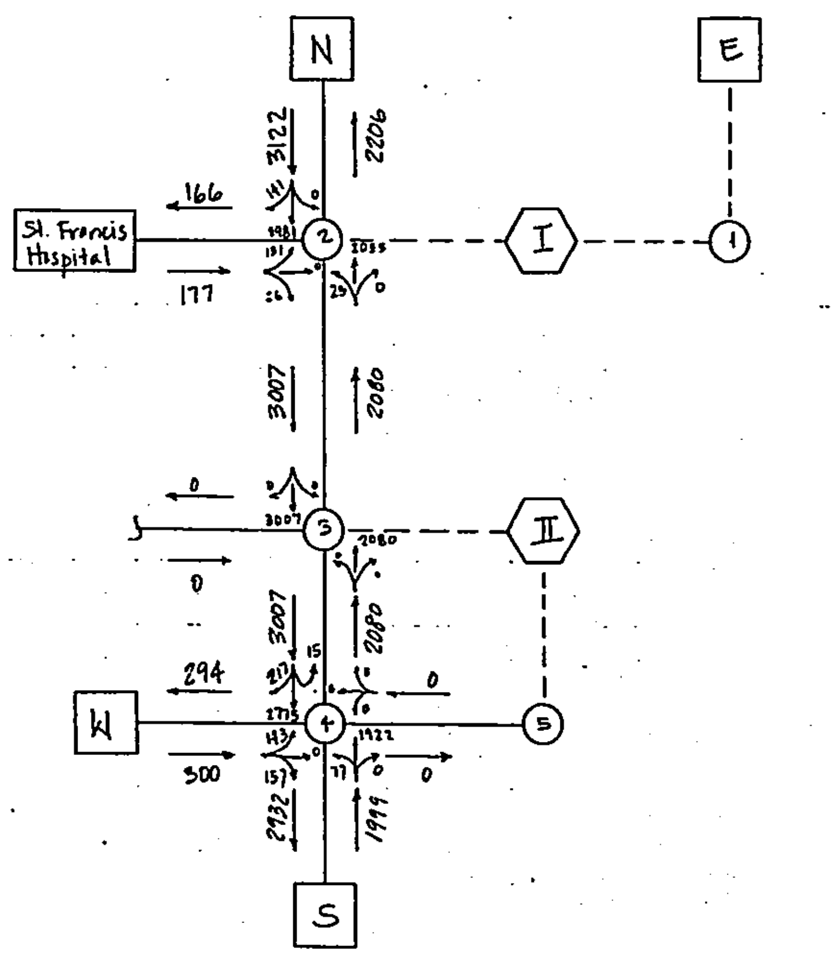
These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

APPENDIX B

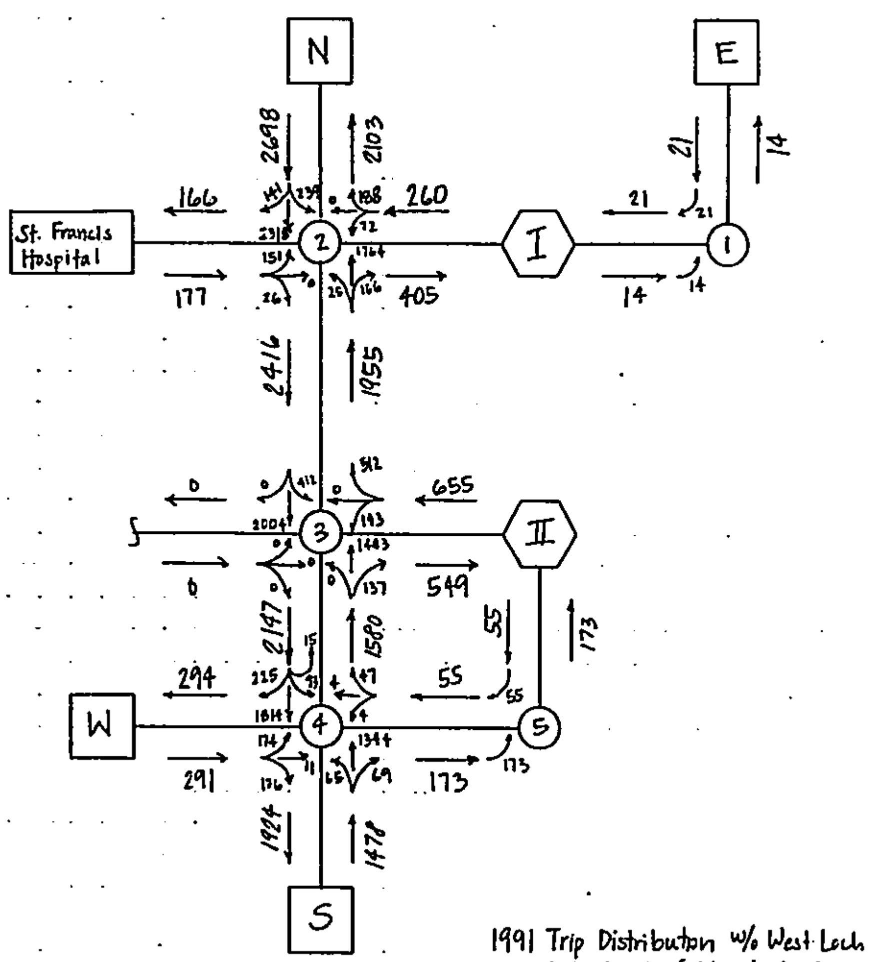
1991 TRAFFIC FORECASTS

1997 TRIP DISTRIBUTION FOR THE PM PEAK HOUR w/o WEST LOCH



1987 PM Peak Hr Traffic
\+ Trips Into St Francis Hospital
\+ Trips Out of St Francis Hospital
\+ Trips Into EWA Area 1987–1997
\+ Trips Out of EWA Area 1987–1997
= 1997 Trip Distribution w/o West Loch

1991 TRIP DISTRIBUTION FOR THE PM PEAK HOUR W/ WEST LOCH



1991 Trip Distribution w/o West Loch
\+ Trips Into & Out of West Loch Only
= 1991 Trip Distribution w/ West Loch

CORRECTION

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

APPENDIX A

APPENDIX A
DEFINITION OF LEVEL-OF-SERVICE

The concept of levels of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

Level-of-Service definitions--In general, the various levels of service are defined as follows for uninterrupted flow facilities:

Level-of-service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

Level-of-service B is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

Level-of-service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

<u>Level-of-service D</u> represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

<u>Level-of-service E</u> represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuver. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

<u>Level-of-service F</u> is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go wave, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of the vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

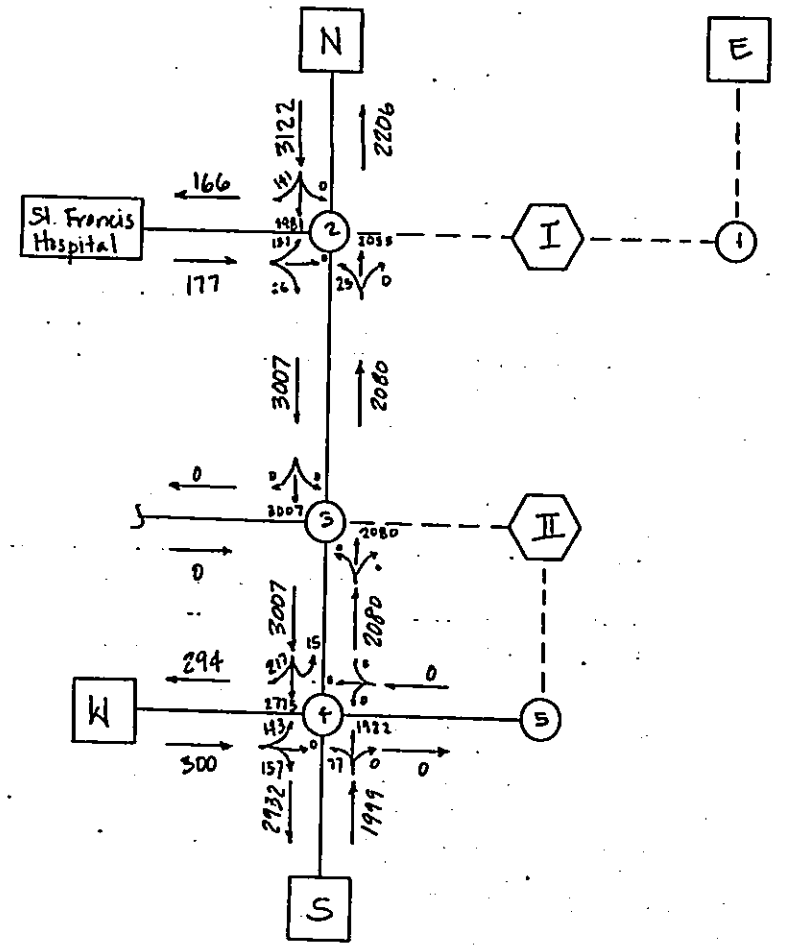
These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

APPENDIX B

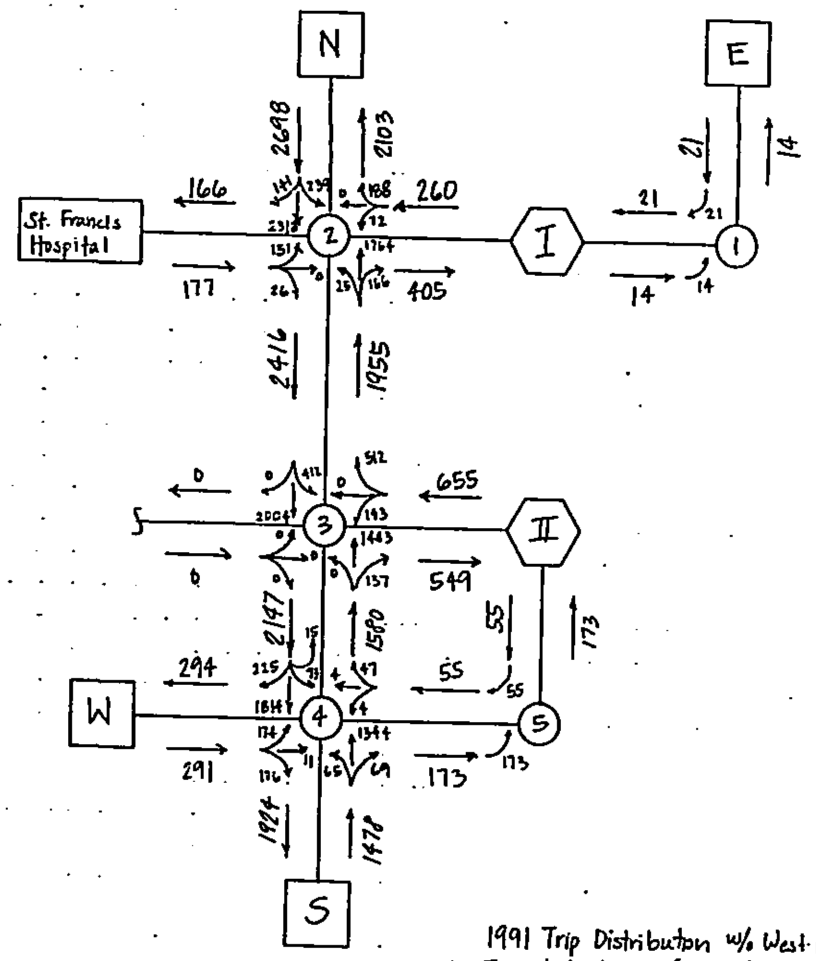
1991 TRAFFIC FORECASTS

1997 TRIP DISTRIBUTION FOR THE PM PEAK HOUR w/o WEST LOCH



1987 PM Peak Hr Traffic
+ Trips Into St Francis Hospital
+ Trips Out of St Francis Hospital
+ Trips Into EWA Area 1987–1997
+ Trips Out of EWA Area 1987–1997
= 1997 Trip Distribution w/o West Loch

1991 TRIP DISTRIBUTION FOR THE PM PEAK HOUR W/ WEST LOCH



1991 Trip Distribution w/o West Loch
+ Trips Into & Out of West Loch Only
= 1991 Trip Distribution w/ West Loch

APPENDIX C

PLANNING APPLICATION WORKSHEETS

INTERSECTION CAPACITY ASSESSMENT

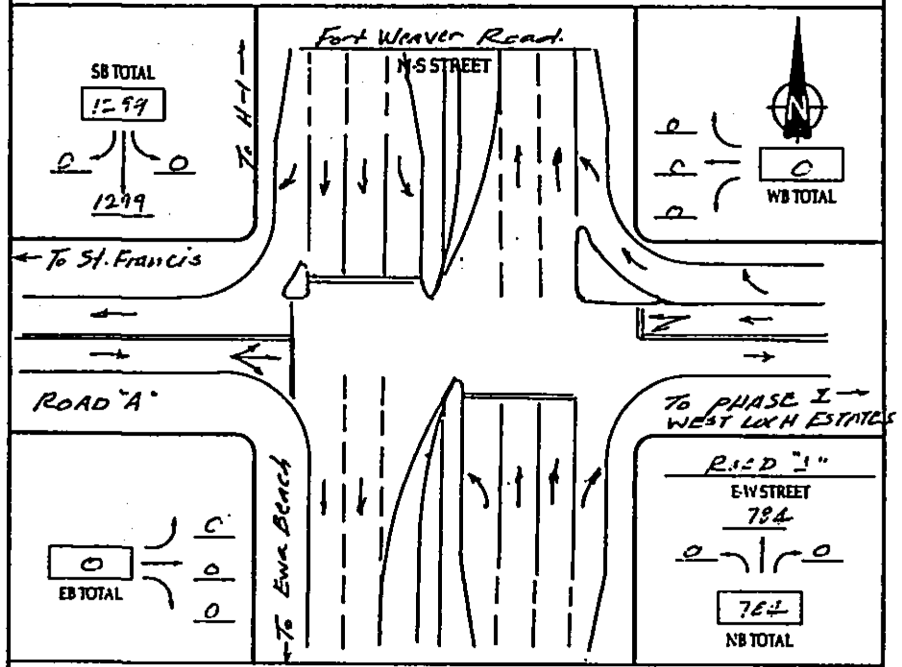
1987 CAPACITY LEVEL

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Road & Road "A" Date: Aug 19 1987

Analyst: UCA Time Period Analyzed: 3:30 - 5:30 PM

Project No. 1987 Loch Estates City/State: City & County of Honolulu



EB LT = 0	NB LT = 0
WB TH = 0	SB TH = 650
$\boxed{0}$ OR	$\boxed{650}$ OR
WB LT = 0	SB LT = 0
EB TH = 0	NB TH = 392
$\boxed{0}$	$\boxed{392}$

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

0 (E-W CRITICAL) + 650 (N-S CRITICAL) = 650 STATUS? UNDER

1991 CAPACITY LEVEL W/O WEST LOCH

SIGNALIZED INTERSECTIONS 9-81

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Road & Road "A" Date: Sept 1991

Analyst: HCA Time Period Analyzed: 3:30 - 6:30

Project No. WEST LOCH ESTATES City/State: City & County of Honolulu

Fort Weaver Road
N-S STREET

SB TOTAL 2079
141 | 0
1936

WB TOTAL 0
0 / 0 / 0

EB TOTAL 177
151 / 0 / 26

Road "A"
E-W STREET
1272
25 |
NB TOTAL 1297

EB LT	=	151
WB TH	=	0
		151
WB LT	=	0
EB TH	=	0
		0

OR

NB LT	=	25
SB TH	=	969
		994
SB LT	=	0
NB TH	=	636
		636

OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

151 (E-W CRITICAL) + 994 (N-S CRITICAL) = 1145 STATUS? under

1991 CAPACITY LEVEL W/ WEST LOCH

SIGNALIZED INTERSECTIONS 9-81

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Road & Road "A" Date: Sept 1991

Analyst: HCA Time Period Analyzed: 3:30 - 6:30 PM

Project No. West Loch Estates City/State: City & County of Honolulu

Fort Weaver Road
N-S STREET

SB TOTAL 2692
141 | 260
2291

WB TOTAL 259
167 / 0 / 72

EB TOTAL 177
151 / 0 / 26

Road "A"
E-W STREET
1754
25 | 166
NB TOTAL 1945

EB LT	=	151
WB TH	=	0
		151
WB LT	=	72
EB TH	=	0
		72

OR

NB LT	=	25
SB TH	=	1145
		1170
SB LT	=	260
NB TH	=	877
		1137

OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

151 (E-W CRITICAL) + 1170 (N-S CRITICAL) = 1321 STATUS? near

1987 CAPACITY LEVEL

PLANNING APPLICATION WORKSHEET

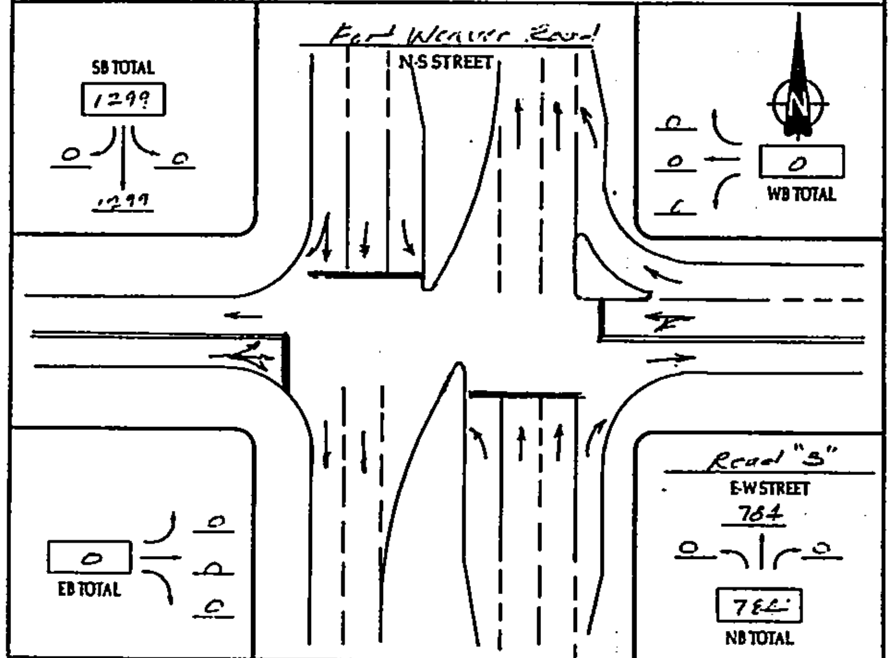
Intersection: Ft Weaver Road & Road "B" Date: Aug 19 1987

Analyst: HCA Time Period Analyzed: 3:30 – 4:30 PM

Project No. West Loch Estates City/State: City & County of Honolulu

N-S STREET: Fort Weaver Road

E-W STREET: Road "B"



SB TOTAL: 1299 (0 / 1299 / 0)

WB TOTAL: 0 (0 / 0 / 0)

EB TOTAL: 0 (0 / 0 / 0)

NB TOTAL: 784 (0 / 784 / 0)

EB LT = 0	NB LT = 0	
WB TH = 0	SB TH = 650	
[0]	[650]	
WB LT = 0	SB LT = 0	
EB TH = 0	NB TH = 392	
[0]	[392]	

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

0 (E-W CRITICAL) + 650 (N-S CRITICAL) = 650 STATUS? under

1991 CAPACITY LEVEL WITHOUT WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Road & Road "B" Date: Sept 1991

Analyst: HCA Time Period Analyzed: 3:30 – 4:30 PM

Project No. West Loch Estates City/State: City & County of Honolulu

N-S STREET: Fort Weaver Road

E-W STREET: Road "B"

SB TOTAL: 1977 (13 / 1964 / 0)

WB TOTAL: 0 (0 / 0 / 0)

EB TOTAL: 5 (5 / 0 / 0)

NB TOTAL: 1297 (0 / 1297 / 0)

EB LT = 5	NB LT = 0	
WB TH = 0	SB TH = 982	
[5]	[982]	
WB LT = 0	SB LT = 0	
EB TH = 0	NB TH = 649	
[0]	[649]	

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

5 (E-W CRITICAL) + 982 (N-S CRITICAL) = 987 STATUS? under

1991 CAPACITY LEVEL WITH WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Road & Road 'B' Date: Sept 1991

Analyst: HCA Time Period Analyzed: 5:30 - 6:30 PM

Project No. West Loch Estates City/State: City & County of Honolulu

Ft Weaver Road
N-S STREET

SB TOTAL: 1409
0 — 421 — 1988

WB TOTAL: 534
463 — 0 — 71

EB TOTAL: 5
5 — 0 — 0

Road "B"
E-W STREET
1222
0 — 118

NB TOTAL: 1576

EB LT	–	5
WB TH	–	0
		5
WB LT	–	71
EB TH	–	0
		71

OR

NB LT	–	0
SB TH	–	994
		994
SB LT	–	421
NB TH	–	786
		1209

OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

71 (E-W CRITICAL) + 1209 (N-S CRITICAL) = 1280 STATUS? Near

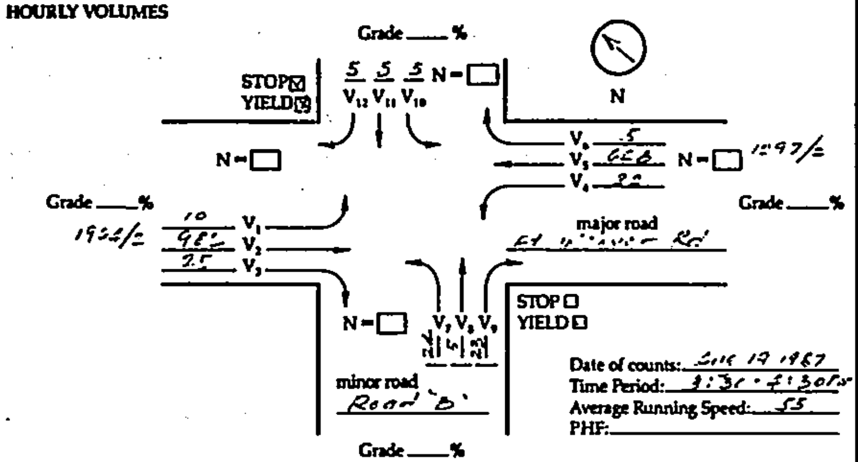
1987 LOS WITHOUT SIGNALIZATION

WORKSHEET FOR FOUR-LEG INTERSECTIONS

Page 1

Location: Waipahu – Ewa Beach Name: Ft Weaver Rd & Road "B"

HOURLY VOLUMES

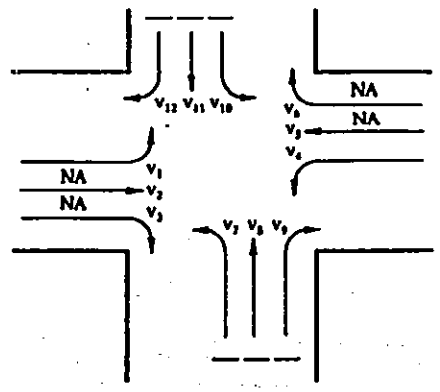


Date of counts: June 17 1987
Time Period: 5:30 - 6:30 PM
Average Running Speed: 55
PHF:

VOLUME ADJUSTMENTS

Movement No.	1	2	3	4	5	6	7	8	9	10	11	12
Volume (vph)	10	955	25	22	648	5	24	5	23	5	5	5
Vol. (pcph), see Table 10-1	10			22			24	5	23	5	5	5

VOLUMES IN PCPH



WORKSHEET FOR FOUR-LEG INTERSECTIONS

Page 2

STEP 1: RT From Minor Street	V_9	V_{12}
Conflicting Flows, V_c Critical Gap, T_c (Tab. 10-2) Potential Capacity, c_p (Fig. 10-3) Percent of c_p Utilized Impedance Factor, P (Fig. 10-5) Actual Capacity, c_m	$1/2\,V_3 + V_2 = V_{c9}$ 12 + 982 = 994 vph 5.5 (sec) c_{p9} = 340 pcph $(v_9/c_{p9}) \times 100$ = 6.76 % P_9 = 0.96 $c_{m9} = c_{p9}$ = 340 pcph	$1/2\,V_6 + V_5 = V_{c12}$ 2 + 648 = 650 vph 5.5 (sec) c_{p12} = 530 pcph $(v_{12}/c_{p12}) \times 100$ = 0.94 % P_{12} = 0.99 $c_{m12} = c_{p12}$ = 530 pcph
STEP 2: LT From Major Street	V_4	V_1
Conflicting Flows, V_c Critical Gap, T_c (Tab. 10-2) Potential Capacity, c_p (Fig. 10-3) Percent of c_p Utilized Impedance Factor, P (Fig. 10-5) Actual Capacity, c_m	$V_3 + V_2 = V_{c4}$ 25 + 982 = 1007 vph 6.0 (sec) c_{p4} = 260 pcph $(v_4/c_{p4}) \times 100$ = 8.46 % P_4 = 0.94 $c_{m4} = c_{p4}$ = 260 pcph	$V_6 + V_5 = V_{c1}$ 5 + 648 = 653 vph 6.0 (sec) c_{p1} = 450 pcph $(v_1/c_{p1}) \times 100$ = 2.22 % P_1 = 0.98 $c_{m1} = c_{p1}$ = 450 pcph
STEP 3: TH From Minor Street	V_8	V_{11}
Conflicting Flows, V_c Critical Gap, T_c (Tab. 10-2) Potential Capacity, c_p (Fig. 10-3) Percent of c_p Utilized Impedance Factor, P (Fig. 10-5) Actual Capacity, c_m	$1/2V_3+V_2+V_1+V_6+V_5+V_4=V_{c8}$ 12 + 982 + 10 + 5 + 648 + 22 = 1679 vph 7.0 (sec) c_{p8} = 70 pcph $(v_8/c_{p8}) \times 100$ = 7.14 % P_8 = 0.96 $c_{m8} = c_{p8} \times P_1 \times P_4$ 64 = 70 × .98 × .94 (pcph)	$1/2V_6+V_5+V_4+V_3+V_2+V_1=V_{c11}$ 2 + 648 + 22 + 25 + 982 + 10 = 1659 vph 7.0 (sec) c_{p11} = 70 pcph $(v_{11}/c_{p11}) \times 100$ = 7.14 % P_{11} = 0.96 $c_{m11} = c_{p11} \times P_1 \times P_4$ 64 = .70 × .98 × .94 (pcph)
STEP 4: LT From Minor Street	V_7	V_{10}
Conflicting Flows, V_c Critical Gap, T_c (Tab. 10-2) Potential Capacity, c_p (Fig. 10-3) Actual Capacity, c_m	V_{c8} (step 3) $+ V_{11} + V_{12} = V_{c7}$ 64 + 5 + 5 = 74 vph 7.5 (sec) c_{p7} = 730 pcph $c_{m7} = c_{p7} \times P_1 \times P_4 \times P_{11} \times P_{12}$ 639 = 730 × .98 × .94 × .96 × .99 (pcph)	V_{c11} (step 3) $+ V_8 + V_9 = V_{c10}$ 64 + 5 + 23 = 92 vph 7.5 (sec) c_{p10} = 710 pcph $c_{m10} = c_{p10} \times P_4 \times P_1 \times P_8 \times P_9$ 590 = 710 × .94 × .98 × .96 × .96 (pcph)

WORKSHEET FOR FOUR-LEG INTERSECTIONS

Page 3

SHARED-LANE CAPACITY

$$c_{SH} = \frac{v_l + v_r}{(v_l/c_{ml}) + (v_r/c_{mr})}$$ where 2 movements share a lane

$$c_{SH} = \frac{v_l + v_t + v_r}{(v_l/c_{ml}) + (v_t/c_{mt}) + (v_r/c_{mr})}$$ where 3 movements share a lane

MINOR STREET APPROACH MOVEMENTS 7, 8, 9

Movement	v(pcph)	c_m(pcph)	c_{SH}(pcph)	$c_R = c_{SH} - v$	LOS
7	24	639	639	615	A
8	5	64	64	59	E
9	23	340	340	317	B

MINOR STREET APPROACH MOVEMENTS 10, 11, 12

Movement	v(pcph)	c_m(pcph)	c_{SH}(pcph)	$c_R = c_{SH} - v$	LOS
10	5	590	590	585	A
11	5	64	64	59	E
12	5	530	530	525	A

MAJOR STREET LEFT TURNS 1, 4

Movement	v (pcph)	c_m (pcph)	$c_R = c_m - v$	LOS
1	10	450	440	A
4	22	260	238	B

COMMENTS:

1987 CAPACITY LEVEL

PLANNING APPLICATION WORKSHEET

Intersection: Fort Weaver Road & Renton-Arizona Road Date: Sept. 3, 1987
Analyst: Conrad Higashionna Time Period Analyzed: 3:30 to 4:30 PM
Project No. West Loch Estates City/State: Waipahu Hawaii

Fort Weaver Road
N-S STREET

SB TOTAL 1299
217 | 1067 | 15

WB TOTAL 0
0 0 0

217 533 534 15
143 0 75
0
56 513 312

EB TOTAL 218
143 0 75

Renton-Arizona Road
E-W STREET
626
58 0
NB TOTAL 664

EB LT = 143
WB TH = 0
143
WB LT = 0
EB TH = 0
0
OR

NB LT = 58
SB TH = 534
592
SB LT = 15
NB TH = 313
328
OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

143 E-W CRITICAL + 592 N-S CRITICAL = 735 STATUS? UNDER

1991 CAPACITY LEVEL WITHOUT WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Rd & Renton/Arizona Road Date: Sept 1991
Analyst: HCA Time Period Analyzed: 3:30 - 4:30
Project No. West Loch Estates City/State: City & County of Honolulu

Fort Weaver Road
N-S STREET

SB TOTAL 1962
217 | 1732 | 15

WB TOTAL 0
0 0 0

EB TOTAL 249
143 0 106

Renton/Arizona Rd
E-W STREET
1297
65 0
NB TOTAL 1204

EB LT = 143
WB TH = 0
143
WB LT = 0
EB TH = 0
0
OR

NB LT = 65
SB TH = 866
931
SB LT = 15
NB TH = 649
664
OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

143 E-W CRITICAL + 931 N-S CRITICAL = 1076 STATUS? under

1991 CAPACITY LEVEL WITH WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Ft Weaver Rd & Renton/Arizona Rd Date: Sept 1991

Analyst: ______ Time Period Analyzed: 3:30 - 4:30 PM

Project No. ______ City/State: ______

Fort Weaver Road
N-S STREET

SB TOTAL [2143]: 225, 1812, 106

WB TOTAL [54]: 46, 4, 4

EB TOTAL [290]: 173, 11, 106

Renton/Arizona Rd
E-W STREET
1272
65, 68

NB TOTAL [1407]

EB LT	=	173
WB TH	=	4
		[177]
WB LT	=	4
EB TH	=	11
		[15]

OR

NB LT	=	65
SB TH	=	906
		[971]
SB LT	=	106
NB TH	=	637
		[743]

OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

177 E-W CRITICAL + 971 N-S CRITICAL = 1148 STATUS? under

1987 CAPACITY LEVEL

PLANNING APPLICATION WORKSHEET

Intersection: Farrington Hwy & Leoku/Leoole Date: August 19 1987

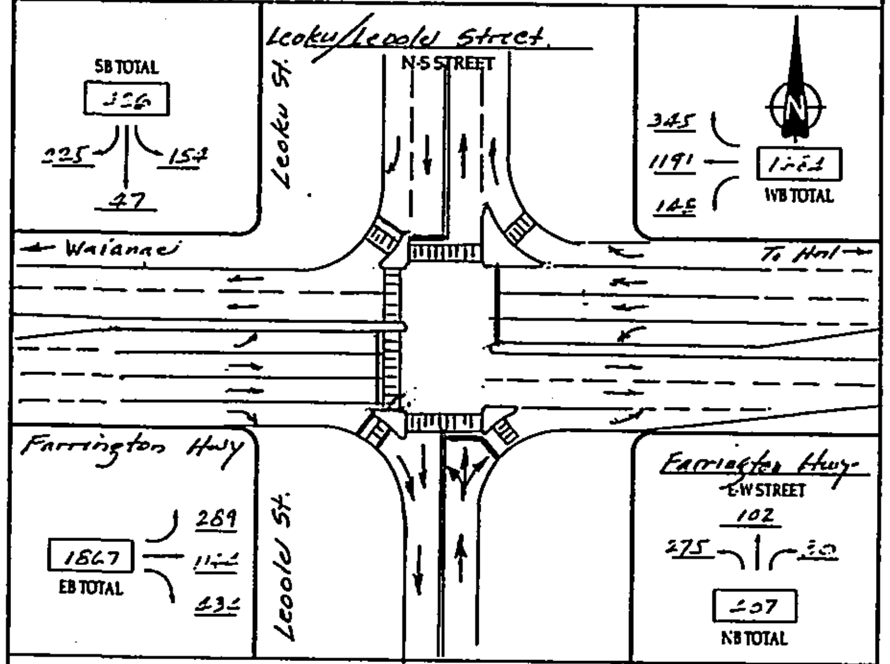
Analyst: HCA Time Period Analyzed: 3:30 - 4:30 PM

Project No. West Loch Estates City/State: City & County Honolulu

Leoku/Leoole Street
N-S STREET

SB TOTAL [356]: 225, 47, 154

WB TOTAL [1684]: 345, 1191, 148



Farrington Hwy

EB TOTAL [1867]: 289, 1144, 434

Farrington Hwy
E-W STREET
102
275, 30

NB TOTAL [407]

EB LT	=	289
WB TH	=	595
		[884]
WB LT	=	148
EB TH	=	5[illegible]
		[7[illegible]0]

OR

NB LT	=	275
SB TH	=	47
		[322]
SB LT	=	154
NB TH	=	102
		[256]

OR

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

884 E-W CRITICAL + 322 N-S CRITICAL = 1206 STATUS? Near

1991 CAPACITY LEVEL WITHOUT WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Farrington Hwy & Leoku/Leoole Date: Sept 1991

Analyst: HCA Time Period Analyzed: 3:30 - 4:30 PM

Project No. West Loch Estates City/State: City & County of Honolulu

N-S STREET: Leoku/Leoole St.

E-W STREET: Farrington Hwy

SB TOTAL: 469 — 247, 53, 169

WB TOTAL: 1852 — 350, 1309, 163

EB TOTAL: 2054 — 318, 1259, 477

NB TOTAL: 448 — 302, 113, 33

EB LT	- 318	NB LT	- 302
WB TH	- 654	SB TH	- 53
	972		355
	OR		OR
WB LT	- 163	SB LT	- 164
EB TH	- 630	NB TH	- 113
	793		282

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

972 (E-W CRITICAL) + 355 (N-S CRITICAL) = 1327 STATUS? Near

1991 CAPACITY LEVEL WITH WEST LOCH

PLANNING APPLICATION WORKSHEET

Intersection: Farrington Hwy & Leoku/Leoole Date: Sept 1991

Analyst: HCA Time Period Analyzed: 3:30 - 4:30 PM

Project No. WEST LOCH ESTATES City/State: CITY & COUNTY OF HONOLULU

N-S STREET: Leoku/Leoole St.

E-W STREET: Farrington Hwy

SB TOTAL: 490 — 225, 54, 154

WB TOTAL: 1958 — 397, 1370, 191

EB TOTAL: 2147 — 332, 1316, 499

NB TOTAL: 489 — 316, 118, 55

EB LT	- 332	NB LT	- 316
WB TH	- 685	SB TH	- 54
	1017		370
	OR		OR
WB LT	- 191	SB LT	- 177
EB TH	- 658	NB TH	- 118
	849		295

MAXIMUM SUM OF CRITICAL VOLUMES	CAPACITY LEVEL
0 TO 1,200	UNDER
1,201 to 1,400	NEAR
> 1,400	OVER

1017 (E-W CRITICAL) + 370 (N-S CRITICAL) = 1387 STATUS? Near

APPENDIX H

Socio-Economic Impact Assessment For Proposed
West Loch Estates Subdivision
Ewa Division, Island of Oahu

by

COMMUNITY RESOURCES, INC.

September 1987

COMMUNITY RESOURCES, INC.

SOCIO-ECONOMIC IMPACT ASSESSMENT FOR PROPOSED WEST LOCH ESTATES SUBDIVISION AND WEST LOCH GOLF COURSE AND SHORELINE PARK, EWA DIVISION, ISLAND OF OAHU

September 1987

Prepared for:

R. M. Towill Corporation

Prepared by:

Community Resources, Inc.

1188 Bishop Street • Suite 909 • Honolulu, Hawaii 96813 • Phone (808) 528-2211

ACKNOWLEDGEMENTS

Sections of this report were prepared with assistance from subcontractors:

- o Earthplan (Section 4.4 on community issues and concerns; Section 4.5.1 on surrounding civilian uses; and Sections 4.6.1 through 4.6.5 on uses to be displaced);
- o John R. K. Clark (Section 4.4.4 on recreational issues);
- o David W. Rae (Section 4.6.7 on on relocation).

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1.0 PROJECT DESCRIPTION

The West Loch Estates subdivision -- proposed by the City and County of Honolulu Department of Housing and Community Development -- is a two-phase, 1,500-unit housing project which will also include:

- a 3.6-acre commercial site for convenience-type activities;
- a 2.8-acre park-and-ride facility;
- a 1.7-acre child care facility;
- an 18-acre district park;
- a 6.1-acre elementary school site;
- 34 acres of green belts, buffers, and setbacks, as well as 16 acres of roads and circulation.

In coordination, the City Department of Parks and Recreation is also proposing:

- a new 18-hole, 175-acre municipal golf course; and
- a 39-acre shoreline park extending along the entire coastal area of the West Loch Estates housing project.

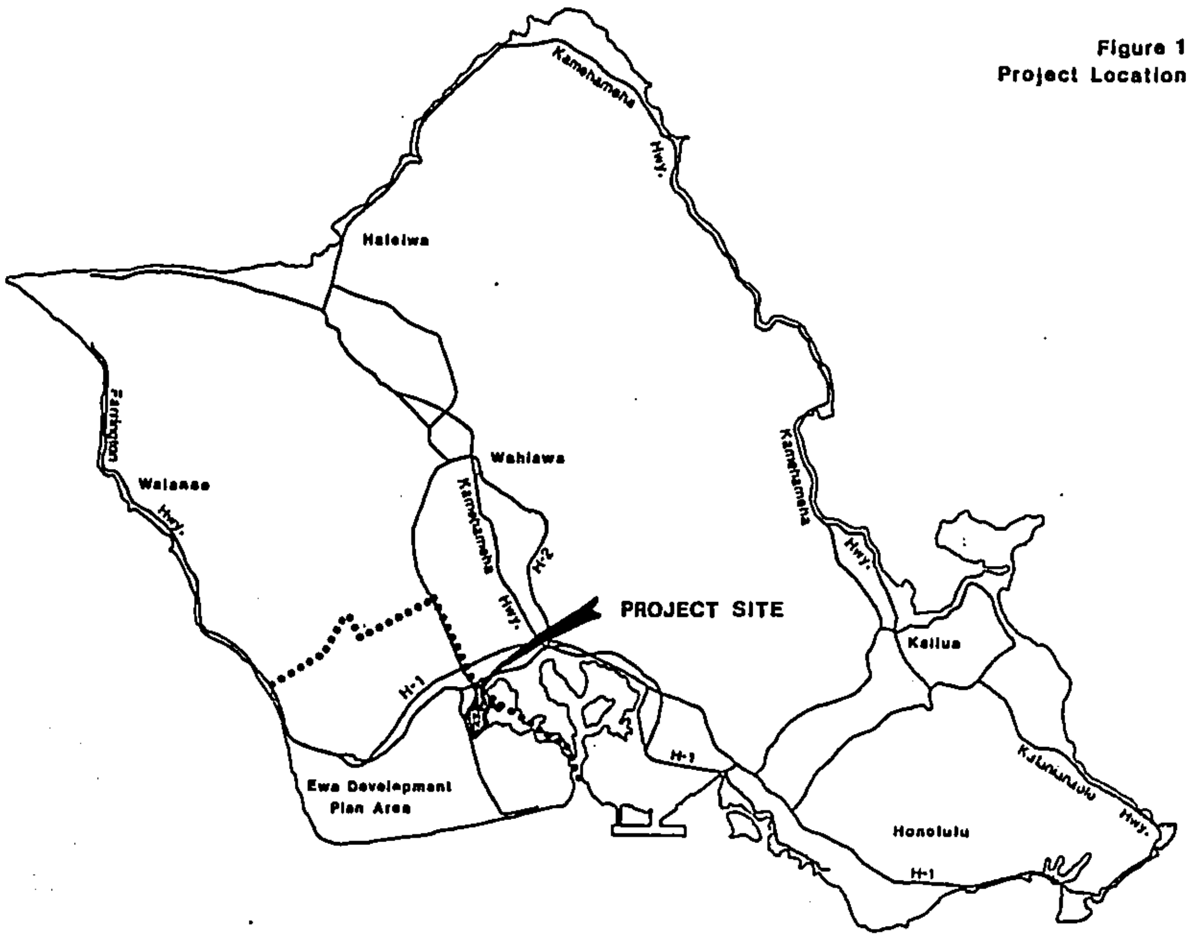
The combined projects -- which will be treated as a single effort for purposes of this report -- are to be situated on approximately 500 acres of land located south of Waipahu between the Fort Weaver Road bypass and the West Loch of Pearl Harbor (Figure 1). Geographically, the major uses within the project site would be the residential housing development (173 acres) and the 175-acre golf course (Figure 2).

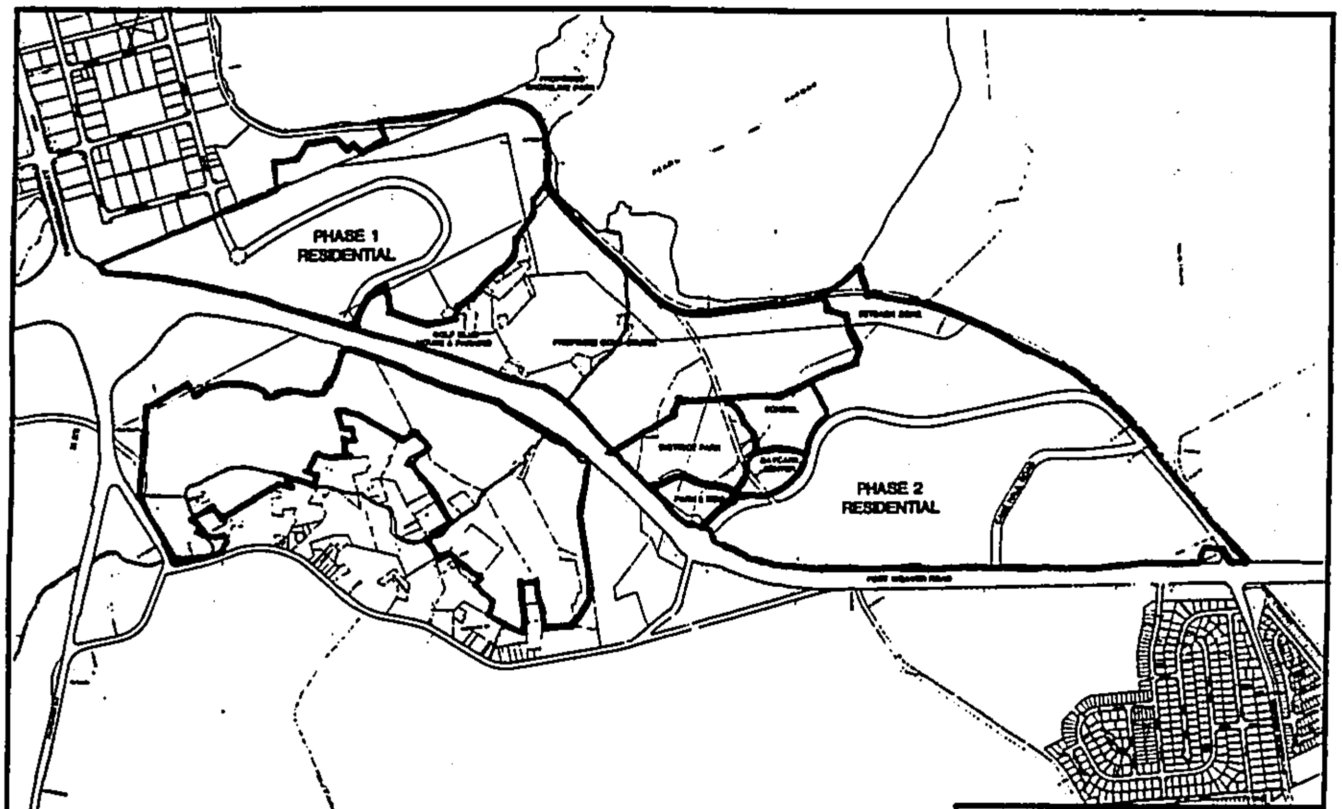
Of the total 1,500 housing units planned for construction, 900 units (60 percent) are proposed for "gap group" families -- i.e., households with incomes too high to qualify for most housing subsidy programs but too low to afford most market housing. Of these 900 units, 150 units would be targeted for the elderly. The remaining 600 units will be sold at market prices. All residential units will be single-family homes, except for the elderly units, which will be townhouses.

Phase I of development is expected to include the construction of the golf course and approximately 586 housing units, along with some roads and green belts. Phase II will include the remaining housing units (approximately 914, including all 150 elderly units), plus all additional activities -- i.e., both parks, the commercial area, and civic amenities.

Construction is expected to begin on Phase I in 1988 and on Phase II in the following year, with all aspects of the project being completed by 1991. It is expected that the majority of residential units will be sold and occupied by 1993.

Figure 1
Project Location





West Loch Estates
SITE PLAN Figure 2

2.0 DESCRIPTION OF SURROUNDING REGION

This section focuses on the general region in which the project is to be located. More detailed descriptions of current socio-economic conditions in (1) the project site itself and (2) immediately surrounding small communities are reserved for Section 4 of this report, which addresses project impacts.

2.1 DEFINITION OF STUDY AREA

For purposes of this study, the surrounding region -- or "study area" -- will be defined as the Ewa Development Plan Area and the Waipahu Census Designated Place (CDP).

The City and County of Honolulu divides the island of Oahu into eight Development Plan Areas (Figure 1). The project falls within the Ewa Development Plan Area, although it borders the Central Oahu Development Plan Area.

Because the Central Oahu Development Plan Area encompasses a large area with several dissimilar communities, it was decided to include only Waipahu in the "study area" for this report. Waipahu is the Central Oahu community closest to the project site and would be closely linked to West Loch Estates by the existing highway system, whereas the other major Central Oahu communities (Mililani and Wahiawa) are located off the H-2 freeway, which represents a separate transportation route to and from Honolulu.

Figure 3 shows the boundaries of the Waipahu CDP. It may be noted that several small communities sometimes considered part of Waipahu -- Village Park, Crestview/Seaview, Waipio Gentry, and the future Waikele area -- are not included in the CDP. These are primarily bedroom communities separated from Waipahu by the H-1 freeway, and they sometimes have community identities to some degree separate from Waipahu.

2.2 HISTORIC AND ECONOMIC FORCES AFFECTING STUDY AREA

The study area has been shaped by at least three significant forces: national defense needs, the growth of large-scale sugar cultivation, and the post-Statehood expansion of single-family, suburban housing opportunities on Oahu.

Military: A significant military establishment developed in the area when the U.S. Navy based Pacific naval operations at Pearl Harbor. Waipahu's growth as an industrial and commercial center is tied in part to nearby defense activities. Many area residents work for the military, either as civilian or uniformed personnel, and two Ewa communities -- Iroquois Point and Barbers Point Naval Air Station Housing -- consist almost entirely of service people and their dependents. The presence of significant numbers of military families in the area would tend to shift population characteristics toward a younger population, with a

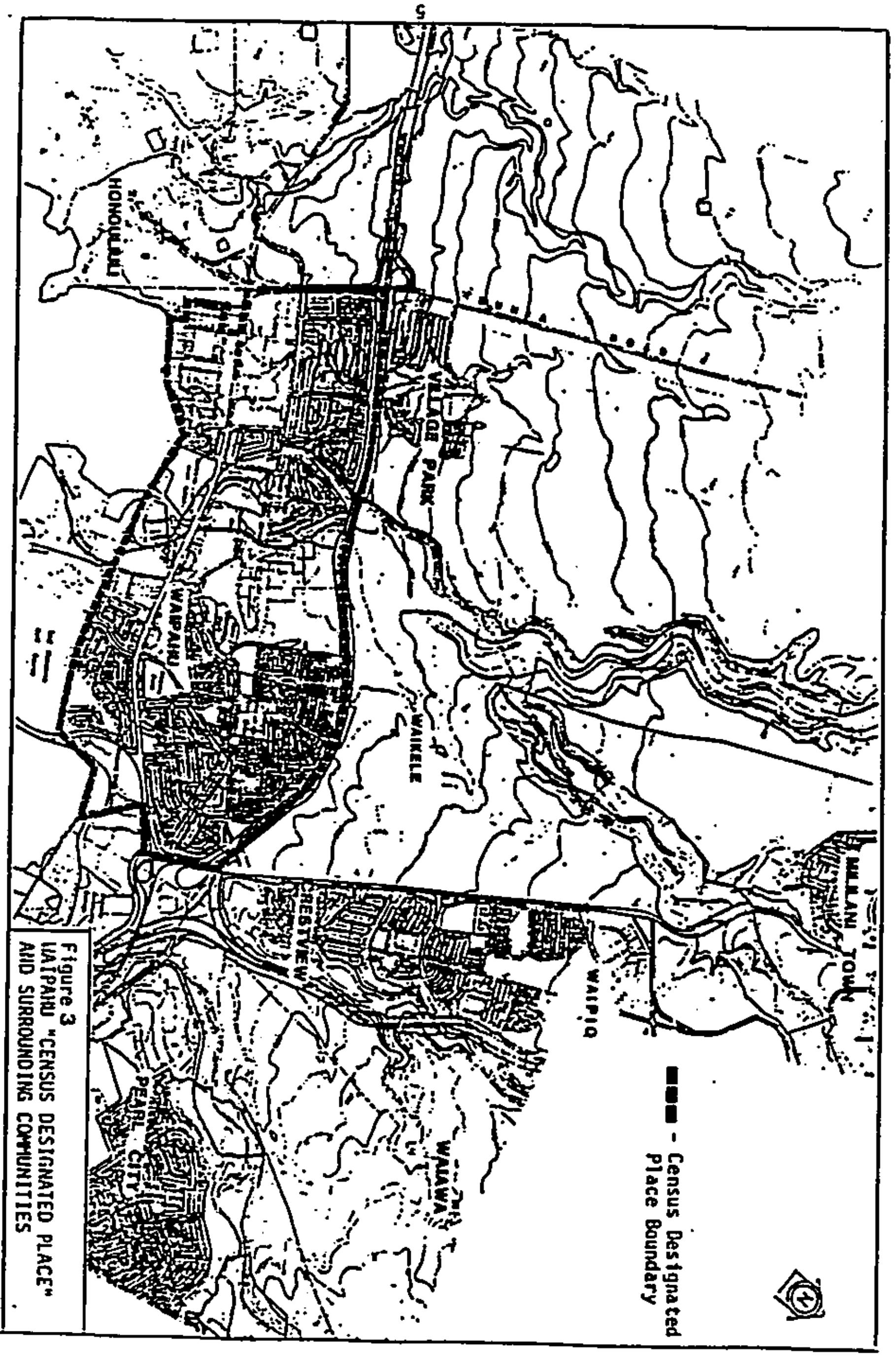


Figure 3
WAIPAHU "CENSUS DESIGNATED PLACE" AND SURROUNDING COMMUNITIES

greater proportion of Caucasians, people born elsewhere in the United States, and with slightly lower education levels.

Sugar: Sugar has been grown on the Ewa Plain since the early days of the industry in Hawaii. Many families with ties to the industry still live in Waipahu and Ewa, and one group of Ewa communities -- called the "Ewa Villages" -- were formed as plantation housing areas. Immigrant groups brought to Hawaii as contract labor still predominate in some communities, along with more recent immigrants. Waipahu's growth can also be tied to the location of the Oahu Sugar Company's major sugar mill there. However, Hawaii's sugar industry has faced increasingly difficult times in recent decades. Since a consolidation in 1970, Oahu Sugar is the only surviving plantation in the study area, and one of only two surviving sugar operations on Oahu. Virtually all the land now cultivated by the Amfac-owned Oahu Sugar Co. is leased from the Campbell Estate, and the leases expire in the early 1990's.

Housing Development and Population Shifts: As the amount of land needed for sugar has decreased, the demand for housing has grown. The agricultural lands in Ewa and around Waipahu have found increasing value to developers seeking to satisfy demand for moderately-priced, single-family homes on Oahu. Thus, Waipahu's and Ewa's population have come to include greater numbers of residents who work in other areas, and whose livelihoods are tied more to the island's general economy than to the military and sugar industries traditionally central to the local communities of Ewa and Waipahu. Increasing numbers of suburbanites would tend to increase the proportion of homeowners, younger families, and persons moving from elsewhere on the island, as well as increasing housing values and monthly mortgage payments.

While much of the population in new housing development meets this "suburbanite" description, the turnover of existing housing stock -- particularly in the Waipahu CDP itself -- has resulted in longtime Hawaii residents "moving up" to higher-priced homes closer to Honolulu, with some tendency for replacement by recent immigrants from the Philippines or, secondarily, Samoa. The recent Filipino immigrants may themselves by "moving up" from rental housing in urban Honolulu to fee-simple homes in Waipahu. A recent survey of Ilocano immigrants found that home-ownership is much higher in Waipahu (60 percent) than in lower Kalihi (33 percent) or upper Kalihi (23 percent) (East-West Population Institute and Operation Manong, 1985, p. 5).

2.3 STUDY AREA EMPLOYMENT AND ECONOMIC BASE

The Hawaii State Department of Transportation's (1982) Urban Transportation Planning Package (UTPP), comprised of special computer printouts, provides 1980 Census data on place of work. Thus, it gives information on the number of jobs located in the study area, as compared with the number of employed persons

living in the area (a topic which will be discussed in the following Section 2.4). The UTPP data provide information on primary workplaces as of April 1980 and thus would exclude second jobs.

State Traffic Assignment Zones (TAZ's) 143 to 146 are roughly comparable to the Waipahu CDP, although this aggregated traffic zone would also include Honouliuli and part of the project site. According to the UTPP data, Waipahu was the site of 5,880 primary jobs in 1980, all of them civilian in nature. The industry with the largest single number of jobs (1,617) was retail trade, thereby underscoring Waipahu's role as a regional center of trade. The industries comprising sugar plantation operations -- agriculture and manufacturing -- provided a combined 1,156 jobs.

TAZ's 137 to 139 encompass southeastern Ewa, the area served by Fort Weaver Road and lying to the south of the project site. The UTPP data indicate a total of 6,170 jobs in 1980, but the majority of these -- 3,303 -- were for active-duty armed forces personnel. The 2,867 civilian jobs were distributed across a wide variety of industries, many of these presumably involving defense-related activities, as well as retail activities and field activities for the sugar plantation.

TAZ's 140 and 142 comprise the remainder of Ewa (plus a sliver of Waianae east of Nanakuli), consisting of Makakilo, Campbell Industrial Park, and other areas served by Farrington Highway. This area had 3,445 jobs in 1980 -- 2,344 civilian and 1,101 military. Expectably, principal civilian industries included manufacturing and retail trade.

Major civilian employers in the study area would include the collective activities at Campbell Industrial Park, which provide approximately 2,500 jobs at present (personal communication, David McCoy, Industrial Real Estate Manager, Campbell Estate, September 11, 1987) and Oahu Sugar Company, which maintains a total payroll of about 450 workers (personal communication, Masao "Cranky" Watanabe, Consultant, Oahu Sugar Co., September 14, 1987).

The principal military installation actually located in the study area -- Barbers Point Naval Air Station -- was the worksite for 2,430 federal Department of Defense personnel in 1985, according to national data reproduced in the 1986 State Data Book, (Hawaii State Department of Planning and Economic Development, 1986, p. 308). Of these, more than 80 percent were active-duty military personnel.

With 18,350 Department of Defense personnel (11,000 of them civilians), Pearl Harbor is a much larger employer. However, while many Pearl Harbor military families live at Iroquois Point within the study area, the vast majority of Pearl Harbor activities and employment are located by the East and Middle Lochs, rather than the West Loch western shore falling in the study area.

According to Naval officials contacted for this report (personal communication, William Liu, Assistant Naval Base Civil Engineer, various dates in August and September 1987), the only substantial military activities on the western shore of West Loch involve an ammunition storage area (further discussed in Section 4.5). Due to the sensitive nature of this facility, the Navy has declined to discuss aspects such as number of personnel; however, it is believed that the numbers are not substantial.

2.4 SOCIO-ECONOMIC CHARACTERISTICS OF STUDY AREA POPULATION

Tables 1 through 4 show selected demographic, income, labor force, and housing characteristics for the City and County of Honolulu, the Waipahu CDP, and the Ewa Development Plan Area. Data presented are from the 1970 and 1980 U.S. Censuses. This time period was one of significant population growth in the study area. Ewa, which had 24,037 residents in 1970, grew by more than 50 percent to 36,234 in 1980. Waipahu's population grew from 24,150 to 29,139.

The most recent estimate of population in the study area is for 1985. The City and County Department of General Planning (personal communication, Steve Young, planner, September 14, 1987) estimates the Ewa Development Plan Area population as 37,400 and the Waipahu CDP population as 29,400. If correct, these estimates suggest much slower study area population growth rates in the 1980's than in the 1970's, possibly due in part to the high interest rates and general slowdown in housing construction experienced during much of the early 1980's.

The City provides updated estimates for total population figures only, and thus a discussion of more detailed characteristics must rely on the Census data contained in Tables 1 though 4.

2.4.1 Ewa

Ewa's largest civilian community is Ewa Beach, located a few miles south of the project site. With a 1980 population of 14,400, Ewa Beach is partially a military support community and partially a bedroom community of commuters to Honolulu. Proximate to Ewa Beach are the military housing areas of Iroquois Point (1980 population of 3,900) and Barbers Point Housing (1980 population of 1,400). In western Ewa, the major community is Makakilo (1980 population of 7,700, with ongoing construction and population growth).

Demographics: Caucasians and Filipinos are the largest ethnic groups among Ewa's population. Almost half of the area's residents are Caucasian (44.5 percent) and almost one quarter are Filipino (24.8 percent); these shares are higher than the 33.1 percent and 12.8 percent shares, respectively, for all of Oahu.

The Ewa area has a relatively young population. Greater percentages of Ewa residents are under five years of age (10.7

Table 1:
Total Population and Demographic Characteristics: City and County of Honolulu and Various Parts of Study Area, 1970 and 1980

	CITY AND COUNTY OF HONOLULU 1970	1980	EWA D.P. AREA* (C.T. 83-86.02) 1970	1980	WAIPAHU (CENSUS DESIGNATED PLACE) 1970	1980
TOTAL POPULATION	630,528	762,565	24,037	36,234	24,150	29,139
	%	%	%	%	%	%
ETHNICITY						
Caucasian	41.2	33.1	60.4	44.5	28.9	13.5
Japanese	26.8	24.9	N/A	8.8	26.9	20.3
Chinese	7.7	6.9	N/A	2.0	2.8	2.0
Filipino	10.4	12.8	N/A	24.8	32.7	41.6
Hawaiian	8.5	10.5	N/A	12.4	4.0	8.4
Other	5.5	11.8	N/A	7.5	4.6	14.2
AGE						
Less than 5 yr.	9.3	7.9	13.3	10.7	13.4	10.2
5 - 17 yr.	26.3	24.2	31.1	27.8	28.6	24.5
18 - 64 yr.	59.4	60.7	53.1	58.6	54.0	59.1
65 or more yr.	5.0	7.2	2.5	3.0	4.0	6.2
Median age	24.6 yr	28.1 yr	N/A	N/A	22.5 yr	24.5 yr
PLACE OF BIRTH						
Hawaii	NC	55.1	NC	49.6	NC	56.9
Other U.S.**	NC	30.1	NC	36.0	NC	15.2
Foreign country	NC	14.8	NC	14.5	NC	27.9
RESIDENCE 5 YRS. PREVIOUS (people aged 5+)						
Same house	42.5	48.2	31.0	44.0	38.7	46.5
Same island	NC	25.5	NC	23.6	NC	34.5
Different island	NC	1.3	NC	0.8	NC	1.2
Different state	NC	18.4	NC	26.1	NC	8.5
Different country	NC	6.6	NC	6.1	NC	9.3
EDUCATION (people aged 25+)						
0-8 years only	20.8	14.4	21.0	13.6	30.8	27.5
Hi school only	37.5	46.0	NC	56.0	56.2	49.9
Some post H.S.	26.2	18.3	NC	17.8	5.9	14.9
College, 4+ yr.	15.5	21.7	NC	12.6	7.1	8.7

Notes: All figures (except "Total Population and Age") based on 15% sample; hence, numbers represent estimate.
* In this and immediately following tables, the small Central Oahu town of Kunia (1980 pop. 829) is counted with Ewa rather than Central Oahu because it falls in one of the Ewa census tracts.
** Including persons born in U.S. territories, and persons born abroad or at sea to American parent/s.
"NC" = 1970 categories or bases "Not Comparable" to 1980 (1970 Census kept a "non-response" category, while 1980 Census allocated non-responses to other categories shown). "N/A" = "Not Available."

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88, and 1980 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC80-2-183, and 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

Table 2:

Family Characteristics and Income Levels: City and County of Honolulu and Various Parts of Study Area, 1970 and 1980

	CITY AND COUNTY OF HONOLULU 1970	1980	EWA D.P. AREA (C.T. 83-86.02) 1970	1980	WAIPAHU (CENSUS DESIGNATED PLACE) 1970	1980
POPULATION IN FAMILIES	N/A	653,118	N/A	34,071	N/A	27,115
as percentage of total population	N/A	85.6%	N/A	94.0%	N/A	93.1%
NUMBER OF FAMILIES	138,277	178,516	6,229	8,329	6,011	6,133
	%	%	%	%	%	%
HEAD						
Husband/wife	86.6	82.8	89.5	87.9	88.3	78.0
Male only	3.6	4.5	2.4	3.3	3.8	5.2
Female only	9.8	12.7	8.1	8.9	7.9	16.9
WITH OWN CHIL-DREN UNDER 18	63.4	59.4	76.1	70.8	N/A	65.9
Female head	6.2	7.5	6.8	7.1	N/A	13.9
BELOW POVERTY LEVEL*	7.2	7.5	8.7	7.2	7.5	14.4
MEDIAN FAMILY INCOME*	$12,035	$23,554	$10,109	$21,000	$11,184	$22,576
NON-FAMILY HOUSEHOLDS	N/A	52,415	N/A	794	N/A	806
percentage below poverty level	N/A	15.9%	N/A	49.6%	N/A	17.5%

Notes: * These figures based on 15% sample; hence, numbers represent estimates.
"N/A" = "Not Available."

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88, and 1980 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC80-2-183, and 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

Table 3:

Labor Force Size and Characteristics: City and County of Honolulu and Various Parts of Study Area, 1970 and 1980

	CITY AND COUNTY OF HONOLULU 1970	1980	EWA D.P. AREA (C.T. 83-86.02) 1970	1980	WAIPAHU (CENSUS DESIGNATED PLACE) 1970	1980
POTENTIAL LABOR FORCE (aged 16+)	427,601	574,803	14,110	23,862	13,932	20,309
not in labor force	33.0%	30.8%	38.3%	31.9%	34.0%	32.9%
armed forces	11.5	10.1	25.5	18.5	7.9	7.2
civil. labor force	56.5	59.1	36.3	49.5	58.2	59.8
CIVILIAN LABOR FORCE	237,338	339,863	5,115	11,821	8,105	12,151
unemployed	3.0%	4.6%	4.3%	8.0%	3.7%	6.4%
TOTAL EMPLOYED CIVILIAN LABOR FORCE	230,252	324,113	4,893	10,873	7,803	11,373
	%	%	%	%	%	%
OCCUPATION						
service	16.0	17.6	14.0	19.3	14.5	20.3
manager./profes.	NC	24.7	NC	14.2	NC	12.4
technical, sales & adminis.	NC	33.7	NC	31.0	NC	28.6
farm/fish/forest	NC	1.8	NC	3.9	NC	2.7
precision, craft, repair	NC	11.3	NC	15.5	NC	17.2
operators, fabricators, laborers	NC	10.9	NC	16.3	NC	18.9
INDUSTRY (selected)						
agric., forest, fish, mining	2.1	1.7	N/A	6.1	N/A	2.1
construction	9.5	6.6	6.6	7.5	N/A	10.1
manufacturing	10.3	7.7	18.8	12.0	N/A	13.4
retail trade	18.0	20.5	15.7	20.1	N/A	21.9
financial, insur., real estate	5.6	8.1	2.4	5.2	N/A	0.5
personal, entertain. % recreat. services	7.6	8.1	N/A	5.9	N/A	9.5
health, educ., & professional	18.1	18.5	11.0	12.7	N/A	11.2
public adminis.	12.6	10.9	16.0	13.4	N/A	10.5
COMMUTE TO WORK						
45 minutes or more	N/A	13.4%	N/A	22.6%	N/A	17.8%
mean travel (min.)	N/A	22.6 m	N/A	25.8 m	N/A	26.3 m

Notes: All figures based on 15% sample; hence, numbers represent estimates.
"N/A" = "Not Available" in published form. "NC" = 1970 categories or bases "Not Comparable" to 1980 Census.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88, and 1980 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC80-2-183, and 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

Table 4:
Housing Stock and Characteristics: City and County of Honolulu and Various Parts of Study Area, 1970 and 1980

	CITY AND COUNTY OF HONOLULU 1970	CITY AND COUNTY OF HONOLULU 1980	EWA D.P. AREA (C.T. 83-86.02) 1970	EWA D.P. AREA (C.T. 83-86.02) 1980	WAIPAHU (CENSUS DESIGNATED PLACE) 1970	WAIPAHU (CENSUS DESIGNATED PLACE) 1980
TOTAL YEAR-ROUND HOUSING UNITS	174,107	250,866	5,723	9,465	5,557	7,118
vacant (total)	5.4%	8.2%	4.2%	3.4%	3.5%	2.5%
vacant for sale	0.6	0.5	0.5	1.0	0.6	0.1
vacant for rent	2.5	3.6	1.9	0.6	2.5	1.8
held for occas'l use	N/A	0.9	N/A	0.4	N/A	0.1
other	N/A	3.2	N/A	1.4	N/A	0.5
TOTAL YEAR-ROUND OCCUPIED UNITS	164,763	230,214	5,484	9,139	5,362	6,939
TENURE						
owner-occupied	45.0%	49.9%	32.7%	50.2%	48.3%	49.0%
renter-occupied	55.0	50.1	67.3	49.8	51.7	51.0
SELECTED CONDITIONS						
lacking some or all plumbing	3.5%	1.5%	3.0%	0.6%	4.6%	1.3%
1.51 or more persons/room	6.9	7.4	6.9	8.5	10.4	13.8
PERSONS PER HOUSEHOLD	3.60	3.15	4.39	3.96	4.50	4.11
MEDIAN CASH RENT (renter-occupied)	$130	$279	$ 89 to $158	$230 to $372	$155	$295
as % of median family income	12.9%	14.2%	10.6%-18.8%	13.1%-21.3%	16.6%	15.7%
MEDIAN VALUE* (owner-occupied)	$38,400	$130,400	$29,100 to $32,000	$ 98,000 to $120,400	$31,700	$112,000
MEDIAN MONTHLY MORTGAGE* (owner-occupied)**	N/A	$494	N/A	$514	N/A	$420
as % of median family income	N/A	25.2%	N/A	29.4%	N/A	22.3%

Notes: * For 1980, median values are for non-condominium housing units.
** Figures based on 15% sample; hence, numbers represent estimates.
The ranges for "Median Cash Rent" and "Median Value" under Ewa Development Planning Areas reflect ranges among the census tracts comprising these areas.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88, and 1980 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC80-2-183, and 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

percent) and between five and 17 years of age (27.8 percent), as opposed to Oahu as a whole (7.9 percent and 24.2 percent, respectively). The proportion of residents aged 65 years and older is especially low in Ewa -- senior citizens constitute 7.2 percent of Oahu's population, but only three percent of Ewa's. The youth of the Ewa population can be attributed in large part to the substantial numbers of military force members and dependents living there -- 18.5 percent of Ewa residents aged 16 years and above were in the armed forces in 1980, a figure well above the Oahu-wide average of 10.1 percent.

Ewa residents are somewhat more likely than all Oahu residents to have been born elsewhere in the United States; 36 percent were born outside of Hawaii, while 30.1 percent of total Oahu residents in 1980 were born elsewhere in the United States. Ewa's share of foreign-born residents was similar to Oahu's; thus, the percentage of Hawaii-born residents was lower than for the island as a whole.

As would be expected from data on place of birth and age, Ewa residents show greater mobility than the entire Oahu population. Relatively fewer Ewa than overall Oahu residents reported living in the same house or on the same island in 1980 as in 1975. The principal mobility difference was that Ewa residents were markedly more likely (26.1 percent) to have resided in a different state five years previously than were Oahu residents generally (18.4 percent).

The adult population of Ewa contains proportionately fewer highly-educated people than does Oahu as a whole. While a slightly lower proportion of Ewa residents completed eight or fewer years in school and the proportion of high school graduates is higher, the percentage who have completed four years of education beyond high school (12.6 percent) is considerably lower than for Oahu (21.7 percent).

Family and Income Characteristics: Conventional family patterns, in which both parents are present, are more typical of Ewa than for the island generally. Both parents are present in 87.9 percent of Ewa households, a figure considerably higher than Oahu's 82.8 percent. Family orientation is also shown by the 70.8 percent of Ewa households with children at home, well above the islandwide figure of 59.4 percent.

The incidence of poverty level incomes among Ewa households is similar to that for the island as a whole. Ewa's median family income of $21,000 in 1980 was more than ten percent lower than the islandwide median, but about the same percentage of families (7.2 percent, compared with 7.5 percent for the island as a whole) had incomes below the poverty level, thereby suggesting less variability in income in Ewa than was the case islandwide. The small number of non-family households in Ewa had particularly low incomes -- almost half (49.6 percent) earned less than the poverty level in 1980, compared with 15.9 percent for all non-family households on Oahu.

Labor Force: After adjusting for the high proportion of Ewa residents aged 16 years or above in the military as of 1980, labor force participation rates are relatively lower for Ewa (61 percent) than for Oahu as a whole (66 percent). Other census data indicate the low labor force participation rates are primarily due to proportionately fewer females in the workforce. Additionally, it may be noted that Ewa's 1980 unemployment, at 8.0 percent, was significantly higher than the islandwide average of 4.6 percent.

In terms of occupational category, Ewa workers are more likely than workers islandwide to be found in service employment (19.3 percent, compared with 17.6 percent for all of Oahu); farming, fishing, and forestry (3.9 percent, vs. 1.8 percent): precision, craft, and repair (15.5 percent, compared with 11.3 percent); and operators, fabricators and laborers (16.3 percent, as opposed to 10.9 percent). Also, fewer Ewa workers are employed in managerial and professional or technical, sales and administrative categories than is the case for all of Oahu.

In terms of industry, Ewa workers are more likely than most other Oahu workers to be employed in agriculture, forestry, fishing and mining; construction and manufacturing. However, more Ewa workers (13.4 percent) are employed in public administration than for all of Oahu (10.9 percent); this could be attributed to military and Federal facilities located in the area. The work force in Ewa is less likely than average to be employed in retail trade; finance, insurance and real estate; personal and other services, or health, education and professional services.

Housing: Housing tenure in Ewa resembles the pattern for all of Oahu; 49.8 percent of dwelling units are owner-occupied. Crowded units -- those occupied by more than 1.51 persons per room -- are somewhat more common in Ewa, where 8.5 percent of all homes would be defined as crowded by this standard. This could be related to a larger-than-average family size in Ewa, (3.96 persons per household, compared with 3.15 for all of Oahu). While the 1980 median value of owner-occupied housing was lower than for the island as a whole, median monthly mortgage payments (at $514) were higher than the islandwide average of $494. This would suggest that Ewa homeowners had, in general, purchased their homes more recently than was the islandwide norm, a proposition supported by the fact that Ewa residents were more likely to be in-migrants to Hawaii than Oahu residents as a whole.

2.4.2 <u>Waipahu</u>

The Waipahu CDP includes census tracts 87.01, 87.02, 89.01, and a portion of tract 88. As previously suggested, several of the more suburban-oriented neighborhoods -- such as Village Park, Waipio and Crestview/Ocean View -- are within the Waipahu Neighborhood Board area, but not within the census designated place of Waipahu.

Demographics: Waipahu's ethnic characteristics indicate a substantially greater proportion of Filipinos than is the case for the island as a whole. This is consistent with the historic roots of Waipahu as a plantation community comprised heavily of immigrants. More than 40 percent of Waipahu residents (41.6 percent) reported Filipino ancestry, far greater than the 12.8 percent for the island as a whole. Each of Hawaii's other major ethnic groups show lower representation in Waipahu than for all of Oahu. Differences are most pronounced for Caucasians, who made up 33.1 percent of Oahu's population in 1980 but just 13.5 percent among Waipahu residents.

Waipahu has a relatively young population. Considerably higher proportions of Waipahu residents are less than five years of age (10.7 percent) than for the City and County (7.9 percent); Waipahu's median age of 24.5 years is much younger than all of Oahu's 28.1 years.

The population of Waipahu contains considerably larger numbers born in a foreign country than is the case for the entire island. More than one in every four Waipahu residents (27.9 percent) was born abroad, compared with 14.8 percent of all Oahu residents. Waipahu also has a slightly higher proportion of Hawaii-born residents (56.9 percent) than the county as a whole (55.1 percent), and only about half as many people who were born elsewhere in the United States (15.2 percent, compared with 30.1 percent for all of Oahu).

Mobility patterns, measured by residence five years prior to the 1980 Census, are similar for Oahu and Waipahu residents. The chief differences, as suggested by differences in birthplace, are that greater proportions of Waipahu residents (9.3 percent) than of Oahu residents as a whole (6.6 percent) lived in a different country in 1975. Similarly, relatively fewer Waipahu residents (8.5 percent) reported having lived in a different state in 1975, compared with 18.4 percent for all of the island's population.

Education levels of Waipahu residents are somewhat lower than for Ewa or for all of Oahu. While 14.4 percent of Oahu's population aged 25 years and above completed eight school years or less, the similar statistic for Waipahu was 27.5 percent. Less than ten percent of Waipahu residents (8.7 percent) have four or more years of education beyond high school, compared with 21.7 percent for Oahu residents generally. Education levels rose for Waipahu, as for the island as a whole, between 1970 and 1980. The proportion of Waipahu's population with some education beyond high school almost doubled over the decade, moving from 13 percent to 23.6 percent.

Family and Income Characteristics: Data on family characteristics show that some of the measures associated with poverty apply in Waipahu to a somewhat more widespread degree than for the overall island. The number of families headed by a female (16.9 percent) is greater in Waipahu than the 12.7 percent figure for Oahu. Considerably more households with children present are headed by women in Waipahu (13.9 percent) than in the island as a whole (7.5 percent).

The incidence of households with incomes below the poverty level is significantly higher in Waipahu (14.4 percent) than for all of Oahu (7.5 percent), although Waipahu's median family income of $22,576 in 1980 was only slightly lower than the islandwide median of $23,554.

Labor Force: Labor force statistics indicate that -- after adjusting for armed forces personnel living in Waipahu -- civilian labor participation rates in Waipahu (35 percent) are similar to those for the island as a whole (34 percent). However, the 1980 civilian unemployment rate in Waipahu (6.4 percent) was higher than the islandwide rate (4.6 percent).

Like Ewa workers, employed Waipahu residents tend to hold service and manual or mechanical labor positions to a greater degree than all island workers. While relatively fewer Waipahu residents are found in managerial and technical, sales and administrative positions (12.4 percent and 28.6 percent, respectively, compared with 24.7 percent and 33.7 percent islandwide), greater proportions are found in other occupations. In service jobs (20.3 percent, compared with 17.6 percent for the county as a whole), precision, craft and repair positions (17.2 percent, relative to 11.3 percent), and operators, fabricators and laborers (18.9 percent, compared with 10.9 percent), Waipahu residents hold greater proportions of jobs than the islandwide population of wage earners.

In terms of industry, similarly to those in Ewa, Waipahu workers tend to be engaged in agriculture, construction, manufacturing, and retail trade; in all of these industries, employment among Waipahu workers is higher than for the island as a whole. The representation of Waipahu workers is considerably lower in finance, insurance, and real estate (0.5 percent, compared to 8.1 percent islandwide) and health, education and professional services (11.2 percent, relative to 18.5 percent for all of Oahu).

Housing: Waipahu's housing stock characteristics are similar to those of the entire county so far as tenure (owner- vs. renter-occupied units) and availability of plumbing facilities are concerned. However, Waipahu contains a larger than average number of "crowded" dwelling units, where crowding is defined as 1.51 persons or more per room. The percentage of such units in Waipahu (13.8 percent) was almost twice the islandwide rate of 7.4 percent. More widespread crowding may be related to Waipahu's relatively large household size; average number of persons per household was 4.11 in 1980, compared with 3.15 for Oahu as a whole.

As of 1980, renters in Waipahu were slightly worse off in comparison to all island renters, while Waipahu homeowners were marginally better off than owners on the entire island. Median

cash rent was $295 for Waipahu, and represented 15.7 percent of median family income. For Oahu as a whole, median cash rent was $279, representing 14.9 percent of median family income.

The median value of owner-occupied housing in Waipahu ($112,000) was lower than the islandwide median in 1980 ($130,400). However, Waipahu homeowners had lower median monthly mortgage payments ($420) compared to Oahu as a whole ($494). The Waipahu median constituted 22.3 percent of median family income, well below the islandwide average of 25.2 percent.

2.5 COMMUNITY ISSUES AND CONCERNS INDEPENDENT OF PROJECT

This sub-section examines current community goals, values, concerns, and issues which are independent of the project but which may interact with public response to the project. Issues and concerns focusing directly on the proposed West Loch housing project are considered a project "social impact" and are addressed in Section 4.

2.5.1 Public Opinion Surveys

2.5.1.1 Islandwide

Aloha United Way and the Health and Community Services Council (1987) recently assembled an overview of results of polls about Hawaii or Oahu resident priorities in regard to various public issues. Sources reviewed include a series of polls sponsored by the Honolulu Advertiser, the 1984 State Plan Survey, a 1986 Chamber of Commerce poll, and the "Hawaii Quarterly Consumer Survey" conducted four times a year since 1983 by SMS Research & Marketing Services.

Collectively, these polls indicate that the major concerns of the 1980's have consistently involved five key priorities: jobs, crime, traffic, education, and housing. Some surveys have also found a sixth major concern -- inflation and the high cost of living. Of consistently lower priority have been issues related to environmental protection, social problems, growth and land use, taxes, and specific economic concerns such as tourism or preservation of agricultural land.

For example, the 1984 State Plan Survey (SMS Research, 1984) asked for reaction to the following statement: "We should have more affordable housing for residents even if we lose prime agricultural land." Fifty percent of Oahu residents agreed; 37 percent disagreed; and 12 percent were undecided.

Of the five or six top issues, exact priorities have shifted with question wording and date of survey.

The "Hawaii Quarterly Consumer Survey" provides perhaps the best overview of true shifts in community priorities, since question wording has been kept uniform. Following is the summary prepared for the Aloha United Way and Health and Community Services Council, which makes the points that (1) concern over housing seems related to shifts in economic conditions, and (2) public discomfort with traffic conditions has been increasing rapidly in the past few years:

> Oahu residents also answered the question: "What do you think are the two or three most important problems facing Hawaii today -- the ones that government should be working on right now?" ...
>
> Results from the latest Hawaii Quarterly Consumer Survey show that Oahu residents think traffic is the most important problem facing Hawaii today. Concerns about education, housing, and inflation follow close behind.
>
> Problems that fall into the survey's "transportation" category includes major issues like HART and H-3, as well as the basic traffic problems that face people trying to get to and from work. SMS says that the dramatic increase in public concern in this area is due to problems with "traffic" rather than transportation issues.
>
> Concern over traffic problems continues to rise over the last three years as concern about a former number one problem -- inflation and cost of living -- drops. The survey notes that concern over housing and education also rise as the economy gets better.
>
> The SMS survey suggests that the rise in public concern about traffic problems is different than the other problems ... For housing, the level of concern rose sharply as the economy got better back in 1984. As incomes rose to meet the real estate market, concern over housing dropped off again ...
>
> With traffic, a rise is expected to accompany better economic conditions, but not to the extent the survey shows. And issues like H-3 do not appear to be drawing greater attention than they did in 1983. Rather, the traffic is not getting any better, and DOT road crews are working on some of Oahu's major thoroughfares.
>
> The survey has been tracking some 20 problems since 1983, and no single issue has shown the kind of public concern that is given to traffic today. (Aloha United Way and Health and Community Services Council, 1987, p. 17)

2.5.1.2 Study Area

There have been few recent published opinion surveys taken in Ewa or Waipahu. The most recent mail-out survey by the Ewa

Neighborhood Board was conducted in August 1984. Caution in interpreting results is suggested by the fact that the return rate was under five percent (452 replies, out of 9,780 questionnaires mailed out).

Results (published in the August 1986 Ewa Neighborhood Board newsletter) include: (1) about 73 percent of respondents favoring major developments such as Ewa Marina and Ko Olina (West Beach), and 57 percent in favor of the then less well-known "Ewa Expandable" housing project; (2) on a list of 11 community objectives, the top priorities included need to control aircraft noise and need for police sub-stations in Ewa and Makakilo; (3) on the same list, an item about "coordination of future housing developments with the development of adequate public facilities" was ranked approximately in the middle of the list.

The Waipahu Neighborhood Board sponsored a mail-out survey of residents in December 1985, although a low return rate (under three percent) suggests even greater need for caution in interpreting results. Major issues raised in the Waipahu survey included crime and quality of City street maintenance. Considered next most important were needs to repair public school buildings and complaints about trash and abandoned vehicle dumping on the streets. (NOTE: The Board also conducted a survey in 1987, but results have yet to be tabulated.)

A 1982 Waipahu telephone survey commissioned by Amfac (SMS Research, 1982) has been cited with Amfac permission in past social impact assessments in the area (Community Resources, 1985). Some of the major conclusions from this survey -- the most recent to be conducted using scientific methods of random selection -- were:

- As of 1982, the "need to keep Oahu Sugar Company in business" and the need for more "housing that families making less than $40,000 can afford" were essentially tied for first place out of a list of 19 community goals.
- The perceived need was definitely for lower- to middle-income housing, since there was very little concern expressed about need for more "high quality housing."
- While there was some concern at the time over population growth and traffic, a majority of the sample back in 1982 considered traffic "not a problem" -- a perception which may have changed in the intervening years.

The 1982 survey also found that 76 percent of the Waipahu sample agreed with the statement that "Many of Waipahu's important problems can be solved by well-planned growth." Only 19 percent chose the alternative statement that "Any growth, no matter how well-planned, will just add to Waipahu's problems."

2.5.2 Issues and Concerns of Neighborhood Boards

To provide further information about community issues and concerns, the minutes of major community organizations were examined for the past year (August 1986 through August 1987). Because of the large number of organizations in the area, this analysis was restricted to the two Neighborhood Boards, which are elective in nature and therefore among the most representative of community groups.

It may be noted that:

- o The entire project is within the boundaries of the area represented by the Ewa Neighborhood Board, as well as the Ewa Development Plan area.
- o Positions taken to date on the West Loch project by each of the two Neighborhood Boards are given in Section 4.4.

2.5.2.1 Ewa Neighborhood Board No. 23

In the past year, the Ewa Board has dealt with few issues which were of a strongly controversial, divisive nature. At the same time, the Board has been reviewing implications of a number of major development proposals. Board members have supported most such proposals.

Because this Board represents a wide variety of communities distributed over a large area (as compared to the Waipahu Board, which represents an essentially contiguous urban area), the Board's concerns are often regional in scope. Many have been related to land use, in the context of planning and building the City's "Secondary Urban Center" in the Ewa area. Such concerns have focused on the cumulative impacts of various planned developments and the adequacy of existing infrastructure and public services to accommodate anticipated growth.

More specifically:

(1) Proposed major developments triggered discussion of issues such as water availability and water system development; infrastructure costs and responsibility for funding; housing types and availability; and environmental review processes. The focus of these discussions tended to be on ways that infrastructure could accommodate growth, which Board members are expecting to occur which they simply desire to be well-planned.

(2) Housing project proposals raised particular concerns about infrastructure adequacy and also about traffic impacts. The perspective on traffic -- like other infrastructure concerns -- was that it was a serious problem to be planned for and resolved, not a reason for halting growth.

Additionally, Ewa residents and Board members supported efforts to establish community associations to address "undesirable activities" (e.g., cockfighting, raising livestock, and speeding on streets) in recent area housing projects such as the Ewa Expandable development.

(3) Ewa residents have also been strongly concerned about the condition of local schools. Issues related to repair and maintenance of dilapidated classrooms, lack of funding for needed improvements, and need for an overall plan to accommodate the community's educational needs in the upcoming period of expected rapid population growth.

(4) There have also been calls for general community improvements to parks and ballfields -- e.g., lighting of ball courts; repairs to restrooms, bleachers, and backstops; and speedier provision of planned new facilities.

(5) The Ewa Board has given substantial time in the past year to potential community hazards -- e.g., chemical dumping at Campbell Industrial Park; Hawaiian Electric Company's use of hazardous chemicals in its Kahe plant transformers and plans to begin burning fuel with more sulphur; cane-burning activities of Oahu Sugar Co.; and the civil defense evacuation plan.

(6) Ewa residents are eager to participate in the development planning process, and they are willing to try to effect local solutions to many problems. Among such efforts have been establishment of a Neighborhood Watch and various community clean-up efforts.

2.5.2.2 Waipahu Neighborhood Board No. 22

Like the Ewa Board, the Waipahu Board for the past year has been examining community issues and development proposals in a straightforward way, with few emotion-charged controversies. (Just prior to the study period, the Board had expressed concerns over the proposed City Waiola Estates housing project, emphasizing that it supported more housing in the area but was concerned about assuring a balanced mix of housing types.)

Since August 1986, the Board has been focusing on a wide variety of community issues ranging from public services to school improvements to standard review of development proposals. The nature and style of comments (from both Board members and residents) suggest various themes and values:

(1) As reflected by Board minutes, most residents welcome development opportunities for the community and acknowledge Waipahu as a major growth area. This pro-development attitude is qualified by desires for (a) effective citizen input to the decision-making process, and (b) adequate attention to traffic and other negative side effects of growth. Concern over traffic has been increasing, but in

the sense of a problem to be solved rather than a reason to halt development.

(2) Discussions of "affordable" housing have been characterized (as in the case of Waiola Estates) by a desire for a well-balanced <u>mix</u> of different types of housing and economic development. There is some fear that Waipahu could become a stagnant community plagued by problems of crime and poverty if such a mix is not achieved.

(3) Perhaps related to the foregoing is a strong concern over the number of care homes, halfway houses, and special treatment centers (STC's) in Waipahu for people with drug, mental illness, or similar problems. Residents believe Waipahu now has a disproportionate share of such facilities on Oahu, and they complain that STC residents create problems by asking for handouts or other behaviors.

(4) The quality of Waipahu schools has been a particularly emotional issue, with regional community leaders worrying that schools cannot improve without a good mix of students from different income levels and residents of some newer subdivisions fighting for the right to bus their children to Pearl City.

(5) Residents often feel Waipahu does not receive its fair share of police protection and other public services. Particular concerns have been raised about educational and child care facilities; repair and maintenance of roads and recreational facilities; traffic; and provision of drainage and sewer improvements.

(6) At the same time, as in Ewa, Waipahu residents and Board members have themselves taken the initiative to effect local solutions to problems such as littering, abandoned cars, dumping and burning of trash in vacant areas, gang violence and drug-related activities, and provision of more child care.

3.0 <u>CONTEXT FOR IMPACT ASSESSMENT</u>

Specific project impacts are discussed in Section 4. This section provides information on matters considered to constitute important <u>context</u> for the impact assessment: (1) What additional housing is planned for the study area? (2) Will residents find employment opportunities in the region? (3) What major new infrastructure improvements are planned which may affect the character of the region?

Given the nature of topics examined in this section (particularly employment), the study area under consideration is expanded to encompass all of Ewa and Central Oahu, and not just Ewa and Waipahu. While most socio-economic impacts of the project may be expected to be confined to the Ewa-Waipahu area, West Loch Estates residents may travel to employment in a variety of directions: south to the Ewa Beach/Barbers Point area; west to the Ko Olina/Campbell Industrial/Kapolei complex; east to Honolulu; or north to the military and future high-technology park in the Mililani/Wahiawa area.

3.1 PLANNED AND PROPOSED NEW HOUSING

3.1.1 <u>Housing for All Market Segments</u>

The Ewa Development Plan area is designated as Oahu's "Secondary Urban Center" under the Oahu General Plan. Substantial residential growth is expected, consistent with plans to increase Ewa's population from about 37,400 in 1985 (unpublished estimate, City and County of Honolulu, Department of General Planning, 1987) to an allocated figure of 83,100 in the year 2005. Additional housing development is also planned in the adjacent Central Oahu Development Plan area.

While a number of major housing projects are being planned, many are not yet part of the City and County of Honolulu's official Development Plans for Ewa or Central Oahu. Therefore, when describing these projects, a distinction will be maintained between "proposed" and "planned" housing. "Proposed" housing includes projects for which Development Plan approval is still being sought, while "planned" projects are on the Development Plans.

Table 5 details the number of proposed and planned housing units for Ewa and Central Oahu expected to be built through 1993, when the West Loch project units may be fully absorbed. This table shows that much of the housing planned for this period -- fully 33 percent -- is still in the proposal stage, lacking necessary Development Plan approvals.

The total number of planned units between now and 1993 comes to 11,033 (7,213 in Ewa and 3,820 in Central Oahu), while the additional proposed units total 5,289 (1,500 in Ewa and 3,789 in Central Oahu).

Table 5:

Available New Housing Units, Ewa and Central Oahu, 1987 - 1993

	1987	1988	1989	1990	1991	1992	1993	Total
Planned Housing:								
--Ewa	250	463	1050	1300	1300	1300	1300	7213 [1]
--Central Oahu	1277	340	340	688	495	340	340	3820 [2]
Portions of Planned Housing for "Gap Group" Market:								
--Ewa				61	164	164	164	967 [3]
--Central Oahu			102	102	102	102	102	762-972 [4]
Proposed Housing: [5]								
--Ewa			500	500	500			1500
--Central Oahu				500	993	1148	1148	3789

Notes: (1) Includes Gentry-Fort Weaver, Makakilo, Kapolei Village, and Gentry-Ewa projects.

(2) Includes Mililani, Waikele, and Village Park.

(3) Includes 250 gap group Units at Gentry-Ewa, for which delivery date is unknown.

(4) Includes 150-360 gap group units at Village Park, for which delivery date is unknown.

(5) Many proposed projects, in initial announcements, include gap group components, but plans remain speculative at this time.

Source: John Child and Company, "Market Assessments for West Loch Estates," Appendices B & C. 1987.

It should be noted that actual housing construction and sales are highly dependent on interest rates and other market conditions. However, assuming that the schedules suggested in Table 5 can be met, West Loch Estates would increase the inventory of planned housing by 20.8 percent by 1993 for Ewa alone, and by 13.6 percent for the combined Ewa and Central Oahu areas.

If all "proposed" projects counted in Table 5 also win approval, West Loch estates would increase the total inventory by 17.7 percent for Ewa alone, and by 9.2 percent for the combined Ewa and Central Oahu areas.

3.1.2 Housing for the Gap Group

According to the project market analysis prepared by John Child & Co. (1987), much of the planned housing in the study area will be moderately-priced, but relatively little is expected to be priced within reach of gap group families.

Using a unit price of $120,000 as a gap group maximum standard, the following projects are planned between 1987 and 1993:

- About 40 percent of housing units built in the Kapolei Village project by the Hawaii Housing Authority and the City Department of Housing and Community Development would be gap group units. While the delivery dates of the gap group units is not yet known, 717 of the 1,750 planned Kapolei Village units to be built between 1987 and 1993 could be expected to be gap group homes.
- The Gentry-Ewa project will include 250 multi-family gap group units. No delivery date is provided, but for purposes of this analysis it is assumed that they will be built by 1993.
- From 25 to 35 percent of the Amfac Waikele project in Central Oahu is expected to consist of gap group units. While the delivery dates of these specific units have not been given, it is assumed that 30 percent of Waikele units in the time period, or 612 units, would be for the gap group.
- The Village Park expansion in Central Oahu, just above Waipahu, contains 30 acres for subsidized housing. This could yield from 150 single-family units to about 360 multi-family units. Again, no delivery date is available for this particular project, but it will be assumed here that these units would be completed by 1993.

Thus, given the foregoing somewhat optimistic assumptions, already-planned housing projects would add just 967 gap group units in Ewa, plus from 762 to 972 units in Central Oahu.

Development of West Loch Estates -- with 900 units affordable by the gap group and below -- will therefore almost double the supply of new gap group units in Ewa, and result in a 32 to 34 percent increase in the supply of new gap group housing units in the combined Ewa/Central Oahu area.

3.2 FUTURE EMPLOYMENT PROSPECTS

3.2.1 Introduction

A major public policy question about future housing development on Oahu is whether residents will have the opportunity to find employment close to their homes, as opposed to commuting to Honolulu. That issue represents the focus of this section. It should be noted, however, that it is at this time difficult if not impossible to address two related questions:

- o Will future residents actually be interested in nearby jobs, since most will already have employment elsewhere (as evidenced by their ability to afford a new home)? No studies have been carried out to research the actual extent to which new residents switch to nearby jobs.

- o Will the jobs to be developed in the area provide sufficient income to support mortgage payments or rents? Many of the planned future jobs (e.g., resort or technology park employment) would not provide sufficient income to afford housing based on a single paycheck, but most Hawaii families now depend on several paychecks to cover housing costs.

As a preliminary statement, it may be assumed that most West Loch Estates primary wage-earners would already have established jobs (many perhaps already located in Ewa/Central Oahu, but others in Honolulu) which they would be unlikely to drop on short notice for new jobs closer to their new home. At the same time, secondary wage-earners in the home and new labor force entrants from these households would be more likely to apply for new jobs opening up fairly near their homes. However, this assumption is subject to verification as the Ewa area actually develops.

Employment in the general region of the project site is expected to increase significantly in future years. This section presents an overview of potential new job opportunities that may occur due to major projects which are currently planned or proposed in the area. These include projects which have received government approvals, at least at the City Development Plan level, and others which still require Development Plan amendments.

Future job estimates were obtained largely through personal communication with developers of individual projects. Potential

employment at the Kapolei Town Center, Ko Olina, and Campbell Industrial Park were interpolated from a recent study prepared for Campbell Estate (Leventhal, 1986). This study presented high-, mid-, and low-range estimates. A recent update evaluation of the study's findings indicate that the original estimates now appear to be conservative. This means the original high-range estimates now are considered to be mid-range estimates, and new high-estimates are being made (personal communication, Michael Warren, Manager, Residential/Resort Properties, Campbell Estate, September 4, 1987). Therefore, estimates for the projects mentioned above will be those from the high-range of the Leventhal study.

Additional employment in the area is estimated in this section for years 1993, 1998, and the ultimate total at final build-out. The year 1993 was selected because it is assumed that most of West Loch's housing units will be occupied by that time, thus providing a key timeframe for evaluating the potential of jobs for residents of the project. The following five-year period, to the year 1998, can be expected to be a period in which residents of the West Loch Estates may seek second jobs; housewives may enter or re-enter the job market; and others may seek new jobs.

3.2.2 Planned Future Projects

Table 6 lists eight projects in the Ewa and Central Oahu areas which have approval from the City and County Department of General Planning (DGP). This signifies they have gone through the Development Plan review process and have received the necessary land use reclassification on the DGP Development Plan maps. Most of the projects have been ongoing for some time and have essentially completed the requirements for governmental review.

Totals from Table 6 show that the eight projects are expected to generate an estimated additional 14,285 direct on-site jobs by 1993; 22,415 jobs by 1998; and an ultimate total exceeding 27,800. In the long term, the Mililani Technology Park is projected to be the largest generator of new jobs, producing an estimated 8,800 jobs by the year 2003 (personal communication, Kent Keith, Project Manager, September 3, 1987). The Ko Olina Resort project and the continued expansion of the Campbell Industrial Park are also expected to create a significant number of jobs in the future. Estimates for these projects were interpolated from figures presented in the Levanthal report. For the purpose of estimating additional future employment, it was assumed that there are 2,500 existing jobs at the Campbell Industrial Park (personal communication, David McCoy, Industrial Real Estate Manager, Campbell Estate, September 11, 1987).

Amfac's Waikele development project has a total of 56 acres for commercial, retail, office, and light industrial activities. Due to the project's location, the most promising uses appear to be retail and office. Ultimately, it is anticipated the site will provide a total of 300,000 square feet of leaseable area. The developer estimates this will create approximately 2,000

Table 6:

Estimated Cumulative Additional Employment in the Study Area
(Direct On-Site Employment)

Project	By 1993	by 1998	Ultimate Total
<u>Planned</u> (with Development Plan approvals)			
Ko Olina (West Beach)	3,370	5,130	5,130
Campbell Industrial Park (includes the Barbers Point Harbor)	1,450	2,900	4,910
Mililani Technology Park	2,800	5,600	8,800
Gentry Industrial Park	4,150	4,150	4,150
Waikele Retail/Office/ Industrial Center	1,000	2,000	2,000
Mililani Town Center	1,200	2,320	2,320
St. Francis Hospital	250	250	500
H-POWER	65	65	65
Subtotal	14,285	22,415	27,875
<u>Proposed</u>			
Kapolei Town Center (includes the Makakilo Shopping Center)	8,230	13,270	19,373
Amfac Theme Park	900	1,200	1,200
Waiawa Ridge	0	0	3,415
Camp Malakole Industrial Area	50	100	100
Subtotal	9,180	14,570	24,088
TOTAL POTENTIAL NEW JOBS	23,465	36,985	51,963

jobs on-site, half of which are projected to be generated by 1993 (personal communication, Chris Kanazawa, Vice President, Amfac Property Development Corporation, September 2, 1987).

Developer estimates of future jobs were not available for the Gentry Industrial Park or Mililani Town Center projects. However, methods for calculating potential employment were derived through discussions with representatives of each project. At the Gentry Industrial Park, where warehousing is the primary activity, it was suggested that employment could be calculated by assuming two jobs per 1,000 square feet of leaseable floor area (personal communication, Charles Pang, Leasing Manager, Gentry Companies, September 4, 1987). Based on a total of 120 acres at the site and a 60 percent lot coverage, a total of 6,200 jobs may be located at the park at build-out. Current estimates indicate the site is presently about one-third completed. Therefore, it is assumed there are currently about 2,050 jobs at Gentry, and an additional 4,150 may be added in the future. Build-out is expected to occur by 1993.

Future job estimates for the Mililani Town Center were made by assuming one job per 250 square feet of floor area. Developer estimates indicate the project will contain a total of 580,000 square feet of floor area at completion. The first phase of the project will open late in 1987 and is projected to be completed within ten years. According to Brad Myers, the Project Manager for the Town Center (personal communication, September 8, 1987), it may reasonably be assumed that 300,000 square feet of leaseable space will be available by 1993. This would provide approximately 1,200 jobs by that year, with an ultimate total of 2,320 by 1998.

One final project with current approval is the new St. Francis Hospital which is expected to be completed in 1989 across from the West Loch Estates project. The initial phase of construction is projected to provide approximately 250 jobs. In the long term, the hospital is expected to double in size, providing a total of about 500 jobs.

3.2.3 <u>Proposed Future Projects</u>

Table 6 also lists four projects which still require full government review and approval, a process which may take several years. During this process, project proposals can be, and often are, substantially changed. However, these potential projects do provide implications for possible employment in the area.

Totals from Table 6 show that these proposed projects could add an additional 9,180 on-site jobs by 1993; 14,570 jobs by 1998; and an ultimate 24,000 at build-out. By far the major producer of jobs could be Campbell Estate's Kapolei Town Center. Long planned to be the secondary urban center on Oahu, the Kapolei project is expected to be a self-contained community providing a full range of job types. In the long term, over 19,000 new jobs are projected to be created in the new town center.

Figures for 1993 and 1998, as shown in the table, are interpolated from figures presented in the Levanthal report.

The proposed development of Waiawa Ridge may also provide a significant number of jobs in the future. Actually, the City Council in 1986 gave approval for 90 acres of commercial/industrial activities at Waiawa. However, there are no current plans for developing this site by the developer (personal communication, Tosh Hosoda, Planning Director, Gentry Companies, September 9, 1987). The estimated number of 3,415 jobs eventually to be created by the project was obtained from the environmental impact statement for the project (Environmental Communications, Inc., 1986).

One final potential project listed on Table 6 is the Camp Malakole Industrial Area. The developer for this project is currently seeking Development Plan approval from the City. The site, located adjacent to the Barbers Point Harbor, is proposed to provide about 70 acres for warehousing activities for harbor-related uses. A total of about 100 jobs is expected to be created at the site, half of these by the year 1993 (personal communication, Mark Hastert, Helber Hastert & Kimura Planners, September 9, 1987).

3.2.4 Total Potential Job Opportunities

Table 6 shows that current developer plans and estimates total to an estimated 23,400 additional jobs in the Ewa and Central Oahu areas by the year 1993; almost 37,000 by 1998; and over 51,000 in the long-term.

In addition to these on-site jobs, thousands of construction and indirect and induced jobs could also be created. For example, the UTPP 1980 census data cited in Section 2.3 indicates that, for each 1,000 residents in the existing Ewa/Central Oahu population, there were 110 commercial, neighborhood industrial, and local governmental support jobs. In other words, a substantial suburban or urban development automatically generates jobs required to service and support the population. Some of these types of jobs would be included in the foregoing job figures (particularly at Waikele and Kapolei Town Center), but others of these jobs would be located elsewhere -- such as in the West Loch Estates commercial area or additional staff for existing Waipahu and Ewa Beach shopping areas.

Care must be taken when using developer estimates for projecting future employment. Problems involved in these estimates include the varying methods by which numbers are calculated; the fact that availability of commercial or industrial acreage does not necessarily imply its use in the future for that purpose; and the ultimate reality that market forces will actually determine the timing and number of jobs eventually created.

Nonetheless, numbers in Table 6, plus other projects which may be unknown at this point, indicate a substantial number of jobs in the area for future residents of the project.

3.3 MAJOR INFRASTRUCTURE IMPROVEMENTS

This brief sub-section will focus on major planned infrastructure improvements expected to substantially affect the character of the region. (NOTE: The question of infrastructure and public service adequacy to support the project will be separately examined in Section 4.3.)

The primary infrastructure improvement which affects the character of an area is new roadway construction. The current Development Plan facilities map indicates two major roadway construction projects in the Ewa area. The first project, which is already underway, is the expansion of the H-1 Freeway from Kunia Road to Makakilo. New lanes are being added to the freeway in both directions. The second project is the future expansion of Ft. Weaver Road (additional lanes in two directions) from the Ewa town area to Ewa Beach. Both these projects are planned for completion within the next six years, according to the Development Plan facilities map.

Other roadway projects, planned for sometime beyond the next six years, include the expansion of Farrington Highway from Ft. Weaver Road to the Kapolei Town Center area; a new road to the west and parallel with Ft. Weaver Road extending from the proposed Ewa Marina project to the H-1 Freeway; and improvements to Renton Road from Ewa town to the West Beach area.

Within the next six years, additional infrastructure or public facility improvements planned for Ewa include the expansion of the Honouliuli Sewage Treatment Plant from 25 million gallons per day (mgd) to 37.5 mgd; new fire and police facilities in the West Beach and Kapolei areas; and several new community parks.

A recently formed private corporation, the Ewa Plains Water Development Corporation, will develop extensive water systems throughout Ewa during the coming years. The water systems will provide both potable and non-potable water to the West Beach project, Campbell Industrial Park, the Gentry Ewa housing project, and the proposed Ewa Marina. The water systems will be dedicated to the County once they are operational.

4.0 PROJECT IMPACTS

This section addresses socio-economic impacts of the proposed West Loch Estates housing project. The initial three sub-sections focus on relatively tangible topics -- population, employment, and adequacy of public services and infrastructure. The last three sub-sections deal with more qualitative "social" topics -- community issues and concerns; compatibility with neighboring uses; and displacement.

4.1 POPULATION GROWTH TRENDS AND IMPACTS

This section provides islandwide and study area growth trends, and assesses the project in the context of City policies on population distribution.

4.1.1 Islandwide Growth Trends

Oahu's growth rate has been declining since 1950, although the island's population continues to increase. From 1950 to 1960, island population grew at an annual rate of 3.5 percent; from 1960 to 1970, 2.3 percent; and from 1970 to 1980, 1.9 percent. The provisional population estimate for the City and County of Honolulu, as of July 1, 1986, was 816,700 (Hawaii State Department of Business and Economic Development, Hawaii State Data Center, 1987). This would indicate a 1980-1986 annual growth rate of 1.2 percent.

4.1.2 Oahu General Plan Population Guidelines

The Oahu General Plan indicates guidelines for the distribution of resident population for the year 2005. Table 7 shows these guidelines with (1) estimated 1984 populations for each Development Plan area; (2) year 2005 guidelines for the percentage of total island population to be located in each area; and (3) the range of year 2005 population derived from the percentage ranges.

The Ewa Development Plan area is expected to grow from a 1984 population of approximately 36,000 to 83,100 in 2005. Expected growth is based on a model which considers both population capacity for housing developments approved as of 1985 and also estimated additional future housing demand as constrained by land use policies. The expected population of 83,100 is lower than the General Plan guideline range of 85,905 to 95,450.

4.1.3 Study Area Growth Trends

During the 1970's, population in the Ewa development plan area grew by an annual average rate of 4.1 percent. This was a slightly lower rate than for the neighboring Central Oahu development plan area (4.3 percent), but considerably higher than the islandwide rate of 1.9 percent.

Table 7:
Development Plan Area Population Guidelines

DP Area	1984 Population	Projected Year 2005 Population	Year 2005 General Plan Pop. Guidelines %	Actual
Primary Urban Center	436,400	480,000	47.5-52.5	453,388-501,113
Ewa	36,000	83,100	9.0-10.0	85,905-95,450
Central Oahu	114,400	139,800	12.8-14.2	122,176-135,539
East Honolulu	45,600	58,500	6.2-6.8	59,179-64,906
Koolaupoko	113,300	124,200	12.4-13.6	118,358-129,812
Koolauloa	12,100	13,800	1.3-1.5	12,409-14,318
North Shore	14,000	15,600	1.6-1.8	15,272-17,181
Waianae	33,400	39,300	4.2-4.6	40,089-43,907
Total	805,300	954,500	95.0-105.0	906,775-1,002,225

Source: City and County of Honoulu, Department of General Planning, "Residential Development Implications of the Development Plans," 1985.

Virtually all of the 1970 - 1980 growth in Ewa took place in census tracts 83 and 86.01. Census tract 83 includes the community of Ewa Beach, while 86.01 includes Makakilo. Since 1980, residential growth has continued in Ewa Beach and Makakilo, and in smaller subdivision projects such as the City's "Ewa Expandable" project.

As noted in Section 2.4, Ewa's population growth in the early 1980's slowed almost to zero, reflecting the high interest rates and lack of new housing starts through 1984.

According to Department of General Planning (DGP) estimates (City and County of Honolulu, Department of General Planning, 1985), Ewa residential development will increase to higher levels through the year 2005. However, housing is not expected to be built at rates sufficient to meet the year 2005 population guideline. Reasons for this shortfall indicated in the DGP analysis include:

- o Residential projects committed in Ewa were not projected to begin until 1987, and would not reach the 1,000 units per year level until 1990. Of the projects identified as committed by DGP, the Ewa Marina project delivery has been set back to "indefinite" status.
- o A shortage of 19.7 percent in the number of Ewa housing units expected to be built, compared with the number needed to meet the population guideline. This is attributed to a shortage of development plan-approved capacity for new housing.

4.1.4 On-Site Population From Project

New housing development at the project site will add to the population of the Ewa development plan area. Estimating the size of project population depends upon assumptions about the average household size of future residents.

Household sizes will differ among residents of the elderly and single-family units. Elderly families are assumed to average 1.8 persons per household -- a figure equal to the average household size of elderly families in public housing managed by Hawaii Housing Authority (Hawaii Housing Authority, 1987).

For single-family housing, the Department of General Planning assumes 3.3 persons per unit in assessing population impacts. This figure may be somewhat high, as household sizes in Ewa and Central Oahu, as reported by developers, tend to show smaller families. At Mililani, 3.03 persons per unit were reported for single-family homes priced between $160,000 and $219,000, and 2.93 persons per unit were reported for single-family units priced between $115,000 and $164,000 (John Child & Co., 1987). Therefore, the population impact is calculated using 3.0 persons per unit as the lower range for single-family units and 3.3 persons per unit as the upper range.

Derivation of project population is shown in Table 8. The table indicates that the project will produce an Ewa population higher by from 4,320 to 4,725 persons than in the absence of the project. It is noted earlier in this section that projected population for Ewa would be from 2,805 to 12,350 below the guideline range recommended by the Oahu General Plan.

The Oahu General Plan population guideline for Ewa, coupled with projected population, provides sufficient room for new housing to accomodate the project. Project impacts, then, will principally be to provide new housing at an earlier time than could be completed by other projects, and to cause a greater proportion of Ewa's new population to consist of households in the gap group.

Table 8:
Range of Projected Population at West Loch Estates

Housing type	Units	Household size	Population
Elderly	150	1.8	270
Single family	1350	3.0 -- 3.3	4050 -- 4455
Total	1500	NA	4320 -- 4725

Source: Community Resources, Inc.

4.2 PROJECT EMPLOYMENT IMPACTS

Employment impacts at the project site will result from development of certain non-housing uses at the site. Permanent jobs created will include:

- o 22 positions at the public golf course (personal communication, David Mills, Chief, Golf Courses Branch, Department of Parks and Recreation, September 10, 1987);
- o 46 to 51 positions at the elementary school site, if it is accepted by the Department of Education (personal communication, Ed Hasegawa, Business Specialist, Hawaii State Department of Education, September 15, 1987).
- o a maximum of 200 retail and service jobs at the commercial center, based on an islandwide average of one

employee per 250 square feet of leasable area and a planned leaseable area of 50,000 square feet;

- up to 20 positions at the day care center (personal communication, Lynn Koga, Supervising Principal, KCAA Pre-Schools of Hawaii, September 15, 1987);
- a possible single additional job at the park and ride bus transportation facility (personal communication, Howard Takara, Chief, Bus Systems Division, Department of Transportation Services, September 3, 1987).

Thus, potential employment at the completed West Loch Estates project totals approximately 290 positions. (See Section 3.2 for a discussion of other possible future nearby job opportunities for project residents.)

4.3 ADEQUACY OF PUBLIC SERVICES

This section reviews the availability of public services to accommodate the West Loch Estates project.

As noted in Section 3, the project site is located in the Ewa area, where residential and employment growth has started and is expected to increase to constitute Oahu's "Secondary Urban Center" by the year 2005. Public services are generally in place or being developed to accommodate the project.

The following analysis is necessarily limited to the adequacy of public services for the West Loch Estates project alone.

The <u>cumulative</u> impact of all planned and proposed residential growth in Ewa must be separately addressed (outside of individual project EIS's) by the City and County through comprehensive infrastructure planning processes. Comprehensive infrastructure development has already begun, exemplified by actions such as:

- the creation of a privately-chartered authority to build and operate water facilities for all Ewa development;
- agency planning, as by the Honolulu Fire Department, in identifying new Ewa facilities to be developed as service demand increases;
- identification of land to be dedicated for public uses such as school and park sites, as Ewa rojects are submitted for planning approvals; and
- formulation of regional service plans, as mandated for the Hawaii State Department of Education by the 1987 State Legislature.

4.3.1 <u>Hospitals and Health Care</u>

Medical service providers have already begun to move the locus of services leeward, in recognition of population growth in Ewa and Central Oahu. Kahi Mohala, a psychiatric treatment facility, located its statewide facility in Ewa, and three new hospitals have been built or are under development between Moanalua and Waipahu.

Kaiser Foundation Health Plan has opened its new central hospital in Moanalua. Kaiser subscribers in the project area can also use services at Waipahu's Punawai Clinic. The Punawai Clinic is considered adequate to accommodate additional population in the next few years, but Kaiser will consider building another clinic in Ewa in the future (personal communication, Ron Hayashi, Assistant Health Program Manager, Kaiser Foundation Health Plan, September 1, 1987).

A new hospital is being developed on the former Leeward Hospital site near Pearl Ridge Shopping Center. The Pali Momi Medical Center is expected to open in October 1988, with a 116-bed hospital, ambulatory services center, and medical office building. Pali Momi officials expect the medical center to draw most patients from the communities bounded by Halawa Valley and Ewa. These consumers now travel to Honolulu for medical attention (personal communication, Rod Keller, Pacific Region Director of Development, Health Care International, August 31, 1987).

St. Francis Hospital-West is being developed on a 22-acre site near West Loch Estates. The initial phase of the project will include a medical office building, scheduled to open in July, 1988, and a 100-bed hospital/medical center slated to start operations in August, 1989. The hospital will include 30 beds for obstetric patients, an emergency/trauma unit, and fast response services via private ambulance and helicopter. The ultimate project may result in as much as 100 additional beds, and future plans remain flexible to respond to identified service gaps (personal communication, Eugene Tiwanak, Assistant Administrator, St. Francis Medical Center, September 4, 1987).

4.3.2 <u>Emergency Services</u>

Ambulances stationed at the Waipahu Fire Station would respond to emergencies at the project site. Backup service is provided by the City ambulance at Aiea. Private ambulance service is also planned from the new St. Francis Hospital-West facility located near West Loch Estates.

Ambulance service is considered to be adequate to handle the level of current services (personal communication, Donna Maiava, Acting Chief, Emergency Medical Services Branch, State Department of Health, September 1, 1987). At least 95 percent of calls in the area are answered within 20 minutes. Average response time in the Ewa area is about 15 minutes.

Ambulance service is provided by the City Department of Health under contract with the State Department of Health. Ewa is considered to be of first priority on Oahu for a new ambulance unit, if additional funding is provided.

4.3.3 Fire Protection

Primary fire protection for the project site will come from the Waipahu Fire Station, which consists of one engine company (15 firefighters) and one ladder company (six firefighters). Secondary service is available from the Ewa Beach and Pearl City engine companies. The Honolulu Fire Department can also call upon the U.S. Navy for assistance from the Barbers Point Naval Air Station fire company, under a mutual aid agreement.

Fire protection is considered adequate. Response time from the Waipahu Fire Station is estimated to be four to five minutes (personal communication, Battalion Chief Kenneth Word, Administrative Services Officer, Honolulu Fire Department, September 1, 1987).

New facilities are planned for the Ewa district which should reduce future response time to the project site. One additional fire station will be built in Ewa, and two new stations are possible. The Fire Department is seeking land to build stations at Tenney Village and at Campbell Industrial Park. These facilities are shown on the Development Plan public facilities map as "site undetermined" projects to be built in the "six years and beyond" timeframe. According to the Honolulu Fire Chief, the Tenney Village station is sought for completion by 1991 (letter from Frank K. Kahoohanohano, Fire Chief, to Michael M. H. Moon, Director of Housing and Community Development, June 15,1987).

4.3.4 Sewage Treatment

Development at the project site will be served by the City's Ewa and Waipahu sewer systems. The project's first increment will connect with the Waipahu system, and a 1,200-foot long, 12-inch wide relief line is planned to extend from the project site to the Kunia Pump Station. The line may be upgraded to 15-inch width if necessary (personal communication, Jay Hamai, Engineer, Wastewater Division, Department of Public Works, September 1, 1987). Waste from the golf course clubhouse and park comfort stations will also be routed to the Waipahu system.

The second increment of the project will connect to Ewa sewers through lines running under Fort Weaver Road to an 84 inch interceptor line at Geiger Road. Waste will be treated at the Honouliuli sewage treatment plant. A pump station will be constructed at or near the project site to facilitate flows.

Both sewer systems to be used have the additional capacity needed, with the identified improvements. Provision has already been made for project load at the Honouliuli plant.

4.3.5 Education

The Hawaii State Department of Education (DOE) has estimated that project population would include 240 to 480 elementary school-age children, from 90 to 170 intermediate students, and from 160 to 240 high school children (letter from Charles T. Toguchi, Superintendent of Education, to Mike Moon, Director of Housing and Community Development, June 8, 1987).

Students from West Loch Estates would normally be assigned to Ewa Elementary, Ilima Intermediate, and Campbell High School. The Department of Education is currently seeking funds to expand Ewa Elementary's capacity with an eight classroom building which would accommodate 200 additional students. Capital improvement funds will be sought in the 1989 state budget; the building could then be completed by September, 1991 (personal communication, Tom Nakai, Director, Facilities and Support Services Branch, Office of Business Services, Department of Education, August 31, 1987).

At the request of the State Legislature (H.R. 179, H.D. 1 of 1987), the Department of Education is formulating a comprehensive plan for new school and library facilities in Ewa. The Department tentatively identifies a need for one new high school, one or two intermediate schools and six elementary schools. Most or all of the selected sites will be dedicated to the DOE by project developers. However, the DOE is not certain which sites will be selected.

It is expected that students from the project site will attend Ewa Elementary, Ilima Intermediate, and Campbell High School on a temporary basis until new schools are built. Capacities of these schools will depend on the progress of other area residential developers. At the elementary school level, DOE officials would have the options of accommodating increased enrollments in portable classrooms or of providing transportation to other schools in the region -- including Kaimilo, Puakea, and Barbers Point Elementary.

A school site at West Loch Estates has been reserved for DOE in the subdivision plans. The parcel is approximately six acres in size. Acceptance of the site and ultimate development will be decided upon by DOE. If the site is not needed by DOE, it would be returned to the City for other purposes yet to be decided on.

4.3.6 Library Services

West Loch Estates residents will be served by the Ewa Beach Library (affiliated with Ewa Beach Elementary School), a public library at Waipahu, and the Pearl City regional library. The Pearl City library was recently expanded.

The Office of Library Services of the Hawaii State Department of Education expects to construct new (and/or to expand existing) facilities in leeward Oahu, although the pace of new facilities will be determined by actual development in Ewa (personal communication, Clyde Okinaga, Administrative Services Officer, Office of Library Services, August 31, 1987).

Library planners feel that existing libraries are adequate to accommodate additional users from West Loch Estates. It should be noted that, to the extent that residents travel to Honolulu for work or recreation, Hawaii's statewide library system will make all libraries available to project residents.

4.3.7 Water Supply

Uses at the project site will require a supply of potable and non-potable water. Current plans call for irrigation of the public golf course with non-potable water.

Potable water demand for the project is estimated at approximately 750,000 gallons per day (personal communication, George Hiu, Engineer, Board of Water Supply, September 9, 1987). The Board of Water Supply will make about 800,000 gallons per day available, sufficient to service both project increments. A new well at the Waipio Heights 3 well site will provide the new source, and water will be stored at the Board of Water Supply's "595" reservoir (personal communication, Richard Fujii, Engineer, Planning Branch, Board of Water Supply, August 31, 1987).

Sources of, and methods for conveying, non-potable water are still under study. Land in the general vicinity of the project site is believed to have supported taro and rice cultivation. Thus, engineers believe that spring and other subsurface water is probably not brackish, since brackish water would not have supported these crops.

There does appear to be a plentiful supply of subsurface water in the area planned for a golf course. If the subsurface water tests reveal sufficiently low salinity, an irrigation system could be devised using a combination of sand drains, infiltration galleries, sump collection, and pumping against grade to water hazards when the water would be stored (personal communication, Fujii, September 4, 1987). Drawing caprock water or using treated effluent from the Honouliuli sewage treatment plant represent possible alternatives.

4.3.8 Parks

Project residents would be served by parks and recreation programs in Ewa and Waipahu. In addition, the project site will include a new district park and a shoreline park.

Current facilities in the general area include two neighborhood parks, Asing Field, and the Ewa Mahiko park. Asing Field has athletic fields and is located on the future project site; it will be redeveloped as part of the project. Ewa Mahiko is a new neighborhood park located near the "Ewa Expandable" subdivision. The nearest Ewa facility with recreation staff is the Ewa Beach Community Park. The area's current district park complex is the

Waipahu Recreation Center, which has a swimming pool, gymnasium, athletic fields, playing courts, and a multi-purpose building.

District park staff anticipate that current facilities will be able to adequately serve new residents at the project (personal communication, Don Akiyama, Acting Leeward District Supervisor, Department of Parks and Recreation, September 1, 1987). However, growing area population will make development of new parks necessary in the longer term.

An 18-acre site is being reserved at West Loch Estates for development of a new district park. Under the "City and County Recreation Park and Facility Standards" included in the Department of Parks and Recreation's Long Range Plan (1980), a project of this approximate size should be served by at least one neighborhood park on a four- to six-acre site. Both the district park and the 39-acre shoreline park developments will satisfy recreation facility needs of West Loch Estates residents, as well as increasing opportunities for Ewa and Waipahu residents.

4.3.9 Police Protection

Police services to the project will be provided from the Pearl City substation. The Honolulu Police Department indicates that "Our Pearl City District station ... is already operating at near maximum capability... Our ability to provide adequate services for the community will depend primarily on the availability of funding for sufficient personnel, equipment, and communications..." (letter from Douglas G. Gibb, Chief of Police to Mike M.H. Moon, Director of Housing and Community Development, June 2, 1987).

Department officials foresee the need for a new police substation in the Ewa district, with the timing dependent upon the pace of new growth (personal communication, Brandon Stone, Management Analyst, Office of the Chief, Honolulu Police Department, September 8, 1987). A new station is planned in the general vicinity of the new shopping center at Makakilo; it is shown on the "Within Six Years" time frame, with site undetermined, on the Ewa development plan public facilities map.

The Pearl City substation reports no unusual current police problems on the project site. Most police attention to the area relates to traffic congestion on Fort Weaver Road (personal communication, Major Lee Donahue, Commander of Pearl City Substation, Honolulu Police Department, September 9, 1987).

4.3.10 Public Transportation

Bus service at the project site is provided on the Ewa Beach route, which travels along Fort Weaver Road on the line between Ewa Beach and Ala Moana Center. Bus routes will be adjusted to serve the new population at West Loch Estates, and new buses and routes will be added as population grows (personal communication, Howard Takara, Chief, Bus Systems Division, Department of Transportation Services, September 3, 1987).

Phase II of the project is planned to include a "park-and-ride" facility for bus service. The park-and-ride facility would function as a terminal for buses, where bus riders could park their automobiles or transfer from local lines to more direct service to Honolulu and other destinations. The park-and-ride facility will provide more convenient and possibly more frequent service to West Loch Estates residents, and it will improve area bus service generally.

Project residents with special transportation needs related to disability will be eligible for "Handi-Van" service provided by the City and County of Honolulu. Handi-Vans presently serve the Ewa area as part of an islandwide system. Passengers pay $1.00 per ride; must reserve a spot at least 24 hours in advance; and must meet certain eligibility criteria tied to the non-ambulatory nature of their disability and inability to ride regular buses.

4.3.11 Solid Waste Disposal

City trash collection at the project site will be provided from an existing baseyard at Pearl City. Refuse collected at West Loch Estates will be taken to the landfill at Waimanalo Gulch, and would be deposited at the H-POWER plant at Campbell Industrial Park when that plant is completed.

A total of three new routes will have to be created to service the project site. This may have personnel and equipment implications, depending on the timing of new growth elsewhere in the district (personal communication, Frank Doyle, Chief, Refuse Division, Department of Public Works, September 4 and 9, 1987).

4.3.12 Utilities (Electricity and Telephone)

Telephone service to the project will be provided by Hawaiian Telephone Company, and electricity will be provided by Hawaiian Electric Company. Identification of specific service requirements by each utility will require review of specific subdivision plans, which have not yet been completed.

Project electric demand has been estimated at about five million volts per day. Two sets of electric lines abut the project. An existing pole line runs along Ft. Weaver Road, containing one 46-KV circuit. Another electrical line with two 46-KV circuits runs along the Oahu Railway and Land Co. former railroad right-of-way and then along the West Loch shoreline. Power to the site will come from either the Kahe or Waiau existing generating plants. Hawaiian Electric Co. (HECO) is likely to need a new transformer station at or near the project site (personal communication, Gary Funasaki, Engineer, Ronald Ho & Associates, West Loch Estates utilities consultants, September 10, 1987).

Additionally, HECO has recently begun a study to determine a corridor routing for a new 138-KV line from the Waiau power plant to the Campbell Industrial Park sub-station, in order to (1) increase capacity to the Ewa area, in light of proposed major new development; and (2) improve reliability of the overall system, in light of islandwide and regional power outages in the early 1980's (personal communication, David Nagata, project manager, HECO Engineering Department, September 18, 1987). The ultimate corridor will be 70 feet wide or less, with power lines mounted on single-pole structures 90 to 100 feet high.

One potential corridor would include the existing 46-KV route along the right-of-way for the Oahu Railway and Land Co., through the West Loch Estates project site. City agencies and members of the public will be given the opportunity to comment on the compatibility of possible corridors with existing or proposed residential development at public hearings to begin in November 1987. A preferred alignment for the corridor will be announced in April 1988, with final selection targeted for June 1988.

Telephone service will be provided from existing switching sites, of which there are two in the project's general vicinity. Switching stations are located in Waipahu, near Waikele Street and on Renton Road in Ewa (personal communication, Frank Ito, Plant Engineer, Hawaiian Telephone, September 9, 1987). An underground telephone' cable linking Hickam Air Force Base and Kunia crosses the mauka portion of the project site. The telephone company expects that the cable will not be disturbed, or that project development can be coordinated with relocation of the cable. An additional switching station may be needed to service residential growth in this area; location will depend upon negotiations between the utility and residential developers. About 4,000 square feet of land would be needed to accommodate a new switching station.

4.4 COMMUNITY ISSUES AND CONCERNS

This sub-section identifies preliminary issues and concerns related to the West Loch project. Two sets of issues -- compatibility with nearby uses and displacement of current uses or residents -- will be given separate and more expanded treatment in the following, final sub-sections of the report.

4.4.1 Introduction

4.4.1.1 Information Sources for This Section

To provide community input to the West Loch Estates planning process, the City established ad hoc advisory group consisting of representatives of major Ewa and Waipahu groups (Section 4.4.1.2).

Also, in the course of preparing this social impact assessment, informal interviews were held with approximately 25 people from the community (Table 9) to identify preliminary community issues related to the proposed West Loch project.

Table 9:

List of People Interviewed

(Note: Those interviewed provided their comments as individuals and not as representatives of their organizations. Organizational affiliations are provided only to provide some indication of the interests and networks of those interviewed.)

Donald Adriano	Firefighter, Honolulu Fire Department
C. O. Andy Anderson	President, Waipahu 2000 Community Association Waipahu Neighborhood Board Waipahu Community Association
Charles Dick Beamer	President, Ewa Beach Community Association Ewa Neighborhood Board
Steve Berendzen	U.S. Fish and Wildlife Service
Tony Bise	President, Ewa Housing Foundation, Inc.
Ed Castanos	President, Ewa Community Association
James K. Chung	Treasurer, Hoaeae Point Community Association
Mike Crozier	Representative, Hawaii State Legislature Community Advisory Committee of the Ewa Secondary Urban Center Kapolei Task Force
Bill DeMent	Field Engineer and Land Manager, Oahu Sugar Company
Shirley Head	President, Honouliuli Doshi Kai
Cal Kawamoto	Chair, Waipahu Neighborhood Board Executive Director, Waipahu Cultural Garden Park Vice president, Waipahu Community Association Vice president, Waipahu 2000 Community Council
Rodney Kealoha	Captain, Honolulu Fire Department Waipahu Station

(CONTINUED)

Table 9:

List of People Interviewed (Continued)

Benjamin Paul Kekona	President, Hoaeae Point Community Association
Tamae Kekona	Secretary, Hoaeae Point Community Association
Emogene Martin	Chair, Ewa Neighborhood Board Community Advisory Committee of the Ewa Secondary Urban Center
Francis Oishi	Biologist, Division of Aquatic Resources, State Department of Land and Natural Resources
Paul Oshiro	Representative, Hawaii State Legislature Ewa Beach Community Association Community Advisory Committee of the Ewa Secondary Urban Center
Dave Parsons	Ewa Neighborhood Board Ewa Beach Community Association Community Advisory Committee of the Ewa Secondary Urban Center
Theodore Redoble	Resident west of Old Fort Weaver Road
Mike Shire	Chief Engineer, Chevron USA
Loreen Stern	Secretary, Waipahu Community Association
Kay Sunada	Former president, Honouliuli Doshi Kai
Peter Tagalog	President, Ota Camp Makibaka Association, Inc. Waipahu Community Association
Ronald Tongg	President, Tongg Ranch, Inc.
Sharon Walsh	Resident west of Old Fort Weaver Road
Howard Wilson	Part-time fisher in area

Note that those interviewed provided their comments as individuals and not as representatives of their organizations. Organizational affiliations are provided only to indicate some of the networks and interests of those interviewed.

In the course of the interviews, people who may represent three community perspectives were contacted:

- o Those who may not live in the immediate vicinity, but could provide indications of regional impacts on the Ewa and Waipahu regions;
- o Those who live near the project site, and may have more long-range and direct contact with the proposed community -- including residents of Ewa, Honouliuli and the area designated for relocated Ota Camp residents; and
- o Those who live, work, or hold property on the project site, and would be directly impacted if the proposed project were implemented.

Each person was informed that the information they provided would be summarized in the EIS and that individual conversations would remain confidential. The basic piece of information used to explain the project to informants was the "Environmental Impact Statement Preparation Notice For the West Loch Subdivision, Ewa, Oahu, Hawaii," prepared in July 1987. The interviews were either one-to-one meetings or telephone interviews.

The sources for organizational positions on this project included minutes of Neighborhood Board meetings and published letters and testimony.

4.4.1.2 Positions Taken on the Project by Study Area Groups

Organizational positions or testimony on West Loch have been presented by the following groups (all of which currently participate in an ad hoc advisory committee which meets with the City to review plans and make recommendations):

- o Ewa Neighborhood Board No. 23,
- o Ewa Beach Community Association,
- o Waipahu Neighborhood Board No. 22,
- o Waipahu Cultural Garden Park,
- o Waipahu 2000 Community Council, and
- o Waipahu Business Association.

West Loch lies within the area of the Ewa Neighborhood Board, and is contiguous to the boundary of the Waipahu Neighborhood Board.

Except for the Ewa Neighborhood Board, all of these organizations support the West Loch project. The primary reason is the provision of housing. Waipahu organizations also stressed the need for the shoreline park and the positive impacts of the new community on existing businesses (based on review of "Meeting of the Planning Commission: Minutes," July 30, 1987).

At its June 18, 1987 meeting, the Ewa Neighborhood Board voted to submit a number of comments as initial concerns "... with the explanation that the Board has not had sufficient time to fully discuss this issue prior to the required deadline and that we reserve the right to submit additional items of concern to be addressed in the Environmental Assessment" (Ewa Neighborhood Board No. 23, minutes of regular meeting, June 16, 1987).

The list of 13 concerns focused on the City's role as a developer and financial feasibility; the adequacy of roadways; and public services and facilities; the water supply and tsunami precautions (letter from the Ewa Neighborhood Board No. 23 to the Department of Housing and Community Development, dated June 18, 1987).

4.4.2 <u>General Overview of Community Issues and Concerns Related to the West Loch Project</u>

This section provides an indication of community reactions at a given point in time (mid-August to mid-September, 1987), based on the interview process previously described. The interviews and review of published organizational positions provide information very early in the overall EIS process. Only some of those interviewed were aware of all of the project's components; their input was therefore based on their initial reactions to information presented to them during the interviews. Changes in attitude and issues may occur in time, given changes in the project and other events or influences in the community.

Because the interviews were conducted for <u>issue identification only</u>, no attempt was made to quantify the responses, or to assess the extent of project support or opposition.

In general, the project's concept was well received by almost all interviewed. The regional leaders, in particular, liked the proposed land uses because these were appropriate to the current needs of the community.

The project's concept was less important, however, to those who would be more directly impacted. Those who live near the project site tended to be more specific about their concerns about property value impacts, physical infrastructure, and public services.

On-site informants understandably placed more importance on their potential displacement than on regional benefits. Both nearby residents and on-site informants tended to express a dissatisfaction with their access to project information.

The housing component was the aspect of the project which the community tended to view most favorably. Regardless of one's opinion of specific project components, almost everyone acknowledged the need for housing.

Regional community leaders and organizations tended to appreciate the proposed "60/40 housing mix", in which 60 percent of the proposed units would be tailored to the income levels of gap group families and the remaining would be offered at market value. Recommendations for effective management and design controls were seen as possible ways to ensure a quality, planned development.

West Loch's recreational component was also seen by many as an asset to the community. Again, some made recommendations intended to retain the overall quality and family-oriented characteristics in recreational areas, including the golf course. Potential displacees did not appreciate the proposed recreational uses, however, mostly because, at the time of the interviews, such uses would occur on their present sites.

Traffic headed the list of concerns related to infrastructure, followed by drainage (a concern expressed primarily by nearby residents). People also asked about the preparedness of public schools to meet the demands of this and other Ewa proposals.

An issue raised mostly by nearby and on-site residents is a lack of information about the project. Potential displacees were especially critical of receiving no project information prior to notices of potential site entries and preliminary relocation schedules.

A few regional leaders expressed concern about the City's ability to implement the West Loch Estates plans as proposed.

4.4.3 Housing

4.4.3.1 Community Reactions to the Housing Component

The project's housing component appears to be the most positive aspect of the project from the community perspective. The following summarizes viewpoints expressed in informant interviews:

- The need for housing was acknowledged by almost all, and many people cited examples they knew of personally in which there are "doubling up" and crowding situations because of high housing costs.

- Many people, particularly the regional leaders, stressed that they support the project, as long as the housing mix and concept remain intact. The 60/40 housing mix was seen as an asset by both Ewa and Waipahu leaders because both wanted to see a mix of family incomes and housing types in any further development in the area.
- Both Ewa and Waipahu leaders wanted to minimize any form of subsidized housing. Modular housing units were highly discouraged, as well as ohana units.
- People were generally positive about the proposed elderly housing.
- To maintain the project's intent of a planned community, the regional leaders stressed the need for a well-managed community. It was suggested that the City be assertive in the formation of a homeowners association which will set and monitor design and maintenance standards for the entire project area.
- A few people were concerned that the intent of the gap group housing might be lost if the new homeowner re-sells the property at market rate to make a profit.

4.4.3.2 Analysis and Recommended Mitigations

The predominantly favorable reaction to the housing component reflects the region's general attitude toward growth in the area. Both the Ewa and Waipahu communities have been exposed repeatedly over the past few years to proposals of large developments. They have since formulated community goals which strive for the encouragement and promotion of projects which will allow planned growth which is sensitive to the physical and social environments.

Having articulated these goals, these communities are generally receptive to the large-scale growth anticipated for Ewa. Their concerns typically focus less on the magnitude of a proposal than on qualitative aspects such as the exact housing types and mix, as well as other measures which would assure "quality" development.

City representatives have indicated to community groups that they are exploring existing planned communities and their covenants to see which controls might be most effective for the West Loch community. They have also indicated that they will assist the West Loch residents in forming a community association.

It is recommended that, in addition to establishing design controls and management controls, the City also consider maintaining an active and ongoing role with West Loch in some voting or advisory capacity. This would be similar to the phased retention of representation by private developers in planned communities such as Village Park and The Gentry at Waipio.

It is noted that, regarding the re-sale of gap group units, the City will retain the first option to purchase the unit at a price prescribed by law. This will help in retaining the balanced mix of housing by minimizing the introduction of housing intended for gap group incomes to the more expensive market.

4.4.4 Recreation

4.4.4.1 Existing Conditions

The Navy controls the waters of West Loch and generally any civilian use must be approved by the Navy. On nearby Waipio peninsula, between Makalena Golf Course and the project area, shoreline usage requires formal permission and identification. Navy security guards regularly patrol the roads and evict anyone without proper permits.

The waters off the project area shoreline are also off-limits to the general public. Navy patrol boats make runs through the area and illegal boaters and fishers are asked to leave. Further, signs are posted along the shoreline which warns against trespassing and the use of waters.

By Presidential Executive Order 8143 of May 26, 1939, all waters up to the high water mark within Pearl Harbor are owned by the Navy. Furthermore, by Civil Actions 290, 291, 292, and 296, all fishing rights in Pearl Harbor were acquired by the Navy (Department of Navy response letter to 1987 Development Plan annual amendment review package, April 1987).

Due to sensitive activities and other operational requirements at Pearl Harbor, recreational use of Navy waters -- particularly those of West Loch -- is prohibited without the consent of the Navy. The particular sensitivity of West Loch is due to the location of the Navy ammunition storage facility in the area (see Section 4.5.2).

Nevertheless, the area is sometimes illegally used by people in the following manner:

- Crabbing -- Catches include Samoan crabs, blue pincher crabs and "gangster" crabs (believed to be a cross-breed between Samoan and blue pincher crabs). Small boats are often used to set out and recovering crab nets in the inlet. Because the water is shallow along much of the shoreline, people are also observed walking and laying their nets.

- Fishing -- Catches include papio, mullet, tilapia, and occasional runs of oio and halalu. At one time, the area was known for its plentiful schools of mullet, and occasionally schools are still seen offshore.

- Digging for clams and oysters -- Even though there is currently a statewide ban on this activity, people are occasionally seen doing this in several inlets along the shore.

At present, there are a number of old and dilapidated piers in the area.

The proposed park extending along the coastline of the West Loch Estates project does not include boatramps or any other type of structures that would promote in-water activities. Current designs call for repair of and/or improvements to a number of the existing fishing piers, largely on Hoaeae Point. Such improvements to existing piers or construction of additional piers would require approval from the Navy, which would likely be granted because such use would be an on-shore rather than in-water recreational activity (personal communication, Bill Liu, Assistant Naval Base Civil Engineer, September 2, 1987).

In addition to the water usage are the polo and rodeo activities related to the equestrian facilities on lands leased by the Estate to Tongg Ranch and another lessee. The Tongg Ranch has equestrian facilities which include pastures and paddocks, two polo fields and a riding area. Recreational activities associated with these facilities include polo games, private polo lessons, and the training and exercising of polo ponies.

The Asing Park is another recreational site within the project boundaries. This field park is used occasionally for ball games, although old-timers in the area indicated that this park was well-used before facilities were built in Ewa Beach.

4.4.4.2 Community Reactions to the Recreation Component

The project's objectives of providing a shoreline park, a district park, and a golf course were generally viewed as benefits to the regional and West Loch residents. The following summarizes community reactions to the recreation component:

- The proposed shoreline park was favorably received by almost all informants, particularly the Waipahu residents.

- Regional leaders tended to encourage measures which would retain the intended family-orientation and general attractiveness of the park. These measures included (1) prohibiting vehicular parking and traffic on the Hoaeae peninsula, and (2) monitoring the shoreline park for loitering and vandalism.

- There were a few inquiries about water recreation, but almost all of those interviewed felt that water sports would not be appropriate. Some did not feel that the waters were clean; others felt that, because this was not a beachfront development, people do not expect active water use. Some felt that pole fishing might be appropriate. A few of those interviewed had used the West Loch waters for crabbing and digging for clams in the past, and a few people were observed fishing and crabbing in the area during site visits.

- The golf course was generally preferred over the existing agricultural uses. People saw the golf course as:
  - providing permanent open space;
  - cutting down on dust, ash, and stray animals (e.g., dislocated rats or stray cats and dogs) which coincide with cane burning; and
  - possibly increasing nearby property values.
- Some questioned the need for another golf course, however, since there are others being planned for Ewa. This was especially important to current on-site users who felt the golf course was not worth their displacement.

4.4.4.3 Potential Recreational Opportunities and Constraints

The project's water recreation potential is limited by the following:

- Navy operational restrictions and geographical boundaries; and
- limited water circulation in the inner loch areas which may cause stagnant conditions leading to higher bacterial counts and greater accumulations of pesticides, herbicides, and other toxic substances transported by streams and runoff.

Increased shoreline access will nevertheless be a recreational asset and it is recommended that the current activities of fishing and crabbing be enhanced. Appropriately-placed fishing piers would allow people to reach the deeper waters of the loch without having to use a boat or other water craft. Existing examples of this are the fishing piers in Ahukini and Waimea on the island of Kauai. Both are well-used and popular. It is further recommended that lay and throw nets be prohibited.

The project's impacts on current water recreation activities are anticipated to be beneficial in that current users will no longer need the privacy for illegal water entries. They may find that increased water usage may decrease their catch, however.

Although the 3.7-acre Asing Park will be displaced, the general land-based recreational opportunities will be increased. The proposed 39-acre shoreline park and 18-acre district park

will result in more recreational facilities available to the community.

Further, these facilities are consistent with the desires expressed by the community informants and representatives. The Waipahu community has long since been exploring ways to obtain a shoreline park this project is seen as meeting this goal. The Ewa community leaders also expressed a desire for more passive park areas.

It is recommended that community suggestions of stringent security and limited parking be considered on this project. Because of the large land areas of these parks, user safety and attractiveness should be given much attention.

This project will displace the polo activities. While the operation has an alternate site in Palehua, their relocation will entail sitework and relocation ((based on letter from Tongg Ranch to the City Department of Planning dated June 22, 1987).

4.4.5 <u>Physical Infrastructure and Public Services</u>

4.4.5.1 Community Reactions

The following is a summary of such concerns:

- Traffic was a major concern for many of those interviewed. The most frequently-raised location of this traffic in the H-1 on-ramp off Kunia Road. It was felt that this area already is backed up with the completion of the Fort Weaver Road, and that traffic would be exacerbated with this and any other new development. The most frequent solution was the proposed "North - South Road," which would be located further west and be a direct H-1 linkage for Ewa Beach residents.
- Drainage was a concern for people in Honouliuli. Because a portion of the area is low in elevation, people were concerned about the effect of increased runoff due to golf course landscaping.
- The adequacy of the water supply was raised by a few people.
- Many people were concerned about the preparedness of police, fire and educational services to deal with the growth from this project, as well as other new developments in the area.

4.4.5.2 Analysis and Recommended Mitigations

Generally, these types of questions are asked of all proposed developments in the area, and community leaders do not seem to require the individual developments to solve the regional problems.

Although concerns related to infrastructure and public services were frequently expressed, there was no feeling that the project should be halted until all of these problems are solved.

As discussed in Section 4.4.3.2, the Ewa and Waipahu communities are generally prepared for relatively large developments. Their questions pertaining to roadway adequacy and the capacity of police and other public services are directed more towards the responsible agency, rather than the specific developer. They would like to make sure that these projects are accommodated, as long as regional goals and objectives can be met.

4.4.6 Informational Needs and City's Role as Developer

4.4.6.1 Community Issues Concerning Informational Needs and City's Developer Role

Some of those interviewed, particularly the nearby and on-site residents, complained that they did not have any information about the project until very recently. They felt that, since they would be the most directly impacted, they should have been informed earlier in the process.

Some of them indicated that they did not know anything about the project except for letters from the City Department of Housing and Community Development informing them that project consultants may be entering their areas for land tests. The Hoaeae Point residents (see following Section 4.5) claimed that their first awareness of the project was when they were approached by City relocation officers. Since they come under Estate lessees, residential renters reportedly were not notified about the project, unless their landlord or the original lessee had informed them.

Most of the on-site and nearby community organizations had not received formal presentations by City representatives of this writing (mid-September 1987). Further, many were unfamiliar with the formal mechanism of Neighborhood Board representation and they were dissatisfied with these representatives for not notifying them.

Regarding the City's role as developer, there was some skepticism from a few people that the project could be implemented as currently proposed. Questions of financial feasibility and overall ability of a public entity to implement a "quality" development were raised, and it was suggested that such development be left in the hands of the private sector.

4.4.6.2 Analysis and Recommended Mitigations

Both the foregoing issues are related to credibility.

In the first instance, the first impression of the on-site and nearby residents was negative because it was tied to displacement and land acquisition. Consequently, rumors heightened apprehensions and fears. These people will probably continue to question the integrity of the project until they are satisfied that they will receive fair and equitable treatment.

Note, however, that, prior to these interviews, City presentations were made to some community organizations, including the Ewa and Waipahu Neighborhood Boards. Further, representatives from these organizations participate in an ad hoc advisory committee which meets with the City to review plans and make recommendations. In a sense, then, some of the information gaps are also due to the lack of networking of these representatives, although it should also be noted that the July 1987 Ewa Neighborhood Board newsletter did contain a small article about the West Loch Estates project.

The solution to this situation is an information program whereby the appropriate organizations are given presentations about the project. Recognize, however, that any information program targeting these people will need to acknowledge that this effort is being made months after the regional organizations learned about the project. Further, the presentations should be tailored to address the different interests of these organizations. As further discussed in the remainder of this report, these different interests would include: displacement for the Hoaeae Point Community Association; land acquisition and infrastructure impacts for the Honouliuli Doshi Kai; residential contiguity for the "new Ota Camp" residents; and infrastructure and other impacts for the Ewa Community Association.

In the developer-related issues, some people simply do not believe the City -- or any other public entity -- can, or should, implement this type of project. Continued informational programs can address this issue, although successful execution of the project is probably the only real solution to this issue.

4.5 COMPATIBILITY WITH SURROUNDING USES

The following discussion will be divided into two parts: civilian and military uses. The discussion of civilian uses will be, like the foregoing sub-section, primarily based on interviews with community informants. The discussion of compatibility with the U.S. Naval operations will be based on direct contacts with Naval personnel. (It may be noted that the question of compatibility with Naval operations did <u>not</u> emerge as an issue in the interviews with community residents and leaders.)

4.5.1 Civilian Uses

4.5.1.1 Existing Characteristics

As indicated in Figure 4, immediately surrounding uses include:

- o Relocated Ota Camp residents, to the north of Residential Increment 1;
- o Farrington Highway and two medical facilities (one currently under construction) to the north of the western section of golf course;
- o The small community of Honouliuli (a mixture of residential uses, few support commercial establishments, small-scale agricultural operations, and vacant land west of the portion of golf course west of Fort Weaver Road);
- o A cattle slaughterhouse immediately south of the golf course; and
- o Further south, the Ewa community across Fort Weaver Road west of Residential Increment 2.

Kahi Mohala, a Browns School psychiatric hospital, is located across the Old Fort Weaver Road, north of the western section of proposed golf course. Currently under construction, the St. Francis medical hospital is adjacent to the northeast corner of the western section of the golf course.

The three residential communities have distinct identities:

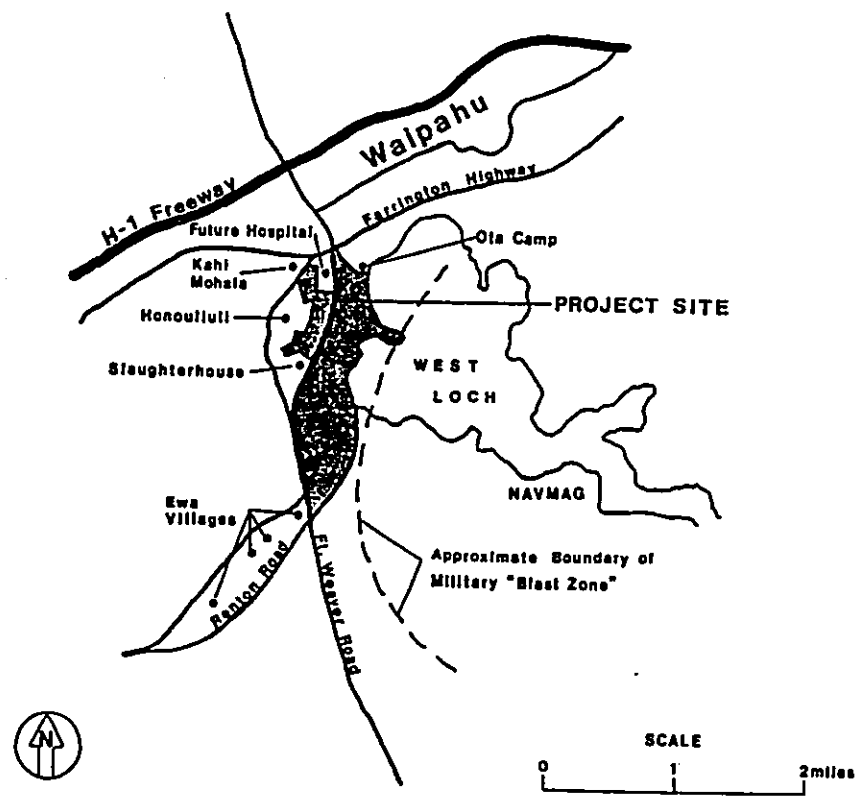
Honouliuli is sandwiched between the Old Fort Weaver Road and the proposed golf course. It is a community of mostly single-family dwellings on lands owned by individual owners. Two convenience stores, one gas station, and two beauty salons front the Old Fort Weaver Road.

Approximately 100 to 120 housing units are in this area (Real Estate Data, Inc., 1986). Based on an average of 3.5 persons per household, it is estimated that 350 to 420 people may live in this area. Many residents are Japanese or Filipino.

It was stressed by current and former Honouliuli residents that this community has always retained an identity separate from the plantations, even though many of them initially worked there. They claim community cohesiveness, which is primarily embodied in their community association called Honouliuli Doshi Kai, roughly translated into the "Honouliuli Helping Each Other" (personal communication with Kay Sunada, former president, Honouliuli Doshi Kai, September 9, 1987).

Figure 4

Communities/Uses Near the Project Site



This organization has a membership of over 100, although many members no longer live here. Their common bond is past and current residence in Honouliuli, and they have frequent socials and support activities (personal communication with Shirley Head, President, Honouliuli Doshi Kai, September 9, 1987).

The relocated Ota Camp residents live in Waipahu, on the northern boundary of the project site. These residents formerly lived in 25 houses in the original Ota Camp which was located further east in Waipahu. In the early 1970's, they were asked to move. In asking for relocation assistance, they had four conditions -- simultaneous relocation, single-family dwellings, a Waipahu location, and community-based control.

In the mid-1970's, they were relocated in 31 homes on their present site. The homes are mostly three-bedroom, two-bath units. Initially rentals, these units are now leased with options to buy at a future date.

This is a close, mostly Filipino, community. Relocation and related lawsuits often required much of their energy and time, as reflected in their organization's name -- the Ota Camp Makibaka ("Struggle") Association (personal communication with Pete Tagalog, President, Ota Camp Makibaka Association, September 3, 1987).

The Ewa community is a series of former, but distinct, plantation villages located west of Fort Weaver Road, perpendicular to the proposed Residential Increment 2.

Over the past few years, the concerns of this community have primarily focused on coordinating, funding and building new and improved houses. To facilitate this effort, the Ewa Housing Foundation, Inc. was formed as an umbrella organization for these former plantation towns (personal communication with Tony Bise, President, Ewa Housing Foundation, Inc., September 8, 1987).

More recently, another organization was formed to address more regional concerns, and issues other than housing ones. This is the Ewa Community Association and the move for a more regional perspective is underway (personal communication with Ed Castanos, President, Ewa Community Association, September 9, 1987).

Adjacent to the southern corner of the western section of the golf course is the Kahua Meat Company, Inc., which is a cattle processing operation. This is one of the island's two slaughterhouses serving the cattle ranches.

4.5.1.2 Reactions of Nearby Residents

Summary: The project's relationship to the surrounding communities was seen from two perspectives. On one hand, the nearby Honouliuli and relocated Ota Camp residents have distinct and independent community identities. Some nearby residents were

wary that their status quo would be disturbed by a new community and that existing small businesses might have difficulty competing with the proposed town center.

Nearby residents also anticipated some changes which may benefit them, however. Increase in property values, access to new shopping and recreational facilities, more customers for existing businesses, elimination of some incompatible agricultural uses (such as those related to cane burning) -- these were seen as potential benefits, providing these nearby communities could retain a separate identity.

Specifics: Reactions of Honouliuli, the "new Ota Camp," and Ewa residents are summarized as follows:

- Because of social ties with on-site residents, initial reactions generally focussed on residential displacement. It is noted, however, that on-site residents do not belong to any of the four community organizations mentioned in Section 4.5.1.1.
- Honouliuli informants were particularly concerned about the acquisition of lands owned by Honouliuli residents. The lands of three families are currently intended for acquisition if the project is implemented, and Honouliuli informants wanted assurances of equitable and fair settlements.
- The Honouliuli and "new Ota Camp" informants basically wanted to retain identities separate from the new community.
- These informants also saw potentials for community benefits, however, primarily in the form of terminating incompatible agricultural activities (mostly cane burning) increased land values for properties fronting the golf course, and access to proposed recreational, commercial and public facilities.
- Honouliuli informants were apprehensive about the impacts of proposed commercial establishments on the small Honouliuli establishments, although increased patronage was also seen as a plus.
- Honouliuli informants expressed concern about further drainage impacts because of reported increased runoff due to the construction of the nearby hospital.
- All, including the Ewa informants, were concerned about traffic increases.

Further, regional Waipahu leaders discussed systemic relationships with the proposed West Loch community. They felt that the traffic generated would have more impact on the Waipahu roadway system rather than Ewa's. On the other hand, it was also felt that until the regional Ewa development is well underway, the new West Loch residents will utilize the closer Waipahu shops, restaurants and service establishments.

4.5.1.3 Analysis and Recommended Mitigations

The compatibility of West Loch with existing surrounding uses depends on a number of factors, some of which include:

- o the general acceptance of existing communities of the concept behind the proposed project;
- o similarities between the social and economic characteristics of the existing communities and new residents; and
- o potential conflicts between residential and non-residential uses.

Acceptance of the concept behind West Loch, though not necessarily the project itself, would be based on an acknowledgment of a major housing need and some awareness of how this project would address this need. Many of the regional community leaders are keenly aware of the island's housing crisis and had some knowledge that project is pending. They generally approved of the goals and concept on which West Loch is based.

Informants living in Honouliuli, the "new Ota Camp," and Ewa, however, were mostly unaware of the proposed project. Further, by the time of the interviews, they were already aware of sensitivities and emotionalism surrounding the displacement of on-site residents and acquisition of small parcels of land. Consequently, there is some resistance to the idea of having any development on the project site which might displace these people or cause others to lose their land through City acquisition.

As was discussed in Section 4.4.6, much of this initial apprehension and criticism by nearby and on-site residents is due to access to project information. This impact can therefore be alleviated through effective and ongoing information programs.

The social and economic characteristics of the existing communities and new residents will mostly likely be different.

The existing communities are relatively homogeneous -- they share common backgrounds as described in Section 4.5.1.1, and have actively worked together on common community objectives.

There is a mixture of housing types. Some appear to be only a few years old; others are original houses in the old plantation camps. In some areas, recent improvements are evident in new stone walls and paving. In other areas, the structures are deteriorated and in need of repair.

The new residents will originate from various parts of the island and state. Based on the target housing mix, there will also be a more representative cross-section of the general community in West Loch.

While they may not share identical backgrounds, however, social compatibility is still possible because of a common Hawaii identity. The common areas -- such as schools, parks, and shopping areas -- will allow for social interactions which can lead to further appreciation of the diversities and complexities of local culture.

A sense of economic disparity could occur because of the "newness" of the planned community. The newer house would generally have more value and, if strict design controls are enforced, the entire development could maintain an overall attractiveness.

Achieving this overall attractiveness would be more difficult for the existing communities, mostly because of the age differentials in the structures and the lack of centralized management controls. An example of where there appears to be economic disparity is the Gentry at Waipio and the older adjacent Seaview and Crestview developments.

Appearances of economic disparities can be alleviated, however, through landscaped buffers and beautification program in the existing communities. It is highly possible that the project will motivate some of the nearby residents to initiate cleanup and beautification programs.

Potential conflicts between residential and non-residential uses need to be minimized through buffers and locating residences away from uses which might be incompatible. The psychiatric and medical hospitals will probably not have problems with West Loch Estates, since these facilities would be closer to the golf course anyway. Further, the medical facility would be conveniently located for West Loch residents.

The project needs to address potential problems with he cattle processing plant, however. The visual, olfactory, and noise factors associated with the slaughtering of animals may be offensive to the new residents and other site users.

The operation will probably not present much problem for the adjacent golfers because they will only be in the area for a short while. The activities on the eastern section of West Loch will be separated by Fort Weaver Road. Nevertheless, facilities directly across Fort Weaver Road should probably accommodate incidental and temporary uses, such as a shopping area, rather than permanent residences.

4.5.2 U.S. Naval Uses

Naval use of the West Loch waters was discussed in Section 4.4.4. This section will focus on proximity to the 640-acre parcel on which the Naval Magazine (NAVMAG), Lualualei, West Loch Branch, is located. This is an ammunition storage facility. For reasons of national security, the U.S. Navy will not reveal the nature or quantity of ammunition stored at the site.

4.5.2.1 Current Situation and Naval Policies

There are two aspects to the question of compatibility: public safety and potential for conflict along border areas.

It is beyond the scope of a socio-economic report to conduct a comprehensive assessment of public safety issues, particularly when relevant data are classified. However, following is a summary of the Naval position contained in the Department of the Navy's April 1987 response to the 1987 Development annual amendment review package, which contained the West Loch Estates housing proposal:

- The project site is outside the facility's "Explosive Safety Quantity Distance," or blast zone (Figure 4). (NOTE: The U.S. Geological Quadrangle maps suggest the blast zone, which appears to be about 7,500 feet in radius, may include the very tip of Hoaeae Point, which is planned for shoreline park purposes.)
- However, such zones "are established at practical limits and do not guarantee absolute safety outside the zone."
- As previously stated in other hearings before the State Land Use Commission, the Navy's position in regard to residential developments "is that the land bordering ammunitiion storage areas be left in agriculture."
- If the proposed housing development does occur, "consideration should be given to establishing a buffer zone such as an open space park, golf course, a roadway, or a parking lot along any portion of this development bordering the station."

There are only about 500 feet of West Loch Estates property actually bordering federal property; this border area is located at the southeastern part of the project site, just west of the wildlife reserve. However, it should also be noted that the Navy recently condemned some 781 acres of Campbell Estate land south of the project and west of the NAVMAG facility (on either side of the Ewa-West Loch Access Road into the ammunition storage facility), and some of this property is separated from the West Loch Estates land by only a few hundred feet or less of sugarcane. The condemned property, like the adjacent land, is under cultivation by Oahu Sugar Company, and the Navy has no plans to terminate either the lease to Oahu Sugar or the agricultural activity

(personal communication, Bill Liu, Assistant Naval Base Civil Engineer, September 14, 1987).

At the closest point, proposed housing sites within the West Loch Estates property are about 8,000 feet from the main docking facility at NAVMAG. At the present time, there are no security fences or military patrols along this area, although unauthorized persons entering on foot would be intercepted and warned off if they penetrated further into federal property.

The Navy has no immediate reason to anticipate difficulties in terms of West Loch Estates residents wandering on foot into the federal area. The wildlife refuge along the shore provides one natural barrier, and there is little in a sugarcane field to attract curious explorers on a nature hike. However, if problems do occur with increasing numbers of people approaching the NAVMAG facility, the Navy might erect fences and signs, and/or increase patrols (personal communication, ibid., September 14, 1987).

4.5.2.2 Recommended Mitigations

The Navy has made its recommendation that portions of the project bordering the facility be kept in extremely low-density uses.

The major additional recommendation would be for increased communication between the City and the Navy in further project planning. The Navy has requested consulted party status for this EIS.

4.6 DISPLACEMENT

As indicated in Section 4.4.6, one emerging community issue has to do with communication between the City and those people whose land would be acquired and/or whose homes or businesses could be displaced.

In any public project requiring condemnation of property and/or displacement of people, there is the potential for controversy. The negative impacts of displacement must be weighed by decision makers against the benefits of housing provision and other public purposes served by the project.

Legal procedures established for condemnation and possible relocation assistance will result in official determinations of individual displacement impacts. The purpose of this sub-section is to disclose general impacts. The major focus will be on describing the uses and approximate numbers of residents and businesses to be displaced.

4.6.1 Overview of Land Tenure

All but nine acres of the approximately 500-acre site are owned by the Estate of James Campbell. Based on a map generated by the Estate (dated January 10, 1986) and interviews with various people knowledgeable of the site, it is estimated that the Estate has approximately 25 leases on the site. Over half of these (14) are for residential purposes on Hoaeae Point.

The remaining leases allow for agricultural and industrial uses throughout the rest of the project site. Uses currently occurring under these leases include the following:

- o equipment storage,
- o sugar cane cultivation,
- o a used auto parts and towing operation,
- o pasture and equestrian activities, and
- o headquarters for a ranch.

At least two of these agriculture-related lessees have sub-leased a portion of their leased land or have established landlord-tenant agreements. Oahu Sugar Co. has approximately six sub-leases which lie within the project boundaries. No residential uses are permitted on these lands, and current uses are related to raising chickens and livestock, equipment storage, and equestrian activities (personal communications with Bill DeMent, Field Engineer and Land Manager, Oahu Sugar Company, September 3 and 8, 1987).

Tongg Ranch, Inc. has landlord-tenant agreements for at least 13 residential structures on lands leased from Campbell Estate (personal communication with Ronald Tongg, President of Tongg Ranch, Inc., September 9, 1987).

Approximately nine acres within the project site are currently owned by seven landowners other than Campbell Estate and are intended for acquisition if the project is implemented (personal communication with Howard Murai, City Department of Housing and Community Development, various dates from August 31 through September 11, 1987).

Of these nine acres, approximately six -- owned by three landowners -- are located east of Fort Weaver Road. These lots appear to be used primarily for an used auto parts and towing operation, and for transportation purposes.

The remaining three acres are distributed among four separately-owned parcels and are located west of Fort Weaver Road. One of these parcels is occupied by renters; the other two have no residential uses, but may have small-scale agricultural activities for personal use.

4.6.2 Overview of Existing On-Site Uses

This section is based on information provided by on-site users and others knowledgeable about the project site, as well as on field observations and on the aforementioned map generated by the Estate. The project area is predominantly in agricultural or related uses; residential and commercial/industrial activities also occur on the site. Major uses are indicated in Figure 5.

The project site can be divided into two sections defined by Fort Weaver Road. The "eastern section" of the site is sandwiched between Fort Weaver Road and the waters of Pearl Harbor. The "western section" lies between Fort Weaver Road and the Honouliuli community.

The eastern portion of the project area has residential uses, agricultural activities, and commercial/industrial operations. The residential uses on this part of the project site are generally in two clusters. One cluster of about 22 units is situated on the Hoaeae peninsula. Further south, the other cluster of about 14 homes fronts Fort Weaver Road, near its junction with the Old Fort Weaver Road. Real estate data based on tax maps suggest there may be another nine units in other parts of the eastern project site.

Agricultural uses on the eastern portion of the site include a ranch headquarters, equestrian activities and support facilities, and the raising of cows and goats, as well as sugar cane cultivation on parts of the site.

This portion of the project area also has industrial uses. There is a used auto parts and towing operation, as well as storage of equipment and vehicles. Along the length of the shoreline there is a petroleum - energy corridor.

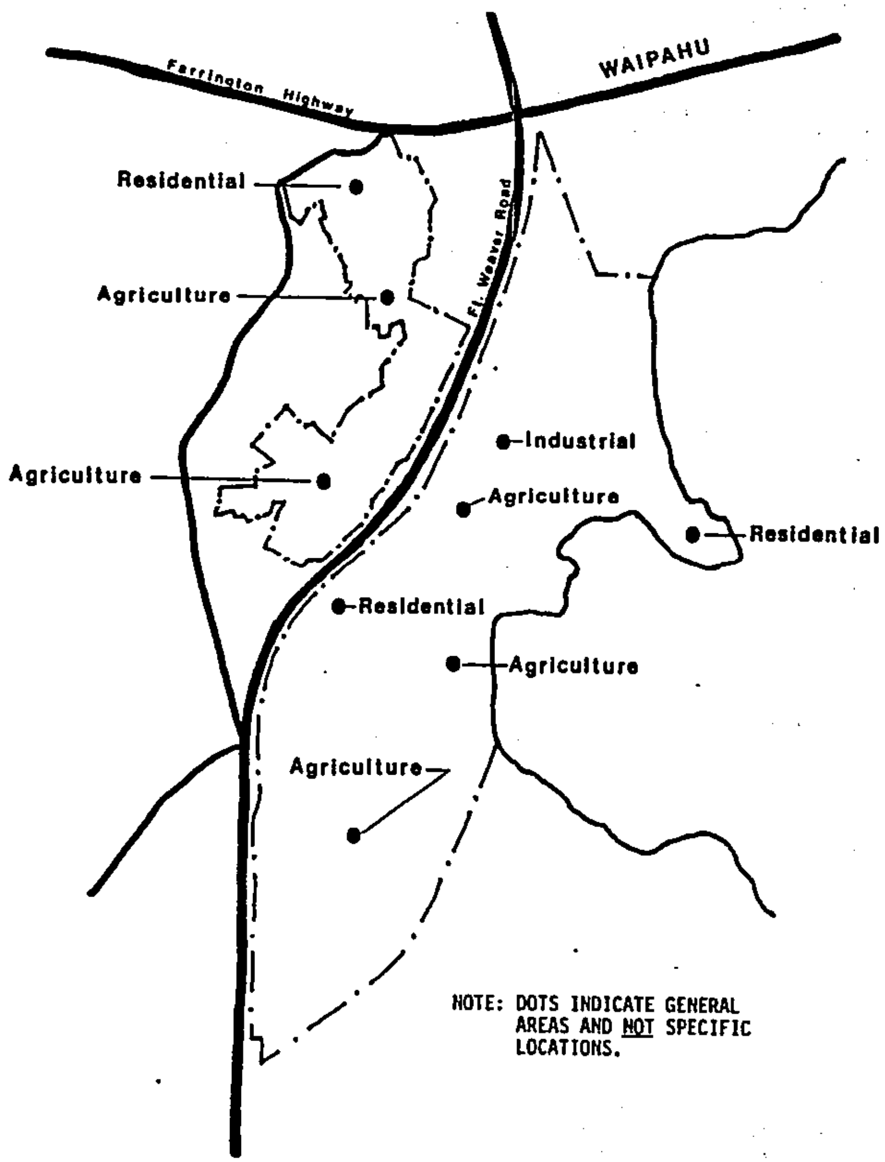
There is less activity on the western part of the project site, across the highway. Almost all of this portion is used for agriculture. Most of this is in sugar cane cultivation, and there is some land used for cattle grazing and raising chickens. There are about three residential units on the northern portion of this site.

4.6.3 Agricultural and Pastoral Uses

Agricultural and pastoral uses are found throughout the site. Lessees of the Estate conduct agricultural activities which include:

- o sugar cane cultivation,
- o a rodeo roping ring and support facilities,
- o raising of cattle, and
- o headquarters for a ranch.

Figure 5
General Vicinity of Existing Uses



The 36-acre portion leased to Tongg Ranch comprises the central headquarters for the ranch (which otherwise consists of a total 6,000 acres of pasture land in Kunia and Palehua). Ranch facilities on the West Loch project siteinclude storage facilities for equipment, marketing, cattle stockyards, pastures, paddock area, two polo fields, and equestrian riding areas, as well as residential units which were discussed in the previous section. Four full-time employees and seven part-time volunteers serve this site (based on letter from Tongg Ranch to the City Department of Planning dated June 22, 1987, and on personal communication with Ronald Tongg, President, Tongg Ranch, Inc., September 9, 1987).

Oahu Sugar Company leases these lands primarily for sugar cane cultivation. As more houses were built in Honouliuli, however, some of the agricultural activities became incompatible with nearby residents. Those lands closest to the residential areas were fallowed and sub-leased to others.

In the project site, Oahu Sugar Company sub-leases approximately five parcels, none of which are permitted residential uses. Uses on these parcels include -- on the eastern portion of the site -- raising goats and cattle, the storing of agricultural equipment and facilities for equestrian activities, and -- on the western portion of the site -- raising chickens (personal communications with Bill DeMent, Field Engineer and Land Manager, Oahu Sugar Company, September 3 and 8, 1987).

4.6.4 Residential Uses of the Site

There are several types of residential uses on the project site, as follows:

Lessees of the Estate of James Campbell: Hoaeae Point is divided into 15 lots of sizes ranging from 0.4 acres to 1.6 acres. Most of these are less than an acre. Beginning in 1947, Campbell Estate granted 30-year leases which ended in the late 1970s. Since then, the occupants are on a month-to-month lease.

These lots are leased by 14 families, each of which belongs to the Hoaeae Point Community Association. With non-profit status, the association owns the water line serving their homes and funds the maintenance of the road leading to their homes. The individual lessees are responsible for erecting and improving their own structures, as well as for home insurance and property taxes. One of the Hoaeae Point parcels is vacant, and another is occupied by renters only. There are 22 units on these parcels, 12 of which are occupied by month-to-month lessees. Monthly rent is $100 per structure (personal communication with three officers of the Hoaeae Point Community Association, August 26, 1987).

Renters or Sub-Lessees: Ten of the Hoaeae Point houses are rented, or occupied by family members of the lessees.

It was estimated that around 90 people live on the peninsula, and that most of these are renters and/or related to the lessees. It was felt that the population has been relatively stable in numbers over the years (personal communication with three officers of the Hoaeae Point Community Association, August 26, 1987).

The Tongg Ranch has nine quonset huts, two duplexes, and three houses on the eastern portion of the project site. Four units are occupied by people who provide services to the Ranch. The remaining 12 are rented to the general public. Monthly rents range from $475.00 to $675.00. Standard landlord - tenant agreements exist between the ranch and its renters. It was estimated that approximately 60 people live in these units (based on letter from Tongg Ranch to the City Department of Planning dated June 22, 1987, and on personal communication with Ronald Tongg, President, Tongg Ranch, Inc., September 9, 1987).

In addition, three on-site rental units are located on the western section of the site. These units -- and the land on which they sit -- are owned by an entity other than the Estate. Approximately 15 people live in these units under a month-to-month rental agreement (personal communication with Sharon Walsh, relative of landowner, September 8, 1987).

Possible Owner-Occupants: There are a number of parcels owned in fee by parties other than Campbell Estate. Based on property tax information collected by a private vendor (Real Estate Data, Inc., 1986), there may be nine dwelling structures on these properties. However, it was not possible to verify this through field observation or interviews. Some of these units may be occupied by owners, and others by renters or lessees.

It is possible that these units may house around ten to twenty people, (based on household sizes of only one to two persons, to reflect current uncertainties about the actual existence of these units).

Residential Totals: In total, approximately 170 to 190 people live on the project site in up to 48 units. Most of these people occupy their units under rental agreements.

4.6.5 Commercial, Industrial, and Other On-Site Uses

Commercial and industrial uses also occur on the eastern section of project site. At Hoaeae Point, residential lessees reportedly also operate a tour bus company, an auto repair shop, a woodworking service, and a party rental supplies business.

Also on the eastern section is a used auto parts and towing operation on land leased from three landowners, one of whom is the Estate. Another parcel is leased from the Estate for the storage of vehicles and equipment.

Along the length of the shoreline is a petroleum pipeline and energy corridor which will not be displaced by the proposed project.

The other existing use is Asing Park, a 3.7-acre park for with a basketball court, ball field, and a comfort station.

4.6.6 Notification

As of this writing (September 15, 1987), no formal notification of displacement had yet been transmitted, although planning for notification was underway. Contact had been established between City representatives and some potential displacees, and a presentation was made to the Hoaeae Point Community Association on September 9, 1987.

Also, the City and County of Honolulu had made initial offers of acquisitions to owners of land comprising the project site.

4.6.7 Relocation and Other Potential Mitigations

Condemnation procedures require reimbursement of landowners, lessees, and tenants for the fair market value of property acquired by the City. Additionally, relocation assistance measures described below provide further cash and in-kind measures to displacees, including renters.

At the same time, it may be expected that some displacees -- businesses as well as residents -- may have expectations or needs beyond those which are covered by laws governing relocation assistance. This has yet to be determined in any definitive way. As previously recommended in Section 4.4.6.2, communication between City agencies and affected residents or property holders needs to be augmented, in order to match the strong efforts being made on the regional level.

Following is a summary of applicable provisions for persons displaced by public projects:

4.6.7.1 Basis of Relocation and Displacement Provisions

Relocation assistance to displaced individuals and businesses is in accordance with State statutes and administrative rules. The applicable State statute is Hawaii Revised Statues, Chapter 111. The applicable administrative rule is Hawaii Housing Authority, Title 17, Chapter 503. The following discussion is taken directly from documents provided by the Department of Housing and Community Development.

4.6.7.2 Relocation Assistance to Displaced Tenants

Individuals who rent housing, either through leases or sub-leases on land to be acquired for the West Loch project, are entitled to relocation assistance. This assistance consists of payments for moving expenses, rental assistance, and aid in finding replacement housing.

Moving assistance may be either a fixed payment for a self-mover or reimbursement, for expenses at the tenant's discretion. If the tenant elects for a fixed payment, he/she would be entitled to payment according to a graduated scale based on the number of rooms of furniture and belongings to be moved. The amount ranges from $135 to $300. If the tenant decides on reimbursement, the tenant need only submit receipts for expenses. The tenant is entitled to either the fixed payment or the reimbursement, whichever is higher.

Mover may also be eligible for rental assistance if they have lived in their homes for at least the last 90 days prior to the City's formal notification of intent to acquire. Tenants will be entitled to the difference between their present rent and the rent of the their new home, for a period of two years up to a maximum payment of $1,500.

Tenants are also eligible for assistance in locating a new home. Such assistance will be given by the Department of Housing and Community Development.

4.6.7.3 Relocation Assistance to Displaced Homeowners

Homeowners who are displaced are entitled to money payments as well as assistance in finding a new home. If the homeowner buys and moves into a replacement home, he/she will be entitled to the difference in cost between the price paid for their present home and the new home, up to a maximum of $5,000. If the homeowner decides to rent instead of buying a new home, he/she will be entitled to the difference in cost between 24 months of rent and 12 percent of the price paid for the present home, up to a maximum of $5,000.

4.6.7.4 Relocation Assistance to Displaced Businesses, Farmers, and Non-Profit Organizations

Businesses, farmers, and non-profit organizations are entitled to choose between either a moving expense payment or a fixed relocation payment. The moving expense payment will reimburse actual expenses up to a maximum of $5,000. If the business does its own moving, it must submit two estimates provided from bona fide moving firms to receive payment. The business may elect to receive a fixed relocation payment instead of the moving expense payment. In this case the payment will equal the average net earnings of the business up to a maximum of $5,000.

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APPENDIX I

Proposed West Loch Estates
Impact on Agriculture

by

Decision Analysts Hawaii

September 1987

PROPOSED WEST LOCH ESTATES: IMPACT ON AGRICULTURE

September 1987

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TABLES

EXECUTIVE SUMMARY

The development of West Loch Estates would result in the urbanization of approximately 206 acres of sugarcane lands which are currently under cultivation by Oahu Sugar Company, Ltd. (OSCo). However, the West Loch Estates—individually or in combination with other major projects planned and proposed for Ewa and Central Oahu—would not adversely affect the economic viability of OSCo, nor would it require layoffs of sugar workers. This assumes the continuation of historic development rates for housing projects—rates which would allow sufficient time to increase yields and thereby partially or completely compensate for the reduced acreage with little or no loss in production. Reductions in employment would occur through retirement and voluntary movement to other jobs. Over the long term, OSCo could accommodate a major reduction in acreage and maintain economies of scale by operating just one mill, rather than two in parallel.

If OSCo were to cease operations for whatever reason (most likely because of low sugar prices), the loss of jobs would be less than 490 direct jobs and 550 indirect jobs. This would be the equivalent of the loss of a hotel about half the size of the Hyatt Regency in Waikiki. Immediately following the mill closing, significant economic loss and social disruption would occur. But over the long term, the economic loss would be absorbed easily by expanding economic opportunities in the Ewa/Central-Oahu area.

The development of West Loch Estates on sugarcane acreage would eliminate the possibility of using these lands for diversified agriculture (including aquaculture). However, it is extremely doubtful that this would adversely affect the growth of diversified agriculture in Hawaii. There are four reasons for this assessment: (1) an extensive amount of prime-agricultural land and water has been freed from sugar and pineapple production because of past mill closings and reductions in operations; (2) a very real possibility exists that additional land and water will be freed from sugar production given the outlook for low sugar prices; (3) some—if not most or even all—of the sugar operations will make their lands available for profitable replacement crops to the extent that such crops are available; and (4) compared to the available supply, a very small amount of land and water is required to grow proven and promising crops to achieve a realistic level of food and animal-feed self-sufficiency, and to increase exports. The increasing availability of prime agricultural land in Hawaii is part of very long-term and accelerating trends occurring throughout most developed and developing market economies. Productivity and yields have been increasing faster than population growth, and genetic engineering and other advances, combined with slower population growth, indicate an acceleration of these trends. Rapid productivity and yield increases require that labor, land, and other resources be withdrawn from agriculture in order to restore balanced markets and to increase farm income for those who remain.

Since the West Loch Estates would not adversely affect the economic viability of OSCo, and would not limit the growth of diversified agriculture, the project is consistent with the major thrust of the agricultural portion of the Hawaii State Plan and the State Agriculture Functional Plan, which is to preserve the economic viability of plantation agriculture and to promote the growth of diversified agriculture. Also, the project would provide a public benefit (i.e., affordable housing) which would override the proposed "important agricultural lands" designation of the Land and Evaluation Site Assessment (LESA) Commission. Furthermore, the project would not adversely affect cultivation of adjacent sugarcane acreage and, therefore, complies with the Hawaii Right-to-Farm Act.

The project is also consistent with County policies of directing population growth to Ewa, which by definition must occur at the expense of sugarcane acreage.

PROPOSED WEST LOCH ESTATES: IMPACT ON AGRICULTURE

The proposed West Loch Estates will involve the urbanization of about 206 acres of sugarcane lands of Oahu Sugar Company, Ltd. (OSCo). The impact of this loss on OSCo operations, as well as on the potential growth of diversified agriculture (including aquaculture), is summarized in this report.

SOIL QUALITY OF AFFECTED SUGARCANE ACREAGE

The affected sugarcane acreage consists primarily of two soil types: Honouliuli clay, 0 to 2 percent slope (HxA), and Honouliuli clay, 2 to 6 percent slope (HxB) (USDA Soil Conservation Service). These soils can be used for sugarcane, truck crops, and pasture.

The soils within the petition area have been rated in terms of four classificaiton systems commonly used in Hawaii:

—Land Capability Classification by the United States Department of Agriculture Soil Conservation Service (SCS).

This classification rates soils according to eight levels, ranging from the highest classification level I to the lowest level VIII. If irrigated, HxA has a capability classification I, which indicates that the soil has few limitations which restrict its use. Soil type HxB is in Subclass IIe if irrigated, which indicates that the soil has a moderate limitation which reduces the choice of plants or which requires moderate conservation practices; the problem is that this soil is subject to moderate erosion if cultivated and not protected.

—Agricultural Lands of Importance in the State of Hawaii (ALISH), by the SCS, University of Hawaii College of Tropical Agriculture and Human Resources, and the State of Hawaii Department of Agriculture.

This system classifies lands into three categories: (1) prime agricultural land which is land that is best suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (2) unique agricultural land which is non-prime agricultural land that is currently used for the production of specific high-value crops; and (3) other prime agricultural land which is non-prime and non-unique agricultural land that is of importance to the production of crops. Most of the petition lands now planted in sugarcane are rated as "prime" agricultural lands.

—Overall Productivity Rating, by the Land Study Bureau (LSB) of the University of Hawaii.

This classification rates soils according to five levels, with "A" representing the class of highest productivity and "E" the lowest. Most of the petition lands now planted in sugarcane is rated B, although some lands are rated C, D or E.

—Proposed Land Evaluation and Site Assessment (LESA) System, by the State of Hawaii Land Evaluation and Site Assessment Commission

Based on soil quality, locational attributes, improvements, nearby activities, and land-use plans, this proposed system would designate a sufficient amount of the better agricultural lands so as to meet projected agricultural goals. The designated lands would be termed important agricultural lands (IAL) and, based on the proposed maps, would include the lands in the petition area now under cultivation. However, the identification would be subject to change based on a change in nearby activities and a change in County land-use plans. Also, the designation could be changed if there is an overriding public benefit.

IMPACT ON OSCo[1]

Background Information

Amfac's OSCo first milled sugar in 1899, and is now the fourth largest sugar operation in the State. It cultivates about 13,540 acres of sugarcane land, and produces about 90,000 to 95,000 tons of raw sugar, or nearly 10 percent of Hawaii's total sugar production. Its lands cover portions of Central Oahu on each side of Kunia Road above Pearl Harbor, and portions of the Ewa Plain to the west of Pearl Harbor. The Ewa lands were taken over from Ewa Sugar Co. in 1970.

Another 4,860 acres of OSCo lands were in production in 1982, the bulk of which are now fallow, while a few hundred acres have been urbanized. These lands are mostly mauka lands with high pumping costs, and lands close to the seashore

[1] Unless otherwise noted, the material in this section is from OSCo, Amfac, and/or Section B, Chapter VI of Hawaii's Sugar Industry: Problems, Outlook, and Urban Growth Issues.

where soils tend to be inferior, yields low, and hauling costs high because of the distance to the mill.

Nearly all of the land which OSCo cultivates is leased, principally from Campbell Estate with a lease expiration date of 1995, and from Robinson Estate with a lease expiration date of 1996. The lease rents on these lands are amoung the highest in the State for sugarcane acreage, and are adjusted as a function of the revenues from sugar operations. Both leases allow partial withdrawal of lands for urbanization. The Campbell Estate lands above H-1 Freeway and west of Kunia Road have been dedicated to agricultural use in order to obtain special property tax assessments.

OSCo is one of the major water users on Oahu, pumping up to 92.5 million gallons per day (MGD) of groundwater, and diverting in normal-rainfall years 25 to 30 MGD from the Windward side via Waiahole Ditch. Per-acre usage by OSCo can exceed 9,000 gallons per day. For comparison, pumpage by the Board of Water Supply averages about 140 MGD, and per-acre useage for single-family homes at 5 units per acre averages about 2,130 gallons per day.

Field, mill, and management employment at OSCo is approximately 490 workers. Indirect employment dependent upon OSCo is estimated to be 550 jobs (multiplier of 1.13, based on the State Economic Model). For comparison, OSCo's economic contribution to Hawaii's economy is less than half that of the Hyatt Regency Hotel in Waikiki.

Because of favorable growing conditions, good farming practices, and drip irrigation, sugar yields at OSCo are very high, about 14.5 to 15.5 tons per acre, versus a 1986 Statewide average of 12.5 tons per acre (HSPA, "Hawaii Sugar News," March 30, 1987). In fact, OSCo holds the world record sugar yield at 21.63 tons per acre set in April 1985 (HSPA, "Hawaii Sugar News," June 26, 1985). The current average yield is about 33 percent higher than the 1979 yield of 11.3 tons per acre.

But even with high yields and very efficient operations, OSCo is only marginally profitable—the principal problem being low sugar prices. The marginal profitability is measured before accounting for new capital investment needed to replace equipment.

Outlook for Sugar Prices

In the long term, the survival of OSCo will depend primarily on the price of sugar, for which the outlook is pessimistic. In the world market, the average price of sugar is expected to remain well below the production costs for all countries. This is because most sugar is traded in controlled and/or subsidized markets, with surplus sugar dumped onto the world market for sale at a loss. Dramatic price increases have occurred, however, following a 6- to 9-year cycle, with prices increasing whenever world production falls short of consumption. But, there have been a number of fundamental developments in sugar and related industries in the past 10 years which appear to have altered the pattern of sugar prices, reducing peak prices and extending the periods of low prices. These changes include: the decline or stagnation of sugar consumption in most developed countries; inroads made by the liquid sweetener high-fructose corn syrup (HFCS); the availability of substantial sugar reserves in the form of sugarcane now devoted to ethanol production; major gains in sugar beet productivity in several European countries which were traditionally cane sugar importers; and the appearance of the European Economic Community ECC as a major exporter of refined sugar (Brown).

In the United States, Federal legislation protects sugar from the low world prices by import quotas, tariffs, and import fees. However, U.S. sugar prices are managed so that they are fairly low in order to prevent accelerating the growth of competing sweeteners, and to maintain public support. Under the U.S. Farm Bill, which runs to 1991, the target price for sugar is 18 cents per pound, with no adjustments for inflation.

The competing sweetener of major concern has been HFCS. It is as sweet or sweeter than regular sugar, costs less to produce, sells for less, is more profitable, is very similar to liquid sugar, can be substituted readily in many applications, and is easier and cheaper to handle. It has experienced rapid growth in sales at the expense of regular sugar sales. However, HFCS has captured nearly all of the liquid-sweetener market so that continued growth will depend on the market acceptance of Crystar, the crystalline version of HFCS. In addition, the new low-calorie sweetener aspartame, sold under the brand name "Equal," is capturing market share and putting additional downward pressure on U.S. sugar prices.

Regarding the long-term outlook for sugar legislation, it should be noted that, because of HFCS, many corn states have joined the sugar and sweetener coalition, making it larger and stronger than in the past, even though a number of sugar companies have closed in recent years. Also, the Farm Act is generally supported by those countries which receive a sugar quota, since they benefit from a high price for a major portion of their sugar. The considered expectation among sugar experts and lobbyists is that sugar will continue to be included in the U.S. Farm Act, but that the price-support level may be relatively low and may increase at a rate that is some-

what slower than inflation. Even though this is expected, there is a risk that efforts by sugar users and consumer groups to exclude sugar from the Farm Act or to reduce the support price will be successful.

<u>OSCo Plans</u>

In 1982, Amfac developed a Master Agricultural Plan which included a Survival Plan for OSCo. This plan, which has been fully implemented, was developed in response to an operating loss of nearly $10 million in 1981 and an outlook for low sugar prices. In recognition of the fact that sugar plantations are in place with substantial improvements, but suitable replacement crops have yet to be identified, the plan amounts to a holding action to gain time to find as many replacement crops as possible before OSCo may be forced by outside economic factors to cease operations. Key components of the plan are:

—continue to improve the economic efficiency of OSCo by increasing sugar yields and reducing production costs (both of which have been improved substantially in the last few years);

—urbanize Waikele (the only OSCo land owned by Amfac) in order to derive revenues to help support and justify continued sugar operations; and

—experiment with a variety of crops (papaya, sweet corn, potatoes, forage and feed crops, coffee, etc.) in order to find profitable replacements to sugar.

An important component of OSCo's cost reduction is a continued decline in the labor force; over the last year, employment decreased by about 50 jobs, or about 10 percent. The employment decrease is accomplished by attrition—that is, employees who retire or leave OSCo for other voluntary reasons generally are not replaced.

Continued success of the OSCo Survival Plan will depend on (1) continued Federal price supports for sugar sufficiently high to justify continued operations, (2) union support to reduce costs, (3) an adequate allocation of water from the Pearl Harbor aquifer, and (4) retaining fields which are economical to farm and which provide sufficient yields to operate the mill at an economical level. After the major leases expire with Campbell Estate and Robinson Estate in 1995 and 1996, respectively, continued sugar operations also will depend on success in negotiating favorable lease terms.

An additional option which has been under consideration by OSCo is to contract operations by running a single mill rather than two mills in parallel as is currently the case. With a single mill, OSCo could reduce production from its current level of about 90,000 to 95,000 tons per year to about 60,000 to 75,000 tons without losing its economies of scale. Based on a yield of 15 tons per acre, land requirements could be as little as 8,000 acres, versus the current 13,540 acres. Of significance, Amfac's Kekaha Sugar Company, Inc., which has climatic conditions similar to those of OSCo and a similar yield potential, historically has been one of the most profitable sugar operations in the State. Yet this plantation has only about 8,000 acres under cultivation, and produces only about 55,000 tons of sugar per year.

Of interest, the combination of cost containment, contraction of operations, and a search for alternative crops is the strategy being pursued by nearly all sugarcane operations throughout the world (Brown).

Urbanization Pressures on OSCo

The gradual growth westward of urban Honolulu has consumed a large amount of former sugarcane land as evidenced by the fact that the eastern boundary of OSCo lands has moved westward by 9 miles from Moanalua Valley out past Waikele Stream. Since the 1960s, four ridges west of Halawa have been urbanized. But because of new plantings in the foothills of the Waianae mountains and on former pasture lands, sufficient acreage was cultivated to maintain economies of scale. The westward urbanization pressures of Honolulu continues, but plantings of new lands to compensate for lost fields is no longer feasible.

The economic forces which create urbanization pressures on OSCo include:

—Returns from urban land uses far in excess of those for agricultural uses.
—Proximity to the new or growing employment centers of West Beach, Barbers Point Harbor, Campbell Industrial Park, and downtown Honolulu.
—Reasonable travel times to these employment centers because of the H-1 Freeway.
—Availability of water if freed from sugar production.
—Proximity to the Honouliuli waste-treatment facility.
—Low construction costs compared to areas that require extensive grading or removal of structures.

In contrast, redevelopment of downtown suffers from the high expense and displacement problems required to remove existing structures, the high expense and inconvenience of redeveloping inadequate infrastructure, less desirable high-rise housing compared to single-family homes, and strong community opposition on occasion. Hawaii Kai suffers from a lack of employment growth centers, relatively little land available for further single-family housing, severe transportation problems, and

community opposition to further development. Similarly, the Windward side suffers from a lack of growing employment centers, transportation problems, and community opposition to further development.

In view of these factors, the City & County of Honolulu has designated the Ewa area as a "Secondary Urban Center" which will be developed to accommodate a major portion of Honolulu's future growth. Major developments approved and proposed for the Ewa/Central-Oahu area which would affect OSCo acreage include:

	Sugarcane Acreage
West Loch Estates	206
Ko Olina (approved)	280
Ewa by Gentry (670 acres approved)	1,073
Ewa Marina (approved)	410
Village Park (547.5 acres approved by the State)	980
Kapolei	735
Kapolei Town Center	700
Kunia Golf Course	190
Golf Course (J. Myers)	270
Total	4,840

Assuming a 20-year development period for the housing developments, Ko Olina, and Kapolei Town Center, and approval of all proposed developments, then the above translates into a loss of about 1,990 acres of sugarcane land by 1995 when the lease with Campbell Estate expires.

Long-Term Outlook for OSCo

Assuming sufficiently high sugar prices to justify continued sugar operations, an important question is whether the West Loch Estates, combined with the other projects, would eventually reduce sugarcane acreage and economies of scale sufficiently to force the closing of OSCo.

According to Amfac, over at least the next decade (to the end of the major leases), and assuming continuation of historic development rates for housing projects, then no combination of the major projects planned and proposed for the Ewa/Central-Oahu area, and resulting loss in sugarcane acreage, will require layoffs of sugar workers. This is because of the expectation for relatively gradual reduction in sugarcane acreage, partial or complete compensation of this acreage loss by increasing yields, and rapid employment loss by attrition. Gradual yield increases are likely to be accomplished through the introduction of new varieties, improved farming practices, chemical ripeners, more efficient harvesters, genetic engineering, etc.

An average yield of about 16 tons per acre, which is slighly above the current average yield of 14.5 to 15.5 tons per acre, would allow production at the current level of about 92,500 tons per year with only 11,550 acres of land, or about 1,990 fewer acres than currently. Such an acreage reduction is likely to be sufficient to accommodate all approved and proposed projects to the year 1995 when the lease with Campbell Estate expires. Increasing yields by about 42 percent to 21.3 tons per year, which may be achieveable within the next two decades, would allow a reduction by 4,840 acres to 8,700 acres, while maintaining the same level of production. Such an acreage reduction would be sufficient to accommodate all approved and proposed projects at full development.

If OSCo is changed from a two-mill to a single-mill operation and produces 67,500 tons per year, then all approved and proposed projects can be accommodated with a yield of 15.5 tons per acre, which is within the range of current average yields. A change to a single mill and an increase in yields would free sufficient land to accommodate even more projects than the approved and proposed ones.

In summary, **West Loch Estates, in combination with other approved and proposed projects, will not threaten the economic health of OSCo, nor require layoffs of sugar workers.** Reinforcing this finding is the fact that OSCo plans to fallow about 60 acres in the petition area because of its isolated location, regardless of whether or not the project proceeds.

__Economic Impact of Closing OSCo__

If OSCo were to cease operations for whatever reason (most likely because of low sugar prices), the loss of jobs would be less than 490 direct jobs and 550 indirect jobs, with the actual number dependent upon the reduced employment made possible by continuing productivity increases. This would be the equivalent of the loss of a hotel about half the size of the Hyatt Regency in Waikiki. Immediately following the mill closing, there would be a significant economic loss and social disruption. But over the long term, the economic loss would be absorbed easily by expanding economic opportunities in the Ewa/Central-Oahu area. For example, the new hotels at Ko Olina will be the equivalent of over eight OSCos in terms of direct plus indirect jobs and—when tip income and all indirect jobs are considered—will provide higher average wages (based on analysis with the State Economic Model). Other new jobs in

the Ewa area will be provided by Barbers Point Harbor, expansion of Campbell Industrial Park, development of Kopolei Town Center, growth of diversified agriculture made possible by lands freed from sugar (growth which is likely to be at the expense of Neighbor Island farmers), and other economic activities which may be attracted to the area or which may spontaneously occur because of the increased availability of land and water, and lower urban land costs than would otherwise be the case. Therefore, most if not all sugar employees can be expected to find other employment if this should be required. However, some unskilled sugar workers and those having non-transferable skills may receive reduced pay when and if they are forced to find non-sugar jobs.

Assuming a policy favoring rapid urbanization of lands freed by the closing of sugar operations—a policy which presumably would be designed to increase the supply of land for housing and various economic opportunities, and increase competition among landowners and developers, with the objective of decreasing housing costs and increasing economic opportunities—three to four decades, or even longer, would be required to absorb the land. During this period, a huge supply of land and water would remain available for diversified agriculture and other economic activities. Even at full urbanization, over 2,000 acres would remain available for agriculture in the blast zone surrounding the Navy's magazine storage area located at West Loch, Pearl Harbor.

IMPACT ON DIVERSIFIED AGRICULTURE

The development of West Loch Estates is an irretrievable commitment of agricultural land to urban use. This commitment raises the question of whether the West Loch Estates will affect adversely the development of diversified agriculture (including aquaculture), either immediately or in the long term. Before addressing this question, the demand for and the supply of prime agricultural land for diversified agriculture is clarified. For the purposes of this discussion, prime agricultural land is loosely defined to mean any high-quality agricultural land capable of providing high yields for a variety of crops, and would include the lands currently cultivated in the petition area.

__Demand for Prime Agricultural Land__

As part of its analysis to identify IAL (see page 2), the LESA Commission adopted projections of the amount of agricultural land required to increase food and animal-feed self-sufficiency given resident plus visitor population growth, and increase crop exports. The projections for the State and Oahu are shown in Tables 1 and 2, respectively. As indicated, an estimated 52,684 additional acres will be required Statewide to accommodate the the 1983-to-1995 increase in production. The corresponding figure for Oahu is 7,979 acres. As shown, the crops and acreage requirements are categorized according to those which generally do not require prime agricultural land (although some crops may be grown profitably on prime agricultural land), those crops which generally do require prime agricultural land, plus a contingency of 10 percent of all acreage other than for beef and cattle.

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

—Based on a thorough, in-depth, and widely reviewed analysis of the market potential for crops grown on Molokai (Plasch and Garrod), and analysis of previous projections distributed by the State of Hawaii Department of Agriculture, the LESA projection for diversified agriculture appears to be excessively optimitistic. Apparently, it is assumed that many unprofitable crops will become profitable, that Hawaii farmers will be able to undersell low-cost summer crops from California, and that each and every activity will experience rapid growth. Verification of the exent of these flaws is hampered by the fact that the assumptions and analysis which underlie the LESA projections have not been made available for public inspection.

—Some of the acreage estimates are for harvested acreage, which leads to an overestimate of the land requirements for those crops which are harvested more than once a year (e.g., a crop harvested twice a year should have its acreage requirement halved).

—The LESA contingency of 29,500 acres is excessive, especially since LESA projects a requirement for less than 9,000 additional acres of prime agricultural lands. The contingency is large primarily because the LESA methodology implicitly allows for expansion of sugar operations—a grossly unrealistic possibility. Furthermore, the contingency amounts to double counting since optimistic projections have a built-in contingency.

—The LESA methodolgy assumes that prime agricultural lands that were freed from sugar and pineapple production and placed in pasture or some other low-profit operation will stay in these uses. This is very unrealistic in that these are holding operations for land until profitable crops can be identified.

—The LESA methodolgy incorrectly assumes that sugar is a healthy industry, and that sugar lands would be unavailable for more profitable replacement crops.

—The Illustrative Generalized IAL Maps incorrectly allocates prime agricultural lands to certain activities which do not need such lands (e.g., aquaculture should be allocated the agriculturally low-quality coastal lands at Kahuku).

The relevant figures from Tables 1 and 2 are not the total figures, but the increase in the amount of prime agricultural land required to accommodate diversified agriculture: the increase is 8,858 for the State, and 2,314 acres for Oahu. As discussed above, these figures are excessive; a more realistic estimate for the State is probably closer to 1,200 acres (Plasch and Garrod). Nevertheless, even using the excessive LESA estimate, the amount of additional prime agricultural land that would be required to accommodate diversified agriculture, and provide the hope (but not the realistic expectation) of profitable operations, is surprisingly small.

If diversified agriculture is to require a large amount of prime agricultural land, then additional crops will have to be grown for the export market rather than the small Hawaii market. However, the extreme difficulty of developing large export markets should be noted. Numerous and extensive crop searches and experiments for over a century by many people and organizations has led to surprisingly few major long-term successes in Hawaii, thereby indicating the extreme difficulty of identifying new export crops and develop them into new and profitable industries. Furthermore, the difficulty in developing export markets is increasing because of increasing competition from other sugarcane-growing areas. As noted previously, low sugar prices have led nearly all sugarcane operators throughout the world to search for profitable replacement crops, particularly crops which can maintain export earnings.

Supply of Prime Agricultural Land

Regarding the supply of land, an enormous and growing supply of prime agricultural land is available for other uses. Since 1970, about 83,000 acres of Hawaii's prime agricultural land has been freed from sugar and pineapple production: about 43,000 acres of land freed from sugar production (about 9,000 acres on Oahu and 33,600 on the Neighbor Islands), and over 40,000 acres freed from pineapple production (about 12,000 acres on Oahu and over 28,000 on the Neighbor Islands) [Plasch, Hawaii's Sugar Industry, HSPA, Hawaii Agricultural Reporting Service]. Some of the land freed from sugar and pineapple production has or will be converted to urban,

Table 1.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, STATE OF HAWAII: 1983 AND 1995

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

Table 1.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, STATE OF HAWAII: 1983 AND 1995 (continued)

[1] Includes marginal grazing and pasture lands. The 1983 figure includes arid zones and other areas having low carrying capacity, while the 1995 figure does not.

[2] Often includes land in a holding operation awaiting discovery of profitable uses.

[3] The decline in acreage primarily reflects the loss of Puna Sugar Co.

[4] Includes some pasture and 8,000 of guinea grass from Molokai.

[5] Overstated in that the acreage figures are for harvested acres, not the amount of land required.

[6] Based on 10% of all acreage other than that for beef/cattle. Adding a contingency amounts to double counting in that the projections are optimistic to begin with. Also, the contingency figure includes 17,770 acres for expansion of sugarcane, even though the sugar industry is expected to decline, not expand.

Table 2.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, CITY AND COUNTY OF HONOLULU: 1983 AND 1995

Crop or Activity	1983	1995	Increase
Crops and Activities which Generally Do Not Require Prime Agricultural Lands			
Beef/cattle[1,2]	18,200	10,090	--
Livestock:			
Dairy	340	402	62
Eggs/Poultry	250	390	140
Swine	144	200	56
Subtotal for Livestock	734	992	258
Unique Crops:			
Aquaculture	300	2,400	2,100
Flowers/Nursery	495	850	355
Papaya	70	170	100
Taro/Watercress	60	85	25
Subtotal for Unique Crops	925	3,505	2,580
Crops and Activities which Generally Do Require Prime Agricultural Lands			
Plantation:			
Sugarcane[2]	27,200	25,300	-1,900
Pineapple	11,829	11,800	-29
Subtotal for Plantation	39,029	37,100	-1,929
Other:			
Guava	--	242	242
Seed Corn	125	180	55
Bananas	540	836	296
Feed/Forage[2,3]	1,741	2,912	1,171
Fruits	90	200	110
Vegetables/Melons[4]	1,155	1,595	440
Subtotal for Other Crops	3,651	5,965	2,314
Contingency[5]	--	4,756	4,756
TOTAL	62,539	62,408	—
TOTAL, Excluding Beef/Cattle	44,339	52,318	7,979

Table 1.— LESA AGRICULTURAL ACREAGE REQUIREMENTS, CITY AND COUNTY OF HONOLULU: 1983 AND 1995 (continued)

[1]Includes marginal grazing and pasture lands. The 1983 figure includes arid zones and other areas having low carrying capacity, while the 1995 figure does not.

[2]Often includes land in a holding operation awaiting discovery of profitable uses.

[3]Includes some pasture.

[4]Overstated in that the acreage figures are for harvested acres, not the amount of land required.

[5]Based on 10% of all acreage other than that for beef/cattle. Adding a contingency amounts to double counting in that the projections are optimistic to begin with. Also, the contingency figure includes 2,530 acres for expansion of sugarcane, even though the sugar industry is expected to decline, not expand.

diversified agriculture, and aquaculture uses. Also, some of the land freed from pineapple use on Oahu was converted to sugar production. Making allowances for the various conversions, uncommitted acreage which remains available to diversified agriculture and aquaculture amounts to many tens of thousands of acres, with a large share of this on Oahu. Much of this land is fallow, in pasture, or some other low-value land-holding operation.

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

Furthermore, much of the sugarcane lands are in holding awaiting the discovery of profitable replacement activities, so is part of the supply of prime agricultural land available to profitable diversified agriculture crops. For example, one of the components of the OSCo Survival Plan is to experiment with a variety of crops in order to find profitable replacements to sugar.

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

Additional lands which have been made available for diversified agriculture are in government-sponsored agricultural parks throughout the State. Lands for agricultural activities which do not require prime agricultural land include pasture land, land for livestock operations, and unique lands. Unique lands are not prime agricultural lands, but are important lands for certain crops, the principal examples are the coffee lands in Kona, and certain lava lands in Puna that are well-suited for growing papaya. The supply of unique lands is quite large and distinct from the supply of prime agricultural lands.

Availability of Land to Small Farmers

Even though considerable agricultural land is available, it should be noted that in many areas of the State small agricultural parcels are not available to small-scale, farmers under long-term leases. The reason for the unavailability is that land-use regulations and the political environment make it unprofitable and too risky to lease small farm parcels. Unprofitable because agriculture is generally a low-value use of

land which can afford only relatively low lease rents, while County subdivision regulations designed for rural estates require expensive electrical power, paved rather than gravel roads, and buried rather than surface water lines. The combination of low rents and expensive subdivision requirements makes it unprofitable to subdivide land for small farms. For example, rather than develop the State agricultural park in Kahuku, it would have been cheaper for the State to give each farmer $100,000. In addition, there is the risk that when the lease expires, the farmer will turn to the legislature to try and prevent an escalation of the lease rent, or to prevent eviction by the landowner in favor of a higher and more profitable use—this is often the case for long-term leases for land on which the farmer has built a home. Such an economic environment favors leases to large-scale operators (including cooperatives consisting of many small farmers), short-term and illegal leases of unsubdivided land, subdivision of the land into rural estates for sale to buyers who can afford the costs of the subdivision requirements, or leaving the land fallow.

The unavailability of small parcels of land to farmers is a serious problem, but does not invalidate the fact that there is a vast supply of prime agricultural land available for profitable diversified agricultural activities. However, the activities must be large scale, or the subdivision requirements circumvented.

Outlook for Diversified Agriculture

Based on the above analysis, ample prime agricultural land will be available to easily accommodate prime-agricultural land requirements of diversified agriculture. This conclusion derives from the fact that there is a vast amount of prime agricultural land and water that has been freed from sugar and pineapple production in recent years, the very real possibility that additional sugarcane acreage and water will be freed given the outlook for low sugar prices, the fact that some if not most or even all of the sugar operations would make their lands available for profitable replacement crops, and the surprisingly modest land requirements for diversified agriculture. In other words, the limiting factor will be the market, not the land supply. West Loch Estates, combined with other major housing developments in the Ewa/Central-Oahu area and elsewhere, involves far too little land to affect this conclusion. Therefore, **West Loch Estates will not affect adversely the growth of diversified agriculture.**

Consistency with Overseas Long-Term Trends

Hawaii's increased availability of prime agricultural land compared to that of prior decades is part of some very long-term and accelerating trends occurring throughout most developed and developing market economies. For example, an excess of about 45 million acres of agricultural land exists in the United States (Dvoskin). Productivity and yields have been increasing faster than population growth; and genetic engineering—which gives promise of developing crops having higher yields, increased resistance to diseases and pests, and increased tolerance to climatic variations—and other advances, combined with slower popolution growth, indicate an acceleration of these trends. Rapid productivity and yield increases lead to overproduction, market gluts, low agricultural prices, low farm income, bankruptcies, and a need to withdraw labor, land, and other resources from agriculture in order to restore balanced markets and increase farm income to those who remain. The major agricultural problem facing the United States and many other economies is how to made this withdrawal an orderly one so as to minimize social problems. This is a problem associated with tremendous success in agriculture, and contrasts sharpely with and invalidates the 200-year old prediction of Thomas Malthus that population will increase faster than the food supply, resulting in massive starvation.

CONSISTENCY WITH STATE AND COUNTY PLANS

The thrust of the Hawaii State Plan and the State Agriculture Functional Plan is to preserve the economic viability of plantation agriculture and to promote the growth of diversified agriculture. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured. The thrust of these two plans is not to preserve prime agricultural lands for the sake of preservation—preservation is to occur only if there is a potential agricultural need for these lands.

Regarding housing, the West Loch Estates is clearly in support of the Hawaii State Plan, particularly those policies, objectives, and priority directions which encourage development of reasonably priced, safe, sanitary, liveable homes in suitable environments. Nevertheless, certain priority guidelines (but not objectives or policies) dealing with population growth and distribution do call for encouraging urban growth primarily to existing urban areas and marginal agricultural lands, and away from important agricultural lands. While this is desirable, it is unrealistic in terms of the supply of lands suitable for building reasonably-priced housing, and unrealistic as to the agricultural market which could use the vast supply of prime agricultural lands profitably.

Since the West Loch Estates will not adversely affect the economic viability of OSCo, will not limit the growth of diversified agriculture, but will contribute to a healthier housing market, the project is consistent with the major thrust of the

Hawaii State Plan and the State Agriculture Functional Plan. Also, the project would provide a public benefit which would override the proposed IAL designation of the LESA Commission. Furthermore, the project would not adversely affect cultivation of adjacent sugarcane acreage and, therefore, complies with the Hawaii Right-to-Farm Act.

The project is also consistent with County policies of directing population growth to Ewa, which by definition must occur at the expense of sugarcane acreage.

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APPENDIX J

Archaeological Reconnaissance Survey
For Environmental Impact Statement

West Loch Estates - Golf Course and Parks

BY:

Paul H. Rosendahl, Ph.D., Inc.

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Consulting Archaeologist

Report 322-102887

ARCHAEOLOGICAL RECONNAISSANCE SURVEY FOR ENVIRONMENTAL IMPACT STATEMENT

WEST LOCH ESTATES - GOLF COURSE AND PARKS

Land of Honouliuli

Ewa District, Island of Oahu

December 1987

305 Mohouli Street • Hilo, Hawaii 96720 • (808) 969-1763 or 966-8038

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SUMMARY

A study of archaeological resources within the approximately 216 ac West Loch Estates - Golf Course and Parks Project area in the Land of Honouliuli, Ewa District, Island of Oahu, was conducted by Paul H. Rosendahl, Ph.D., Inc. (PHRI) during the period October-December 1987. The work was done at the request of the R.M. Towill Corporation (RMTC) for their client, the City and County of Honolulu (CCHONO). The study of the project area included the determination of the presence or absence of archaeological remains within the project boundaries.

On-site field investigation included field survey, shallow subsurface testing by hand tools, and deep subsurface testing by machine auger and backhoe trenching to determine the existence and extent of cultural remains. From the subsurface testing, sample materials were collected for radiocarbon and volcanic glass dating, and for pollen analysis. In addition to field work, historical documentary research was conducted to assist in the identification and interpretation of archaeological remains. Local informants were also interviewed for additional information.

Seven sites were identified during the field studies. These sites include both historic and prehistoric habitation and burial sites situated on Hoaeae Point and on the slopes and uplands surrounding the Honouliuli Stream floodplain. Sites also include the remnants of a once extensive agricultural system which combined aquaculture in fishponds situated on the shores of West Loch, irrigated pondfield cropping of the floodplain, and dryland cultivation of the surrounding slopes and uplands. The historic and prehistoric habitation sites consist of both surface and subsurface deposits containing artifacts and midden. Agricultural use of the Honouliuli Stream floodplain may have begun as early as c. AD 1000, and continuing up to recent times.

Based on the findings of the archaeological study, the significance of cultural remains identified within the project area was assessed. Four of the identified sites (Sites 3318, 3320, 3322, 3324) were determined to be significant for their information content only. Two of the identified sites (Sites 3319, 3321) were determined to be significant both for their information content and for their cultural value because of the presence of one or more human burials. One site (Site 3323) was determined to be significant both for its information content, and as a good example of a site type.

Appropriate mitigation for Sites 3318, 3320, 3322, and 3324 would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. For Sites 3319 and 3321, appropriate mitigation would involve either continued in-place protection (preservation "as is"), or disinterment of skeletal remains according to current State Health Department regulations and procedures. Appropriate mitigation for Site 3323 would involve some degree of further data collection (including historical documentary and local informant research) and continued preservation with some level of interpretive development.

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BACKGROUND

At the request of the R.H. Towill Corporation (RHTC), acting for their client, the City and County of Honolulu (CCHONO), the firm of Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted a combined surface and subsurface archaeological reconnaissance survey of the approximately 216 ac West Loch Estates - Golf Course and Parks project area in the Land of Honouliuli, Ewa District, Island of Oahu. The primary objective of this survey was to provide information--concerning the presence or absence of any sites or features of possible archaeological significance within the project area limits--both appropriate to and sufficient for an Environmental Impact Statement (EIS) being prepared in accordance with Chapter 343-Haw. Rev. Stat. and in anticipation of a Land Use Boundary District Amendment petition to be submitted to the State Land Use Commission.

Field work was carried out September 8-October 23, 1987, under the supervision of PHRI Supervisory Archaeologist A. Merrill Dicks (Project Field Director), and the overall direction of PHRI Principal Archaeologist Dr. Paul H. Rosendahl (Principal Investigator). Both surface and subsurface reconnaissance surveys and limited subsurface testing were conducted. On October 21, 1987, Dr. Rosendahl and Mr. Dicks met on-site with Dr. Ross Cordy, chief archaeologist with the State Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS), for a field inspection and discussion of worked completed. On November 13, 1987, Dr. Rosendahl presented an informal summary of field work findings and preliminary conclusions to representatives of RHTC and CCHONO. On December 8, 1987, a more detailed summary was given by Dr. Rosendahl, with the support of RHTC and CCHONO representatives, to DLNR-HSS chief archaeologist Dr. Cordy and Dr. Joyce Bath, DLNR-HSS staff archaeologist for Oahu. In the course of the latter meeting, both Dr. Cordy and Dr. Bath concurred with the general significance assessments made and general mitigation treatments recommended for the archaeological remains identified within the project area. The present report constitutes the final report on the combined surface and subsurface reconnaissance survey of the West Loch Estates - Golf Course and Parks project area.

SCOPE OF WORK

The basic goal of the combined surface and subsurface reconnaissance survey was to identify--to discover and locate on available maps--all sites and features of possible archaeological significance. A reconnaissance survey comprises the initial level of archaeological investigation. It is extensive rather than intensive in scope, and is conducted basically to determine the presence or absence of archaeological resources within a

specified project area. A reconnaissance survey indicates both the general nature and variety of archaeological remains present, and the general distribution and density of such remains. A reconnaissance survey permits a general significance assessment of archaeological resources, and facilitates the formulation of realistic recommendations and estimates for such further archaeological work as might be necessary or appropriate. Such further work could include intensive survey--further data collection involving detailed recording of sites and features, and selected test excavations; and possibly subsequent mitigation--data recovery research excavations, interpretive planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The principal objectives of the combined reconnaissance survey of the West Loch Estates - Golf Course and Parks project area were four-fold: (a) to identify (find and locate) all sites and site complexes present within the project area; (b) to evaluate the potential significance of all identified archaeological remains; (c) to determine the possible impacts of proposed development upon the identified remains; and (d) to define the scope of any subsequent archaeological work that might be necessary or appropriate. Based on a preliminary review of available background literature and records, and on discussions with Mr. Chester Koga of RHTC and with Dr. Cordy and Dr. Bath of DLNR-HSS, the following specific tasks were determined to constitute an adequate scope of work for the combined surface and subsurface reconnaissance survey of the West Loch Estates - Golf Course and Parks project area:

1. Conduct archaeological background and historical documentary research involving (a) review and evaluation of readily available archaeological and historical literature, historic documents and records, and cartographic sources relevant to the immediate project area, and (b) interviews with available knowledgeable local informants;

2. Conduct variable coverage (partial to 100%), variable intensity (30- to 90-ft intervals) ground reconnaissance survey of the project area, with (a) relatively higher-intensity coverage being given to coastal areas, stream drainages, and non-cultivated and otherwise minimally modified lands, and (b) relatively lower-intensity coverage to areas extensively modified by sugar cane cultivation;

3. Conduct sample-coverage subsurface reconnaissance survey of the entire project area by hand and mechanical-powered coring tools, with relative intensity varying as noted in 2.(a,b) above;

4. Conduct limited subsurface reconnaissance testing, by hand tools and/or mechanical backhoe, of selected coastal areas (e.g., suspected fishpond locations), and areas within the inland portion of the project area where coring revealed possible cultural deposits;

5. Analyze background research data and field data (potentially including, but not limited to, sedimentological, palynological, and chronological analyses); and

6. Prepare appropriate reports.

The combined surface and subsurface reconnaissance survey was to be carried out in accordance with the standards for reconnaissance-level survey recommended by the Society for Hawaiian Archaeology (SHA). These standards are currently used by DLNR-HHS/State Historic Preservation Office (SHPO) as guidelines to review and evaluate archaeological reconnaissance survey reports submitted in conjunction with various development permit applications.

The significance of all archaeological remains identified within the project area was to be assessed in terms of the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60.4). The DLNR-HHS uses these criteria to evaluate eligibility for both the Hawaii State and National Register of Historic Places. To further facilitate management decisions regarding the subsequent treatment of resources, the general significance of all archaeological remains identified during the reconnaissance survey was also to be evaluated in terms of potential scientific research, interpretive, and/or cultural values. Scientific research value refers to the potential of archaeological resources for producing information useful in the understanding of culture history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. Interpretive value refers to the potential of archaeological resources for public education and recreation. Cultural value refers to the potential of archaeological resources for the preservation and promotion of cultural and ethnic identity and values.

PROJECT AREA DESCRIPTION

The West Loch Estates - Golf Course and Parks project area consists of c. 216 acres in the Land of Honouliuli, Ewa District, Island of Oahu (Figure 1). The project area occupies the lower and upper valley segments of Honouliuli Gulch, which extends from the Waianae Range to the West Loch of Pearl Harbor. Bordering most of the project area is the broad Ewa Plain, an emerged Pleistocene reef of level to gently-sloping dissected terrain. North of the project area is the light-industrial urban area of Waipahu; southward and westward of the project area are large tracts of cultivated and fallow sugarcane fields, and eastward of the project area lies the West Loch of Pearl Harbor. The northwestern extent of the project area is where Honouliuli Stream has down-cut through a line of fossil sea-bluffs.

Honouliuli Gulch, which originates northwest of the project area, is approximately 4.5 miles long. Flowing through the gulch is Honouliuli Stream, which extends from the Waianae Range, crosses the southern end of

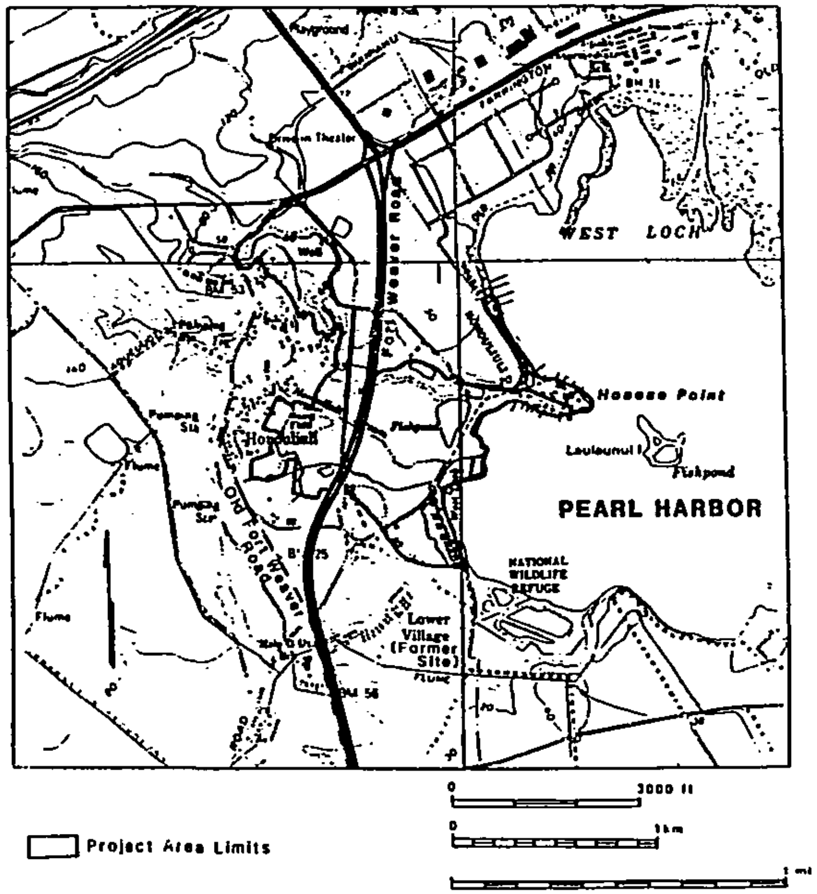

Figure 1.

PROJECT AREA LOCATION MAP

Archaeological Reconnaissance Survey for Environmental Impact Statement
West Loch Estates - Golf Course and Parks
Land of Honouliuli, Ewa District, Island of Oahu

PHRI Project 87-322 October 1987

(Composite map based on current 7.5' series USGS quad maps.)

Schofield Plain and through the Ewa Plain, and finally empties into West Loch. Honouliuli Gulch probably originated during the Pleistocene period, when valley formation by extensive erosional down-cutting coincided with intermittent drops in sea level. In its upper reaches, the gulch is narrow and steep-sided and contains minor expanses of alluvial bottom land. In the Ewa Plain area the gulch widens into a broad valley.

Based on topography and soil pedogenesis, the project area can be divided into three basic sections--an upper valley segment, a lower valley segment, and the upland margins of the Ewa Plain (Figure 2). Except for the Ewa Plain margin segments, terrain in the project area is fairly level. The terrain slopes gradually, from west to east, from one end of the project area to the other. Elevation at the western end, excluding upland margins of the gulch, reaches 35 feet AMSL (above mean sea level). Elevations at upland margins of the gulch range from 15 feet (AMSL) at Hoaeae Peninsula in Survey Area 5, to approximately 75 feet (AMSL) in the western portion of the project area.

The upper and lower valley segments, which can be generally divided along the 10-15 foot (AMSL) contour intervals, undoubtedly reflect environmental trends that occurred in the area--trends which probably remained constant over long periods. The two segments contain major differences in their substrata. The slope gradient of the lower valley segment ranges from 0% to less than 1%--an almost imperceptible gradient. Soils of the lower valley segment are comprised of thick water-saturated muck--a combination of fine alluvial and lacustrine clays, silts, and sands. These soils accumulated gradually, filling in an embayment that once extended from the present margin of West Loch to the line of fossil sea bluffs. The lower valley slope gradient, soil types, and position in the general topography of the area have resulted in very poor drainage, and standing water, the result of a perched water table, is frequently observed in the area.

In contrast, the upper valley segment is well-drained because of its coarse substratum and height above sea level. Narrow and bounded by the gulch walls, this segment is where the gulch intersects the fossil sea bluffs. The substratum in the upper valley is a combination of sands, gravels, cobbles, and boulders--porous Pleistocene deposits which at one time comprised a gravel beach front and talus which the fossil sea bluffs overlooked.

The upland margins of the Ewa Plain are comprised of emerged coral beds which have been overlaid by probable Pleistocene alluvial gravels and clays. Overlying the gravel and clays, and constituting the present soil cover, is a mantle of reddish-brown alluvial and colluvial clays. Where the Ewa Plain meets the margins of Honouliuli Gulch, this clay mantle has eroded away. Although portions of the Ewa Plain outside the project area are somewhat poorly drained, drainage in the plain portion within the project area is generally excellent.

As might be expected, the three designated sections of the project area vary in types of vegetation cover as well as terrain (Figures 3-5).

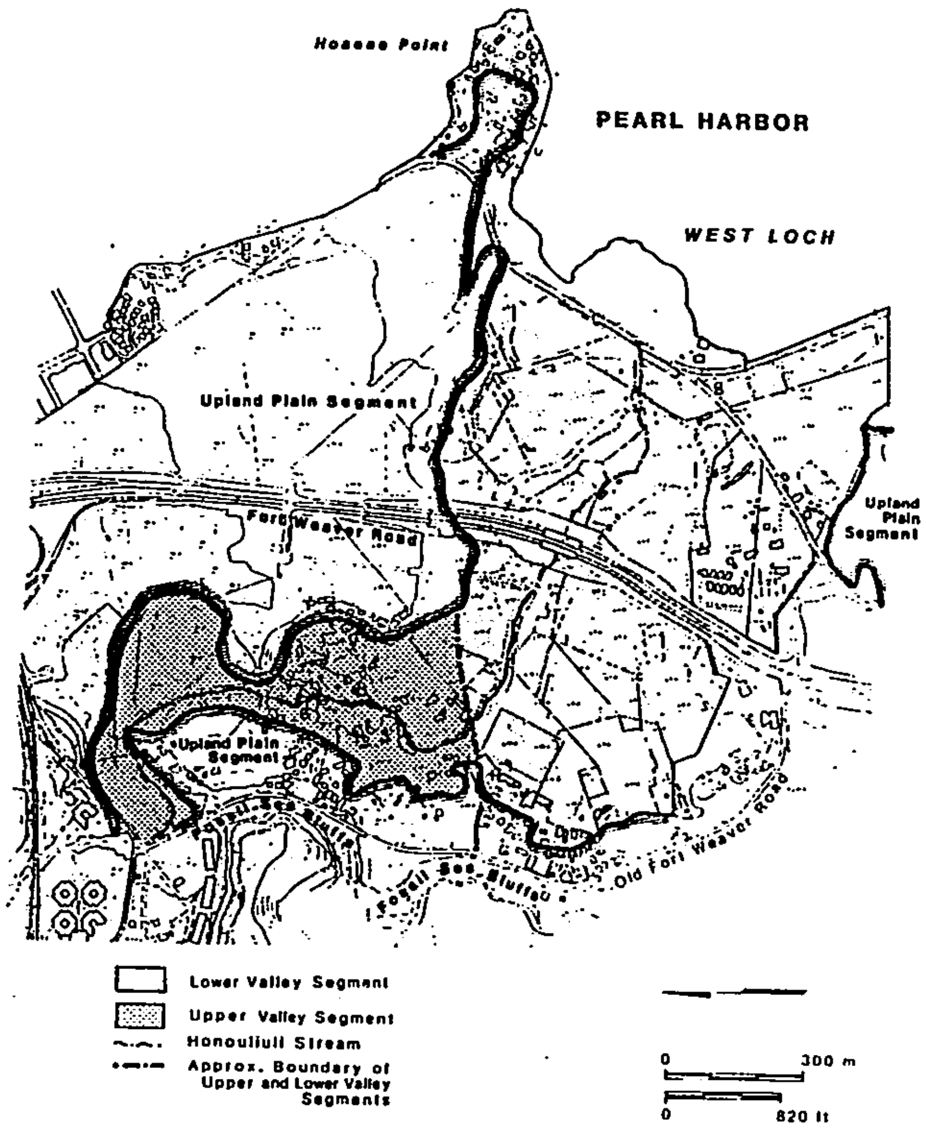

FIGURE 2. SOIL AND TERRAIN DIVISIONS WITHIN THE PROJECT AREA.

Figure 3. GENERAL VIEW OF LOWER VALLEY TERRAIN AND VEGETATION. Honouliuli Stream present along scrub tree line separating Survey Area 1 (foreground) from Survey Area 4 (background). View to ESE. (PHRI Neg.646-22)

Figure 4. GENERAL VIEW OF UPPER VALLEY TERRAIN AND VEGETATION. View from low bluff overlooking vicinity of Site 3321 in northern portion of Survey Area 2. View to NNW. (PHRI Neg.646-2)

Figure 5. GENERAL VIEW OF UPLAND PLAIN TERRAIN AND VEGETATION. Abandoned sugarcane fields in central portion of Survey Area 2. View to SW. (PHRI Neg.646-4)

In general, vegetation in the lower valley segment is predominantly hydrophytic; as one moves toward the upper valley segment, vegetation becomes increasingly xerophytic. In the upland margins of the Ewa Plain, vegetation is generally xerophytic. Differences in vegetation in the project area is due mainly to drainage differences--drainage largely affects soil development and plant growth. Both individual species and specie associations of vegetation in the project area are generally those of plant husbandry. The landscape of the project area, like much of Oahu since prehistoric times, and especially since Western contact, has been highly modified; present vegetational patterns appear to be wholly unlike prehistoric and early historic period patterns. Over-exploitation and overrazing have drastically affected the landscape.

Small sugarcane (Saccharum sp.) fields are present in the upper valley segment. Within the lower valley segment is a limited amount of pastureland. Along the margins of West Loch, fish ponds have lain fallow for many years. Houses are loosely scattered over the entire project area. Upper elevations of the Ewa Plain are generally dominated by sugarcane; lower elevations are drier and contain kiawe (Prosopis pallida [Humb. and Bonpl. ex Willd.] HBK), koa-haole (Leucaena leucocephala [Lam.] de Wit), and feral sugarcane and other exotic grasses. Shoreline portions of the plain and the lower valley segment are dominated by mangrove (Rhizophora mangle L.) and Californiagrass (Brachiaria mutica [Forsk.] Stapf). (For a more detailed description of the present botanical status of the project area, see Char 1987.)

The extensive land modification in the Land of Honouliuli directly influenced the manner in which archaeological research was conducted in the project area; field work strategies were partly based on the history of land modification in the Land of Honouliuli (Frierson 1972). Extensive historic period modification first took place in 1815-1830, with the harvesting of natural forests on the slopes of the Waianae Mountains; this harvesting initiated wide-scale erosion of the slopes. This erosion was accelerated by the subsequent over-population of the slopes with livestock, and the livestock virtually devastated the natural ground cover. Later in the 1800s, in conjunction with agricultural programs aimed at increasing the fertility of the Ewa Plain, the upland slopes of the Waianae Range were deeply plowed to increase erosion intentionally. As intended, the loosened soil eventually transmigrated to the soil-poor, infertile Ewa Plain. The detrimental effects man-induced erosion had on the environment need not be elaborated on here; what is relevant to the present project is that the translocated soil buried large sections of the pre-historic and early historic landscape of Honouliuli, including the present project area. Buried along with that landscape, of course, were the archaeological remains associated with it.

The translocated soils are particularly extensive in the valley sections of the present project area; constricted by the walls of the valley and by the proximity of the ground surface to sea level, soils appear to have accumulated at a rapid pace. In most valley areas, the overburden is one to three feet thick, and is a hindrance to archaeological survey. Mixed with the overburden are sediments derived from localized slope erosion and stream activity. In contrast, the upland margins of the Ewa Plain are considerably less affected by soil translocation. The upland plain, due to intensive cultivation (primarily sugarcane) has over the years been in constant transition. The destabilizing effects of this cultivation, coupled with the slope and elevation of the plain, have disrupted translocated soils or removed them at a rate commensurable to the speed at which they accumulate.

PREVIOUS ARCHAEOLOGICAL WORK

Sites previously recorded within and immediately adjacent to the West Loch Estates - Golf Course and Parks project area are listed in Table 1, and their approximate locations are shown on Figure 6. Prior to the present reconnaissance survey, only a single archaeological site had been previously recorded within the project area. During his 1930 survey of Oahu sites for B.P. Bishop Museum, J. Gilbert McAllister described a possible fishing shrine which apparently was situated on the extreme eastern end of Hoaeae Point:

> **Site 139. Kalanamaihiki fishing shrine (ko'a) at Kapapapuhi, Honouliuli.**
>
> Near the end of the small tongue of land that juts out opposite Laulaunui Island in the west loch of Pearl Harbor, are two large rough stones about 2.5 feet in size, with six or seven smooth stones averaging 1 foot in size in a small pile adjoining the larger stones. The entire site is covered with akulikuli (*Batis maritima*?) and would not be noticed or considered unusual if the Hawaiians did not know of its former sacredness (McAllister 1933:108).

Despite intensive searching of the supposed site location during the present survey, McAllister's fishing shrine site could not be relocated. Several waterworn basalt stones of the general size noted in his description were seen in the vicinity of the apparent site location at the end of Hoaeae Point, but the extensive modern modification of the area (WWII and subsequent) seems to have destroyed whatever McAllister observed in 1930.

McAllister also recorded two other sites in 1930 within the immediate vicinity of the West Loch Estates - Golf Course and Parks project area, a fishpond and a traditional named area:

> **Site 140. Fishpond adjoining Laulaunui Island.**
>
> The pond is possibly Laulaunui fishpond, and named for the island. It is 4 to 5 acres in extent with a wall approximately 900 feet long, 7 feet wide, and 3.5 feet high. There are no outlet gates (makaha).

Table 1.

LIST OF SITES PREVIOUSLY RECORDED WITHIN AND IMMEDIATELY ADJACENT TO THE WEST LOCH ESTATES - GOLF COURSE AND PARKS PROJECT AREA

HRHP Site 50-80-*	Site Type	Previous Site Designation
13-139	Kalanamaihiki fishing shrine (ko'a)	---
13-140	Fishpond adjoining Laulaunui Island	---
13-141	Kaihuopalaai, Ewa [traditional name for entire West Loch area of Pearl Harbor]	---
13-3314	Midden deposit (?)	T-1#
13-3315	Surface artifact collection area	T-2
12-3316	Complex (historic cemetery)	T-3
12-3317	Surface artifact collection area	T-4
12-9714	OR & L (Oahu Railway & Land Co.) Right of Way [National Register Site]	---
13-9992	Pearl Harbor Naval Base [National Register Site]	---

*Hawaii Register of Historic Places (HRHP) site designation system: all site numbers prefixed by 50-80-xx- (50=State of Hawaii, 80=Island of Oahu, xx=12 or 13 [USGS 7.5' series quad map, "Ewa, Oahu" or "Puuloa, Oahu"], three or four digit number=unique Oahu Island site number)

#PHRI Temporary Site Number (Rosendahl 1987)

> **Site 141. Kaihuopalaai, Ewa.**
>
> This name is said to apply to the whole West Loch of Pearl Harbor. Each year, beginning in October or November, large shoals of mullet are said to go from Pearl Harbor east to Makapuu Point and then north and west to Laie or Malaekahana, from which point they return to Pearl Harbor over the same route in March or April. This is a favorite story which one comes across frequently about the island, and the oral versions are as diverse as those written. Kaihuopalaai is the pond from which the mullet come.
>
> The site is named for Kaihuopalaai, said to be the daughter of Konikonia and his wife Hinaaimalama. Fornander...writes

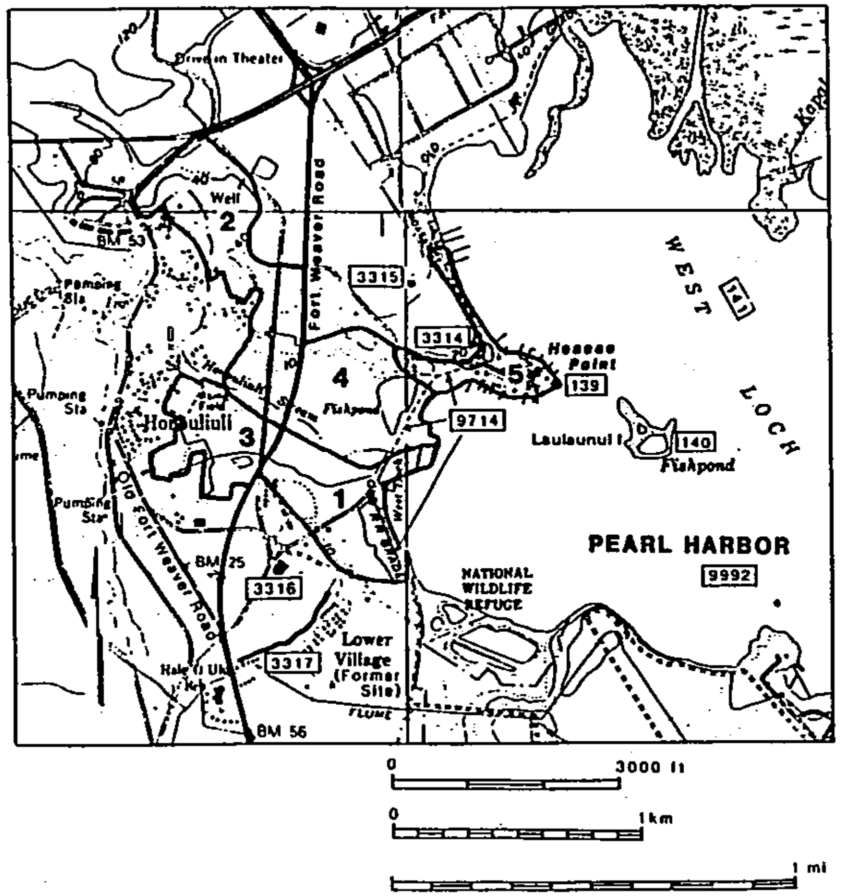

Figure 6.

SURVEY AREAS AND LOCATIONS OF SITES PREVIOUSLY RECORDED WITHIN AND IMMEDIATELY ADJACENT TO THE PROJECT AREA

Archaeological Reconnaissance Survey for Environmental Impact Statement
West Loch Estates - Golf Course and Parks
Land of Honouliuli, Ewa District, Island of Oahu

PHRI Project 87-322 . October 1987

(Composite map based on current 7.5' series USGS quad maps.)

"...on Oahu, Kaihuopalaai saw a goodly man be the name of Kapapapuhi [see Site 139] who was living at Honouliuli, Ewa; she fell in love with him and they were united, so Kaihuopalaai has remained in Ewa to this day. She was changed into that fishpond in which mullet are kept and fattened, and this fish is used for that purpose to this day."
According to old Hawaiians, there never was a fishpond by this name. In another version..., Ihuopalaai is the brother of a woman living in Laie. As the fish were scarce in Laie, this woman sent her husband to Ihuopalaai, who had the mullet follow her husband on his return trip which was made along the shore around Makapuu Point with the mullet following in the water. Makea tells me that Kaihuopalaai's sister was named Malaekahana. Another story tells of a man who lured the mullet around the island by tossing sweet potatoes into the sea (McAllister 1933:108).

In July-September 1987, four new sites were identified by PHRI immediately adjacent to the present project area during a combined surface and subsurface reconnaissance survey of the West Loch Estates - Residential Increments I and II project area (Rosendahl 1987). The latter project area was found to have been extensively and almost entirely modified by decades of historic period sugarcane cultivation, and only four sites were identified. Three of these sites--Sites 3315 and 3317, surface artifact collection area, and Site 3316, a small cemetery complex--were found to be historic period in age, while the fourth--Site 3316, an exposed midden deposit--was ambiguous as to whether or not it even was a cultural feature. Two of the historic period sites, the cemetery (3316) and the larger surface artifact collection area (3317) appeared to be related to relatively recent sugar plantation occupation, while the third site--the smaller artifact collection area (3315) appeared to date somewhat earlier.

While no sites on the National Register of Historic Places are present within the West Loch Estates - Golf Course and Parks project area, an extension/component of one such site--Site 9714, the OR & L (Oahu Railway & Land Co.) Right of Way--does extend along the entire shoreline portion of the project area. While the portion of the OR & L ROW (railroad grade) which is found within both the present project area and along the seaward side of the previously surveyed Residential Increments I and II project area is not itself a formally identified site, the existing section that extends approximately 13 miles--from the Fort Weaver Road intersection at the southern tip of the Increment II, across the Ewa Plain to the intersection of Farrington Highway and Lualualei Road in Nanakuli, is currently listed on the National Register of Historic Places.

A second National Register site is also situated in the immediate vicinity of the Golf Course and Parks project area. This site, the Pearl Harbor Naval Base (Site 9992), is a large historic district comprised of the three lochs of Pearl Harbor, several islands and islets within the harbor, and various naval facilities along the shoreline.

While very little prior archaeological work has been conducted within or immediately adjacent to the present West Loch Estates - Golf Course and Parks project area, considerable archaeological research has been conducted in recent years in the coral plain portion of the Ewa District extending from Ewa Beach to West Beach, and including the Barbers Point area. This work has been summarized recently in a formal data recovery plan prepared by PHRI in connection with the development of the Ko Olina Resort at West Beach (Davis, Haun, and Rosendahl 1986:10-14).

SUMMARY OF HISTORICAL DOCUMENTARY AND LOCAL INFORMANT RESEARCH

Historical documentary research for the West Loch Estates overall project area was conducted by Historical Researcher Ms. Carol L. Silva, whose report is presented in Appendix A. The intent of Silva's work was to examine readily available mythological, historical, cultural, and early land use data regarding Honouliuli. Included in her report are (a) mythological references to Ewa District, (b) traditional references to the Land of Honouliuli, (c) a historical chronology of the general Honouliuli area, (d) an analysis of early land records specific to the West Loch Estates project area and adjacent portions of Honouliuli Valley, (e) several recommendations for further documentary research, and (f) a bibliography.

There are several mythological and traditional references to the general Honouliuli area. Mythological references to Ewa indicate that Ewa lands were quite visble and that Ewa was a desirable place to live. Gods favored Ewa and thus blessed it with much water and rich soil; crops were plentiful, and with large crops came a sizable population. Ewa was noted as the home of a line of chiefs and also as resort for chiefs. Traditional references to Honouliuli usually connect Honouliuli land forms or places to particular characters or events. For example, Kaihuopalaai, a name assigned to the whole of West Loch, was originally a name for a Honouliuli pond from where mullet would spawn and then swim to Oahu's North Shore. Mentioned in traditional references are Honouliuli heiau, a fishing shrine, and a holua slide.

Silva's historical chronology indicates that Honouliuli was extensively cultivated during its early history. Crops raised in the area included yams, bananas, taro, sweet potato, 'awa, wauke, olona, and mamake. Also in Honouliuli were extensive salt works. The chronology provides a number of capsule descriptions regarding life in Honouliuli--descriptions of the population, agriculture, land use, the development of the Ewa Plantation, James Campbell's Honouliuli Ranch, and various other topics.

Silva's land records for Honouliuli include a comprehensive accounting of land use predating 1850. Records generally indicate that Honouliuli contained numerous houses and many cultivated fields--both irrigated pondfields and dryland areas, and that land in Honouliuli was distributed among a great number of people.

In conclusion, Silva recommends that additional research be conducted. She specifically recommends examining records relating to early churches, cemeteries, schools, and prisons which were situated within Honouliuli at as yet undetermined locations. She also recommends further research on Ewa Plantation and military use of Honouliuli, and the gathering of oral histories from individuals familiar with land use in Honouliuli.

Informal interviews with several knowledgeable local informants were carried out by PHRI Principal Archaeologist Dr. Paul H. Rosendahl, and notes from these sessions are presented in Appendix B. Initial local contacts resulted in a list of numerous potential informants, of whom three were selected on the basis of familiarity with the Honouliuli area and availability. In line with Silva's recommendation concerning the gathering of oral histories, it is apparent that it would probably be productive to consult other individuals from the potential informants list in the future, as well as conducting more formal interviews with the three informants that were visited.

All three informants provided information about 20th century occupation and land use within the project area. Of particular value was the information relating to Hoseae Point--to the limited pre-WWII habitation, the extensive WWII utilization and modification of the area, and the more recent post-WWII period of occupation--and information relating to the apparent early presence of an old church and associated cemetery on the low ridge just inland of Hoseae Point, overlooking the OR & L-ROW railroad grade and the fishpond that had been created by the railroad causeway in the early 1890s.

SURVEY METHODS AND PROCEDURES

Field Work

Prior to the reconnaissance survey, the project area was inspected and assessed in order to identify constraints on conducting the survey and to formulate methods and procedures to deal with these constraints. The project area landscape and the potential range of cultural resources that might be encountered in the project area were reviewed and assessed. As indicated by the preliminary findings of the historical documentary research, prehistoric and early historic period habitation sites and agricultural complexes may have once been extensive within Honouliuli Gulch, particularly within a section that includes the present project area. It was expected that these sites and complexes, to a variable extent, along with associated portable cultural materials, had been preserved beneath the overburden of the project area. Field methodology was therefore developed to take into account the buried nature of the remains; e.g., the strategies involved in identifying remains and in retrieving information compatible with the project Scope of Work.

There were several constraints specifically involving terrain in the project area. One constraint concerned access to certain portions covered by heavy vegetation. Extensive surface and subsurface inspection of these areas would have involved problems concerning access of personnel and machinery--problems beyond the temporal and financial limits of the Scope of Work. For such portions of the project area, limited pedestrian coverage was determined to be adequate. Another problem concerned certain low-lying portions of the project area which had been locally filled; in some portions, the fill was five meters thick. Breaching the fill to reach the original landscape was determined to be similarly outside the bounds of the current Scope of Work. Another major constraint was high subsurface ground water. In some low-lying portions of the project area, ground water was perched only a few inches beneath ground level. This was found to be a major hindrance to subsurface testing, as seeping ground water would rapidly fill test units and cause trench walls to collapse. Other portions of the project area were marshy and often bog-like; such conditions would not constrain pedestrian coverage, but subsurface testing would be limited due to the inability to operate any mechanical powered equipment in such areas.

During the period July 28-September 11, 1987, PHRI conducted--as part of the survey of the West Loch Estates overall project area (including both Residential Increments I and II, and Golf Course and Parks), limited systematic pedestrian coverage and subsurface sampling, and a combination of vehicular coverage and pedestrian point inspections in the present project area. Field work was greatly facilitated by black-and-white aerial photographs of the West Loch Estates overall project area (approx. scale 1"=400'; R.H. Towill, Photos No.8311-3, [5/13/84], and No.8500-4, [7/26/87]) and a blueline topographic map (scale 1"=200', 4-ft contours; R.H. Towill, based on 7/26/87 aerial photograph). Systematic pedestrian coverage concentrated on very limited portions adjacent to several shallow gullies and drainages and portions adjacent to very steep slopes which, on the basis of the aerial photographs and initial field inspection, appeared to have been least modified by sugarcane cultivation and other activities. A combination of vehicular coverage and pedestrian point inspections was used to check accessible locations throughout the project area, primarily to verify the essentially total modification of the project area in recent times by sugarcane cultivation. Subsurface sampling consisted of facing off vertical exposures and digging shovel pits and short trenches into areas suspected to contain cultural deposits. Excavated fill was processed through 0.25-in mesh to facilitate recognition of cultural remains.

All identified sites were assigned sequential temporary field numbers prefixed with "T-." The location of sites were plotted onto a field copy of the 1"=200' scale topographic map. A standard PHRI site survey record form was completed for each site. Where appropriate, sketch maps of sites were drawn. Sites and features were photographed using 35 mm black-and-white film (PHRI Rolls No.639, 640-641, 643-646). Each site, or the primary feature of each site complex, was marked with blue plastic flagging tape and was tagged with an aluminum tag denoting temporary site number, PHRI project number (87-322), the letters "PHRI," and the date.

Between September 8 and October 23, 1987, PHRI conducted surface and subsurface reconnaissance survey and limited site testing within the Golf

Course and Parks portion of the West Loch Estates overall project area. For the reconnaissance survey, the project area was divided into two areas, which were based on topography and probable presence/absence of buried cultural deposits. One area encompassed the upland margins of the Ewa Plain, while the other area encompassed the upper and lower valley segments. At the request of the RMTC, the project area was further subdivided into discrete survey areas; the boundaries of these areas were assigned arbitrarily, as the areas were intended purely for organizational purposes (see Figure 6). Each unit was ascribed a tentative completion date and served as an indicator of field work progress.

Upper and lower valley segments underwent both pedestrian survey and subsurface testing. The pedestrian survey was limited because of the evidence suggesting the original landscape was buried; survey attempted to identify obvious surface features, such as pondfields, fishponds, and historic structures, and included inspection of ravines, erosional banks and gullies, and areas of apparent extensive disturbance. Subsurface testing in the upper and lower valley segments took place in two phases; the objective of the first phase was to gather preliminary data on the presence/absence, nature, and extent of deposits. Using this preliminary data, a second, more intensive subsurface testing program was formulated.

The first phase was accomplished using a mounted power-auger rig. This apparatus consisted of a gasoline-powered auger with detachable four-inch bits mounted on a mobile dolly. The auger could reach to approximately sixteen feet below surface. While ideally it would have been advantageous to conduct the first phase using a horizontal grid system, or designated transects, terrain characteristics rendered such an approach unfeasible. Much of the upper and lower valley terrain is sectioned into small irregular plots by various obstructive natural and cultural features which made systematic sampling essentially impossible. Rather, auger hole tests were placed at a high-density level around obstructions in places accessible by the power rig. Each auger hole test unit was numbered consecutively, with unit numbers prefixed by the number designating the survey area in which it was located (e.g., Auger Hole Unit 2 in Survey Area 3 was designated 3-2). So far as possible, the stratigraphies of individual units were maintained on standardized forms. Bulk soil samples were extracted from appropriate proveniences for further analysis.

The second, more intensive phase of testing involved using a backhoe; the backhoe was used to dig trenches primarily to expose long stratigraphic sections. Backhoe excavation allowed more detailed recording of subsurface stratigraphy and better provenience control when excavating bulk soil samples. The backhoe trench excavations were also intended to delineate in subsurface matrices the boundaries of suspected agricultural fishponds and pondfields. These boundaries were expected to be in the form of earthen and/or stone walls, and dams and terraces.

One primary field task of the second phase was soil sampling in conjunction with detailed recording of soil profiles. Bulk soil samples were recovered for pollen content analysis and radiocarbon age determination analysis. Samples were recovered in vertical columns--ideally, though not always possible, in 10 cm increments. Vertical provenience was maintained by measurements below ground surface. Samples of subsurface materials from trenches were keyed to the stratigraphic layers from which they came.

Archaeological reconnaissance in the upland margins of the Ewa Plain consisted of a pedestrian survey and subsurface shovel testing. Only a few isolated areas underwent shovel tests; these were mainly areas where vegetation had obscured visibility, thereby necessitating a certain amount of clearing and exposure of the underlying matrix, or where background research had indicated a high probability of buried cultural remains. Shovel testing was deemed unnecessary where sugarcane cultivation had exposed cultural materials at ground surface.

Recording procedures followed a standard format. Recording included photography, scale drawings, site maps, and various standardized forms covering various aspects of the investigations. Identified sites were initially assigned temporary field numbers, and later were assigned permanent Hawaii Register of Historic Places (HRHP) site numbers. Investigations at newly identified sites were limited by the Scope of Work, but surface reconnaissance, shovel unit testing, and backhoe trench testing were intensified in order to produce information sufficient for a preliminary significance assessment of cultural remains. Efforts were made to retrieve basic information on (a) the depth and extent of subsurface deposits, and (b) the nature and integrity of subsurface deposits and cultural remains, and to recover sample materials pertinent to deriving age estimates and cultural affinity.

<u>Post-Field</u>

All materials collected in the field were placed in bags labeled with provenience information and were transported to the PHRI Laboratory at Hilo for appropriate processing and analysis. Artifacts were cleaned and cataloged, and classified according to type and raw material. Scaled drawings and metric and non-metric attributes were recorded onto standard artifact record cards.

The volcanic glass was examined and coded by a trained technician. Absolute age determinations were obtained from volcanic glass hydration-rind measurements and calculations done by MOHLAB of State College, PA.

Analysis of ecofactual samples involved sifting all retained midden through 1/4-inch and 1/8-inch mesh screens. All material retained by the 1/4-inch mesh was completely sorted and identified, while that retained by the 1/8-inch mesh was thoroughly examined for artifacts and faunal remains not present in the 1/4-inch sample.

All shellfish remains were sorted to genera and species, and shellfish weights were recorded by provenience. Vegetal materials were identified to the degree possible, and vertebrate remains when possible were subdivided into class or species. Positive identification of vertebrate remains generally requires an appropriate specialist.

Soil samples were described using standard procedures and terminology set forth in the <u>Soil Survey Manual</u> (Soil Survey Staff 1962). Selected samples were prepared for radiocarbon dating, pollen analysis, and/or qualitative analysis of faunal remains. All samples were preliminarily sorted, weighed, and described in the laboratory prior to submission for analysis. Radiocarbon analysis of charcoal samples was performed by Beta Analytic, Inc. (Coral Gables, FL); pollen identifications was completed by Linda Scott Cummings of PaleoResearch Laboratories (Denver, Colorado); and faunal remains were analyzed in the PHRI laboratory.

FIELD FINDINGS

Archaeological reconnaissance survey and testing in the West Loch Estates - Golf Course and Parks project area was conducted during the period September 8-October 23, 1987 by a crew two to eight persons. The survey and testing included (a) intensive pedestrian survey, (b) test excavation and recording of 176 auger hole units, 81 backhoe trenches, and 98 shovel units, (c) more detailed recording and limited testing of four designated sites, (d) extraction of more than 260 bulk soil samples from backhoe trenches for various analyses, and (e) informal interviews with several local informants.

The basic findings of (a) the surface reconnaissance and shallow subsurface testing and (b) the deep subsurface auger hole and backhoe trench testing are presented immediately following, while individual descriptions for designated site are presented in a subsequent section. Table 2 summarizes the general distribution of subsurface test units according to unit type and Survey Area, while Table 3 presents a more detailed listing of subsurface units which indicates the general nature of findings for each unit.

Table 2.

SUMMARY OF SUBSURFACE TEST UNITS

Test Unit Type	Area 1	Area 2	Area 3	Area 4	Area 5	Total
SHALLOW TESTING						
Shovel Units (SU)	-	-	-	-	98	98
DEEP TESTING						
Auger Holes (AH)	67	13	68	28	-	176
Backhoe Trenches (BT)	18	42	11	10	-	81
TOTAL	85	55	79	38	98	355

SURFACE RECONNAISSANCE AND SHALLOW SUBSURFACE SHOVEL TESTING

As mentioned previously, lower and upper valley portions of the project area underwent only extensive surface reconnaissance. Upland margins of the Ewa Plain, where cultural deposits were determined to most likely occur on or just below ground surface, underwent intensive surface

Table 3.

DETAILED LISTING OF SUBSURFACE TEST UNITS

Test Unit Number	Cultural: Agricultural	Cultural: Habitation	Non-Cultural	Site Designation
AREA 1				
Backhoe Trenches				
1-3	+	-	-	3324
4	-	-	+	-
5-6	+	-	-	3324
7-11	-	-	+	-
12-15	+	-	-	3324
16	-	-	+	-
17-18	+	-	-	3324
Auger Holes				
1	-	-	+	-
2-8	+	-	-	3324
9	-	-	+	-
10-15	+	-	-	3324
16	-	-	+	-
17	+	-	-	3324
18-21	-	-	+	-
22-30	+	-	-	3324
31	-	-	+	-
32	+	-	-	3324
33-37	-	-	+	3324
38-59	+	-	-	3324
60*	-	-	-	-
61	-	-	+	-
62-67	+	-	-	3324
AREA 2				
Backhoe Trenches				
1-3	-	-	+	-
4-5	+(?)	-	-	3324(?)
6	-	-	+	-
7-9	+(?)	-	-	3324(?)
10-15	+	-	-	3324
16	+(?)	-	-	3324(?)
17	-	-	+	-
18	+(?)	-	-	3324(?)
19-21	-	-	+	-
22	-	-	+	-
23-28	+(?)	-	-	3321
29-40	+(?)	-	-	3324(?)
41-42#	-	-	-	-

*Terminated due to impenetrable material.
#Collapsed and filled with water.

Table 3. (Cont.)

Test Unit Number	Cultural Agricultural	Cultural Habitation	Non-Cultural	Site Designation
AREA 2 (Cont.)				
Auger Holes				
1	-	-	+	-
2-3	+	-	-	3324
4-8	-	-	+	-
9-11	+	-	-	3324
12	-	-	-	-
13	+	-	-	3324
AREA 3				
Backhoe Trenches				
1-9	+	-	-	3324
10-11	+(?)	-	-	3324(?)
Auger Holes				
1-2	+	-	-	3324
3*	-	-	-	(?)
4	-	-	+	-
5	+	-	-	3324
6	-	-	+	-
7-11	+	-	-	3324
12-13*	-	-	-	-
14-15	+	-	-	3324
16*	-	-	-	-
17-19	+	-	-	-
20*	-	-	-	-
21-41	+	-	-	3324
42*	-	-	-	-
43-65	+	-	-	3324
66*	-	-	-	-
67-68	+	-	-	3324
AREA 4				
Backhoe Trenches				
1	+	-	-	3324
2	-	-	+	-
3-7	+	-	-	3324
8	-	-	+	3322
9-10#	-	-	-	-
Auger Holes				
1-24	+	-	-	3324
23*	-	-	-	-
26-28	+	-	-	3324

*Terminated due to impenetrable material.
#Collapsed and filled with water.

Table 3. (Cont.)

Test Unit Number	Cultural Agricultural	Cultural Habitation	Non-Cultural	Site Designation
AREA 5 - HOAEAE POINT (SU-1 thru SU-74)				
Shovel Units				
1-4	-	-	+	-
5	-	+	-	-
6	-	+(?)	-	-
7-9	-	+	-	-
10	-	-	+	-
11	-	+	-	-
12	-	-	-	-
13	-	+	-	-
14	-	-	+	-
15-21	-	+	-	-
22	-	+(?)	-	-
23	-	+	-	-
24-25	-	+(?)	-	-
26	-	+	-	-
27	-	-	+	-
28	-	+	-	-
29	-	-	+	-
30	-	+	-	-
31-33	-	-	+	-
34	-	+	-	-
35	-	-	+	-
36-38	-	+	-	-
39	-	+(?)	-	-
40-42	-	+	-	-
43	-	-	+	-
44	-	+	-	-
45-46	-	-	+	-
47	-	+(?)	-	-
48	-	-	+	-
49	-	+(?)	-	-
50-52	-	-	+	-
53-55	-	+	-	-
56-57	-	-	+	-
58	-	+	-	-
59-66	-	+	-	3320
67-68	-	+	-	-
69-73	-	-	+	-
74	-	+		-

Table 3. (Cont.)

Test Unit Number	Cultural Agricultural	Cultural Habitation	Non-Cultural	Site Designation
AREA 5 - SITE 3319 AND IMMEDIATE VICINITY (SU-1 thru SU-24)				
Shovel Units				
1-3	-	+	-	3319
4	-	-	+	3319
5-6	-	+	-	3319
7-10	-	-	+	3319
11	-	+(?)	-	3319
12-15	-	-	+	-
16	-	+	-	-
17-18	-	+(?)	-	-
19	-	+	-	-
20	-	+(?)	-	-
21-22	-	-	+	-
23-24	-	+	-	3319

reconnaissance. Surface visibility was excellent in cleared areas of the upland margins. In areas where the ground surface was covered, a combination of shovel testing and pedestrian survey was necessary. Residential areas and wooded overgrown areas in particular required intensive shovel testing.

Because the upland plains sections of the project area were relatively small, survey and testing was conducted in a careful but non-systematic fashion. Locations for shovel unit tests were based primarily on background research and intuition. Background research had indicated certain portions of the upland plains had a high potential for containing cultural material. Of particular interest were early historic sites in upland margins bordering West Loch. Hoaeae Point in Survey Area 5 was designated as a high probability area, as were upland plain segments bordering West Loch.

Survey Areas 2 and 5 had upland plain segments. Survey Area 2, in the northern portion of the project area, consists mostly of cleared sugarcane fields and eroded surfaces which located on the edges of the bluff overlooking Honouliuli Gulch. Since surface visibility in Area 2 was high, only pedestrian survey was conducted. No significant cultural resources were detected; present were only scattered historic artifacts. Erosion and disturbance in Area 2 was extensive; if any sites had been discovered, it is likely they would have been poorly preserved. Survey Area 5 is predominantly residential, but it also contains sections of extensive vegetation; thus, it underwent both pedestrian survey and shovel testing. A total of 96 shovel units were excavated in Survey Area 5; 74 on Hoaeae Point, and 24 at or in the immediate vicinity of Site 3319. The distribution of shovel units in these two areas is shown in Figures 7 and 8.

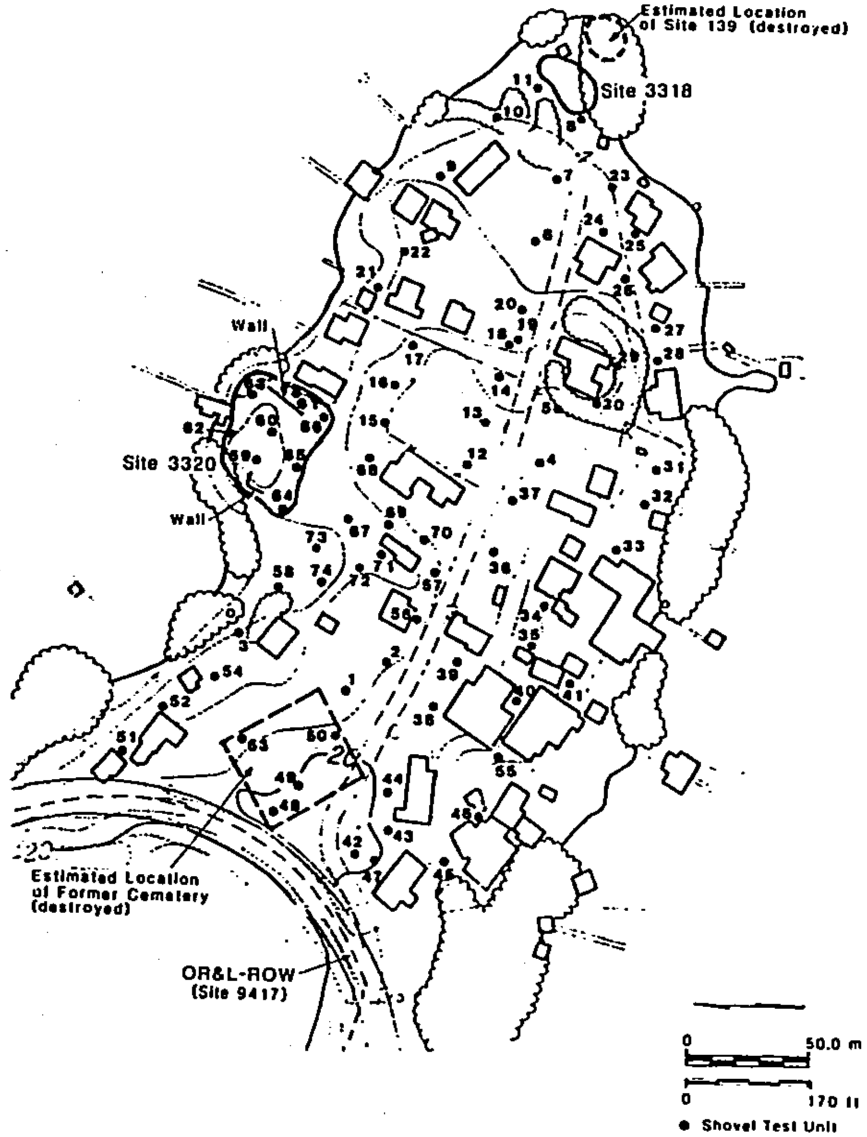

FIGURE 7. DISTRIBUTION OF SHALLOW SHOVEL TEST UNITS ON HOAEAE POINT IN SURVEY AREA 5.

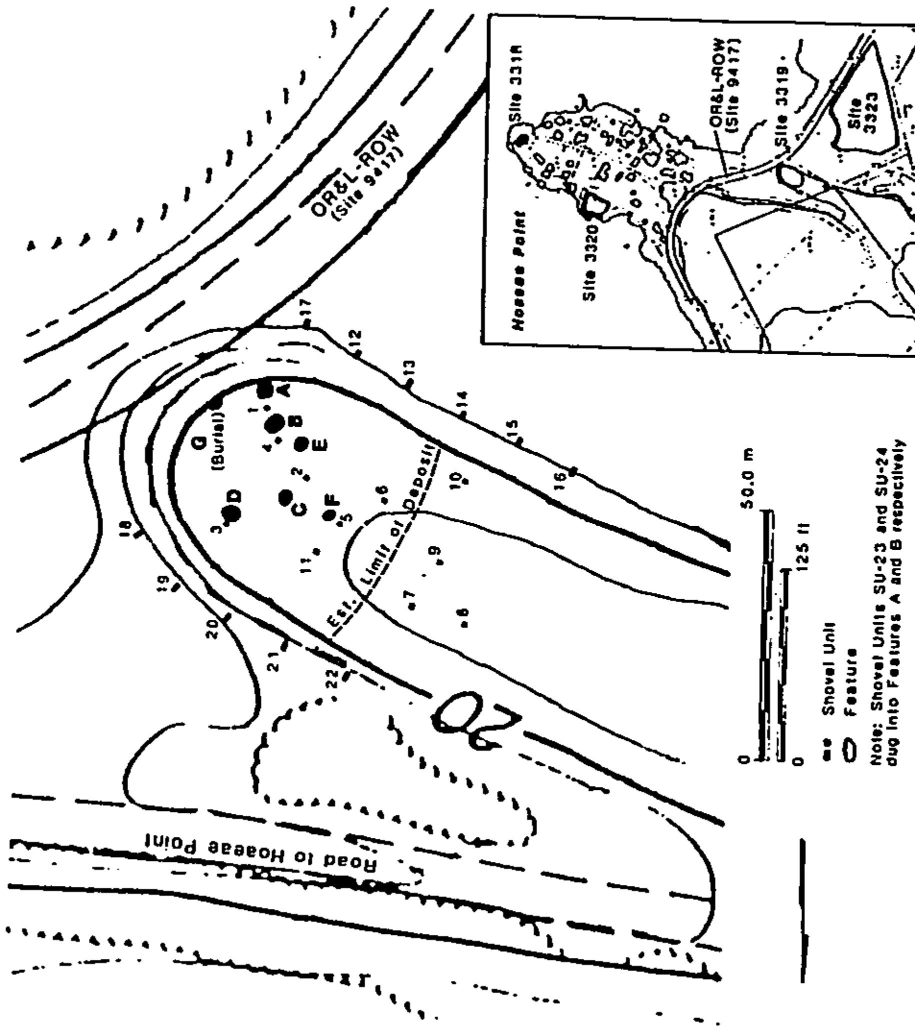

FIGURE 8. DISTRIBUTION OF SHALLOW SHOVEL TEST UNITS AT AND IN THE VICINITY OF SITE 3319 IN SURVEY AREA 5.

Table 2 summarizes the distribution of these tests, and Table 3 summarizes the results of the testing. Appendix D presents detailed stratigraphic descriptions of shovel units.

Inspection of several maps archived in the State Survey Office in Honolulu indicated the presence of fairly dense historic period residential settlement within Survey Area 5. The earliest map, an 1825 map of the south coast of Oahu (Reg. Map No.437), showed good detail of the Pearl Harbor area, and indicated that Hoaeae Point and the immediately adjacent shoreline area to the east were the most densely occupied areas of the entire Pearl Harbor area.

Background documentary research had indicated there were two known sites of potential interest in Survey Area 5, a fishing shrine recorded by McAllister in 1930 (Site 139, Kalanamaihiki Shrine) (1933:108), and a historic period cemetery (Figure 7). In addition, local informants had indicated that perhaps there was a second historic period cemetery and church site present on the low bluff overlooking the OR & L-ROW (Figure 8). Surface reconnaissance failed to relocate the fishing shrine. According to McAllister's description and map, the site should have been situated at the extreme eastern end of Hoaeae Point in Survey Area 5. Careful inspection of the eastern end did reveal several large basalt boulders, but these appeared to have been used as landfill--they were accompanied by fragments of concrete and miscellaneous building material. The purported area of the shrine appeared to have been cleared of vegetation in the recent past. Also present in the area were a small boathouse and a dock. It appears that Site 139 has been destroyed since McAllister observed it over 50 years ago.

A 1928 USGS 7.5 minute series quadrangle map ("Waipahu, Hawaii") indicated there was once a small unnamed cemetery near the neck of the Hoaeae Point. The neck of the point is presently occupied by residential houses and landscaped yards and gardens. Surface reconnaissance was conducted in the area. Again, the results were largely negative. It appeared that formal remnants of the cemetery had been removed. Only a single marble tombstone fragment was discovered; apparently it had been bulldozed into or had been discarded in a small rubbish pile. On the fragment, in Chinese script, was engraved an incomplete inscription. Following the surface inspection, intensive subsurface testing by shovel units and hand-operated bucket auger was conducted. In addition to the four shovel units that were dug, a series of quick bucket auger holes were dug spaced roughly 2.0 m apart over the entire reported location of the cemetery. Again, results were entirely negative. The reconnaissance and subsurface testing indicated the reported area of the cemetery had been substantially altered. Shovel tests indicated that there was no well-developed, old, stable ground surface present in the area. A "berm" or soil bank was discovered in an adjacent area; apparently this berm was part of the original landscape. The berm stood a full meter above the surrounding terrain, suggesting that at least a meter of fill had been removed from the reported cemetery area.

Interviews with local informants proved more productive. Several older residents of the Honouliuli area remembered the cemetery, and they described it as a "Chinese cemetery" containing "many" graves marked with "large" tombstones. According to the informants, the cemetery existed until WWII. During the war, the military "removed" the grave markers and leveled the cemetery, along with much of the point. Informants did not know if the graves were disinterred and relocated, but results of shovel unit and bucket auger testing suggested that they had been. Furthermore, the overall results of the shovel testing strongly suggested that the same WWII occupation and modification of the point had largely eradicated evidence of prior prehistoric and early historic period occupation that the early maps of the area had indicated might be expected.

DEEP SUBSURFACE AUGER HOLE AND BACKHOE TRENCH TESTING

As previously discussed in the description of the project area, the valley bottom portions of the project area are characterized by a thick mantle of alluvial and colluvial clay. This distinctive, wide-spread mantle is a recent phenomenon, having been deposited during the late 19th through 20th centuries. The former land surfaces of the lower and upper valley segments of the project area are, of course, buried beneath this mantle. Historical documentary research indicated that nearly the entire valley floodplain was once used for pondfield agriculture. In order to determine the presence or absence of archaeological remains associated with these former land surfaces, deep subsurface testing, using power-driven auger and backhoe, was conducted.

One hundred seventy-six (176) auger holes, and 81 backhoe trenches were excavated. Table 2 summarizes the distribution of these tests, while Table 3 summarizes the results of the testing. Appendix E presents detailed stratigraphic descriptions of backhoe trenches.

In Survey Area 1 (lower valley segment), 67 auger holes and 18 backhoe trenches were excavated. The distribution of these tests is shown in Figure 9. Of the 67 auger tests, 56 revealed gleyed sediments interpreted as possible pondfield deposits. Backhoe trenching revealed gleyed probable pondfield deposits in eleven trenches (Fig. 10). Six trenches in Survey Area 1 did not contain gleyed deposits. These trenches were located along the southeastern edge of the valley floor in areas which apparently were never used for pondfield agriculture.

Thirteen auger (13) holes and 42 backhoe trenches were excavated in Survey Area 2. The distribution of these tests is shown in Figure 11. Relatively few auger cores were placed in Survey Area 2 because impenetrable materials, presumably rocks, were frequently encountered, particularly in the upper valley segment of Survey Area 2. Two backhoe trenches were excavated in the lower valley portion of Survey Area 2; both immediately filled with water and collapsed upon excavation. Of the seven auger tests conducted in the lower valley portion of Survey Area 2, four units revealed gleyed deposits. Backhoe trenching in the upper valley portion of Survey Area 2 revealed probable buried pondfield deposits in seven trenches and possible pondfield deposits in 19 trenches (Figs. 12 and 13). In addition, six backhoe trenches encountered a stratified cultural deposit subsequently designated Site 3321 (see Site Description section).

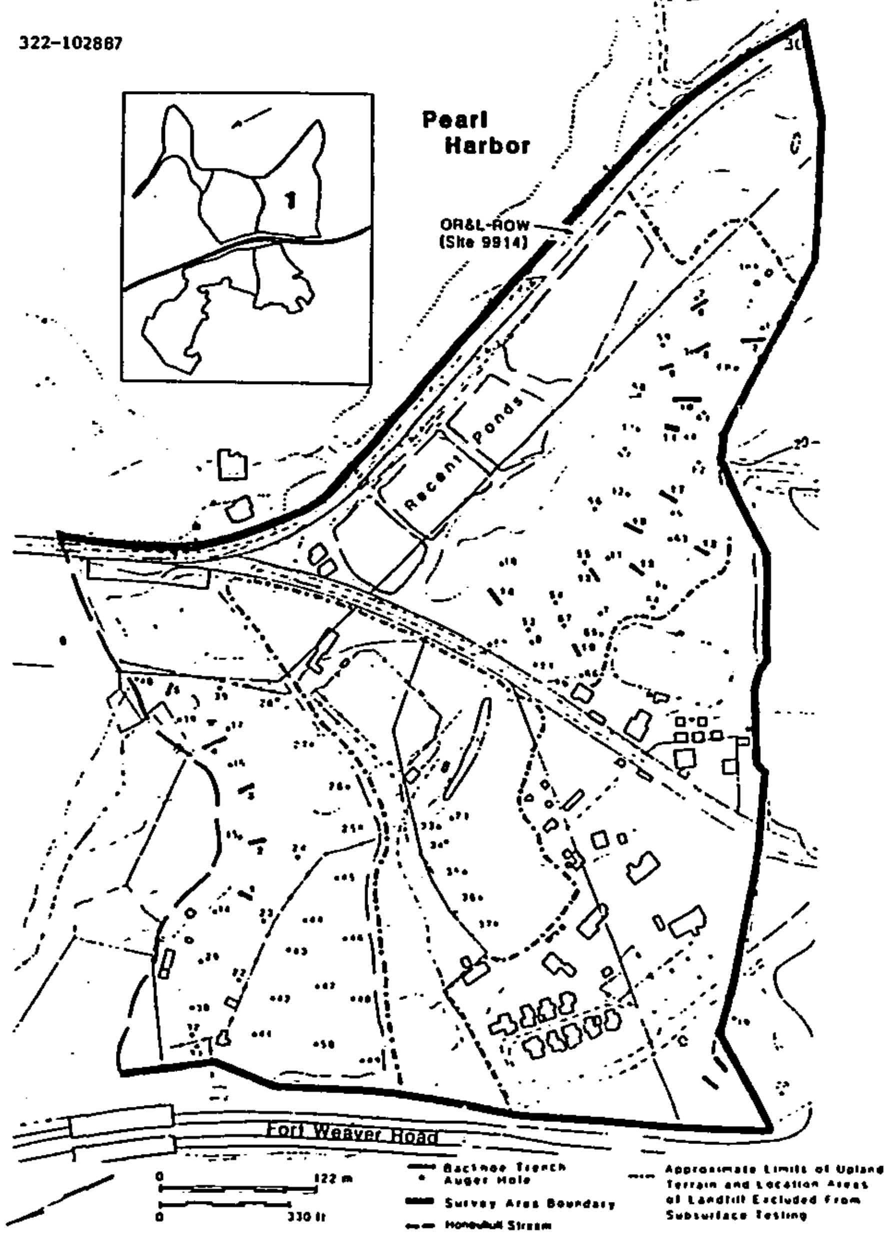

FIGURE 9. DISTRIBUTION OF DEEP AUGER HOLE AND BACKHOE TRENCH TEST UNITS IN SURVEY AREA 1.

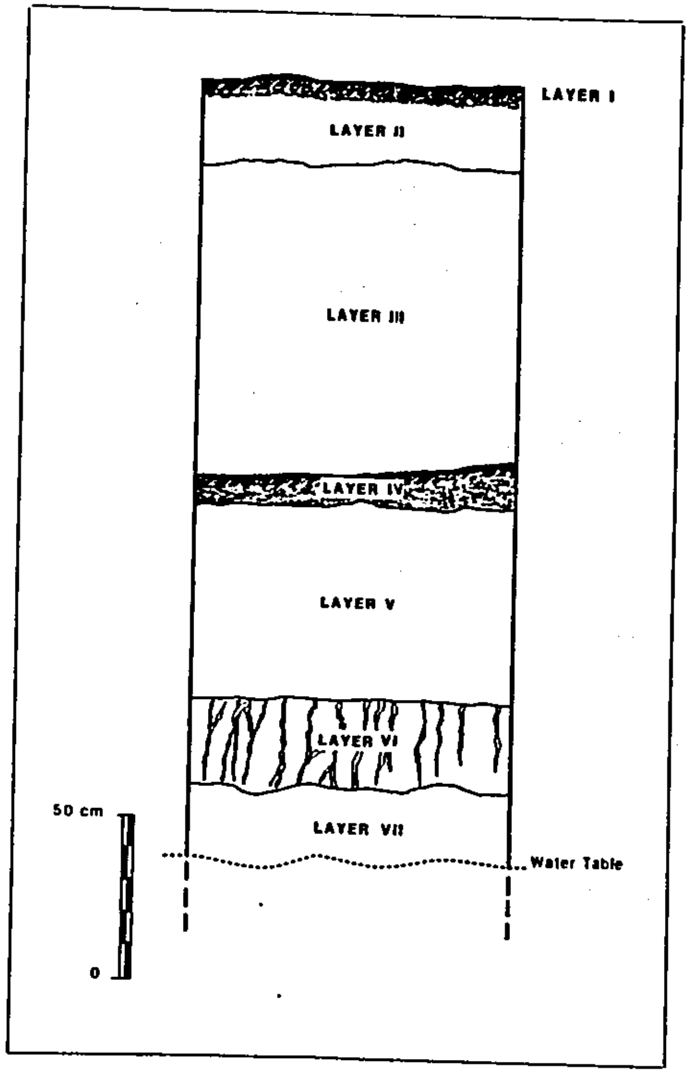

FIGURE 10. PROFILE OF BACKHOE TRENCH 8 IN SURVEY AREA 1. A TYPICAL LOWLAND AGGRADED AND FILLED PONDFIELD. NOTE ROOT-CAST MOTTLING IN LAYER VI.

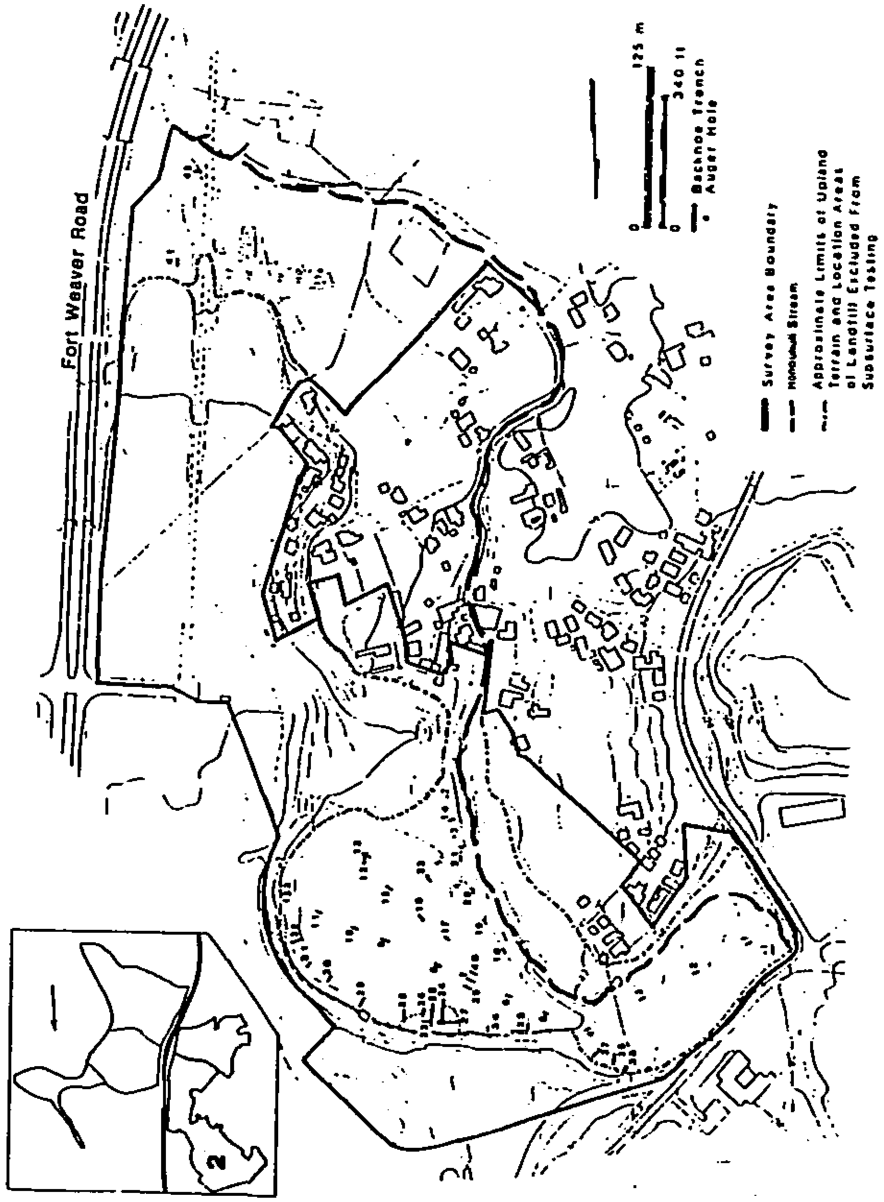

FIGURE 11. DISTRIBUTION OF DEEP AUGER HOLE AND BACKHOE TRENCH TEST UNITS IN SURVEY AREA 2.

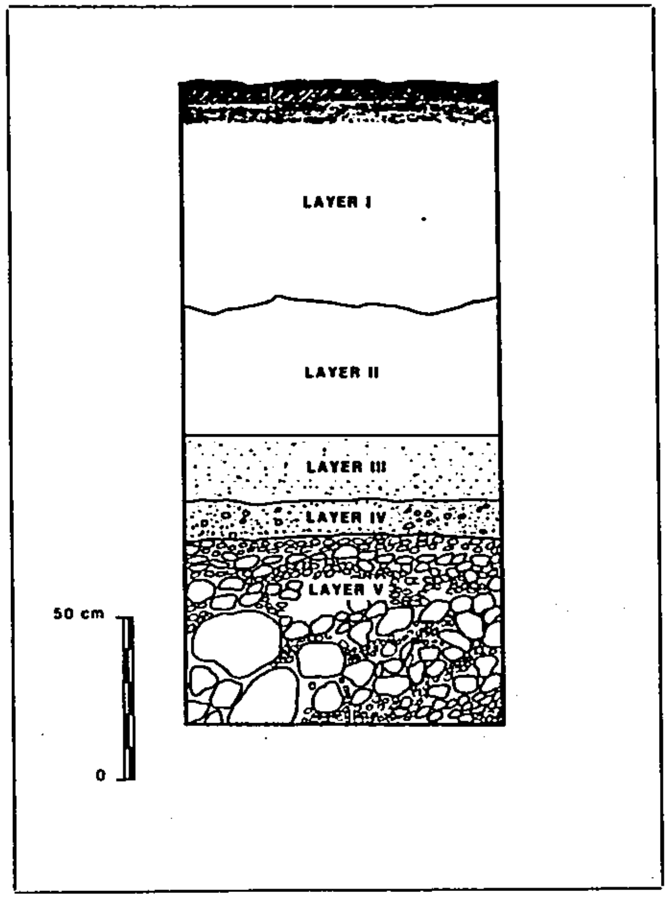

FIGURE 12. PROFILE OF BACKHOE TRENCH 16 IN SURVEY AREA 2.

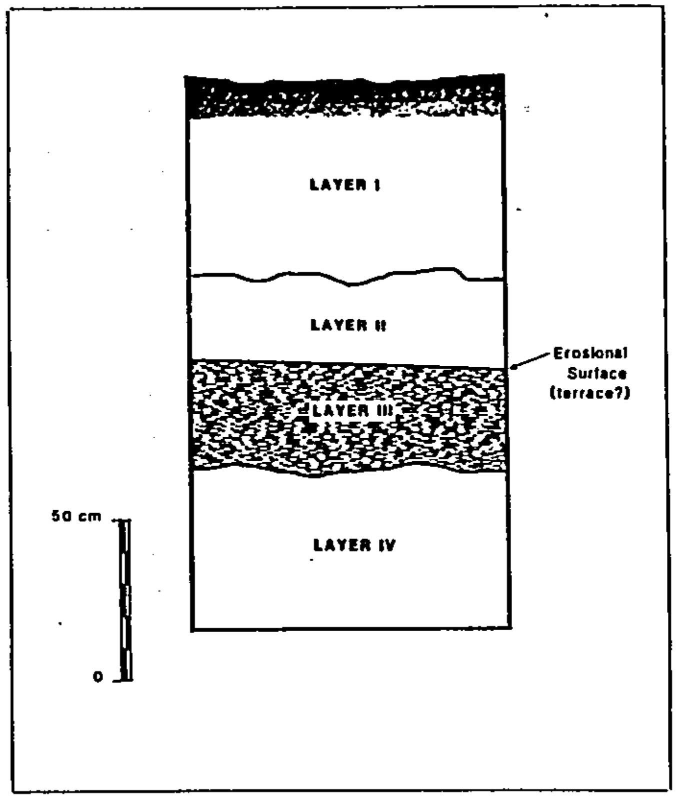

FIGURE 13. PROFILE OF BACKHOE TRENCH 17 IN SURVEY AREA 2, ILLUSTRATING POTENTIAL ALLUVIAL TERRACE. SITE 3321 OCCUPIES A PORTION OF THIS BURIED TOPOGRAPHIC FEATURE.

In Survey Area 3, 68 auger holes and 11 backhoe trenches were dug. Figure 14 shows the distribution of these tests. Except for Backhoe Trenches -10 and -11, which filled with water and collapsed immediately after excavation, nearly all of the test excavations in Survey Area 3 yielded probable evidence of former pondfield cultivation. The two collapsed trenches were excavated in to what appeared to be a buried deposit of recent refuse.

Twenty-eight (28) auger holes and 10 backhoe trenches were excavated in Survey Area 4. The distribution of these tests is shown in Figure 15. Probable pondfield deposits were encountered in 26 auger tests. Seven backhoe trenches contained gleyed deposits. Three backhoe trenches were excavated into a buried fishpond, Site 3322. The results of the latter three excavations are discussed in the Site 3322 site description.

The distribution of deposits interpreted as representing pondfields closely corresponds with the historically documented distribution of pondfields in Honouliuli Valley. These deposits are further discussed in the Site 3324 site description.

DESIGNATED SITES

Based on the findings of the surface reconnaissance and shallow subsurface shovel testing, and the extensive deep subsurface auger hole and backhoe trench testing, seven newly identified sites were formally designated within the project area. These sites are summarized in Table 4 according to HRHP site number, formal type, tentative functional interpretation, significance evaluation mode, appropriate tasks for subsequent field work, and miscellaneous comments. Individual site locations have been shown on previously referenced Figures 7, 8, 9, 11, 14, and 15.

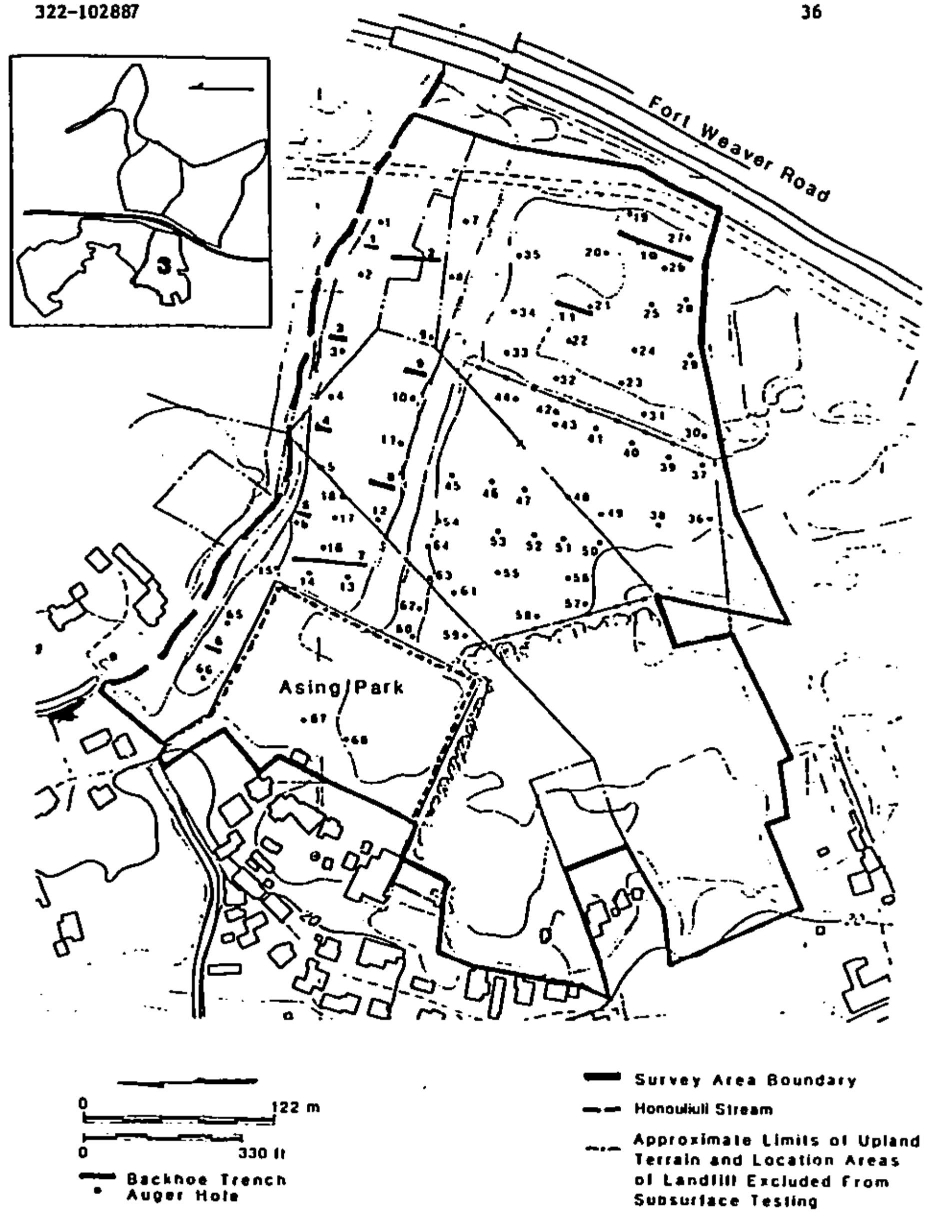

FIGURE 14. DISTRIBUTION OF DEEP AUGER HOLE AND BACKHOE TRENCH TEST UNITS IN SURVEY AREA 3.

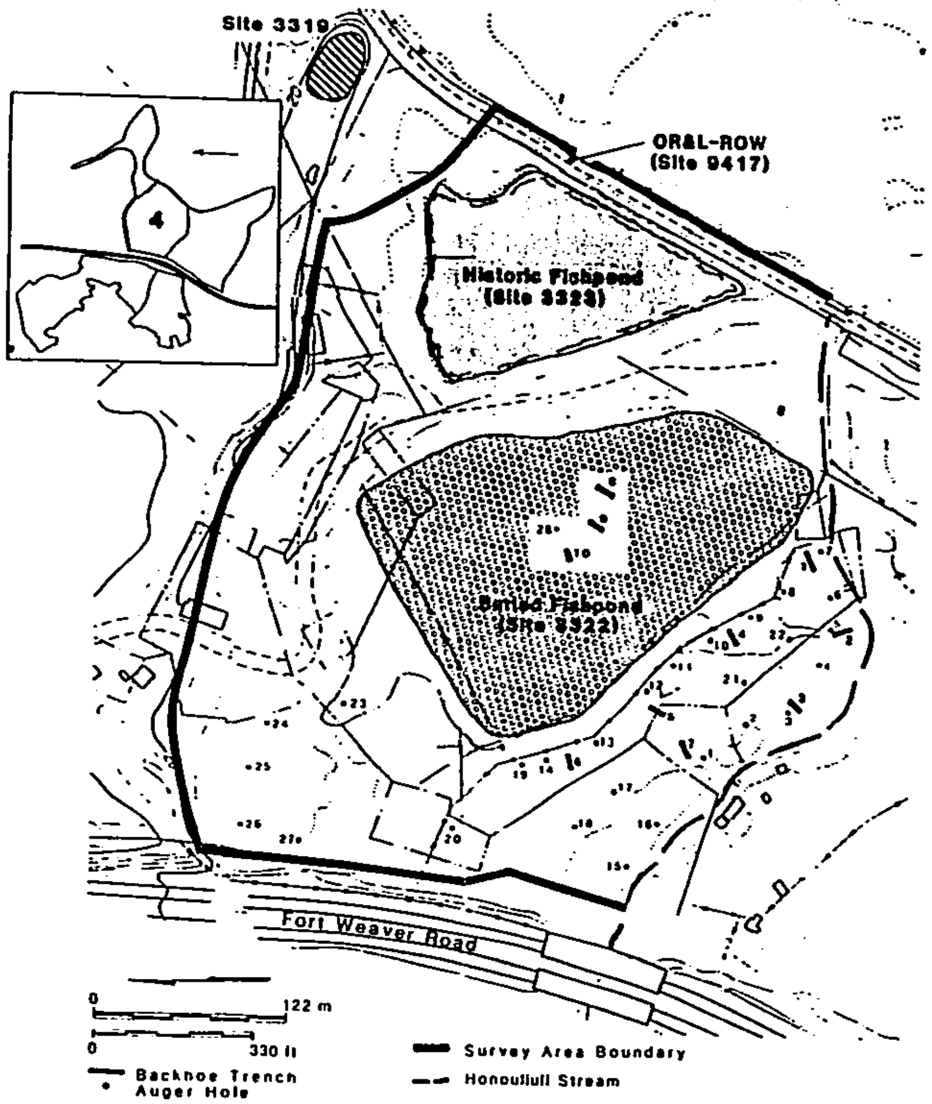

FIGURE 15. DISTRIBUTION OF DEEP AUGER HOLE AND BACKHOE TRENCH TEST UNITS IN SURVEY AREA 4.

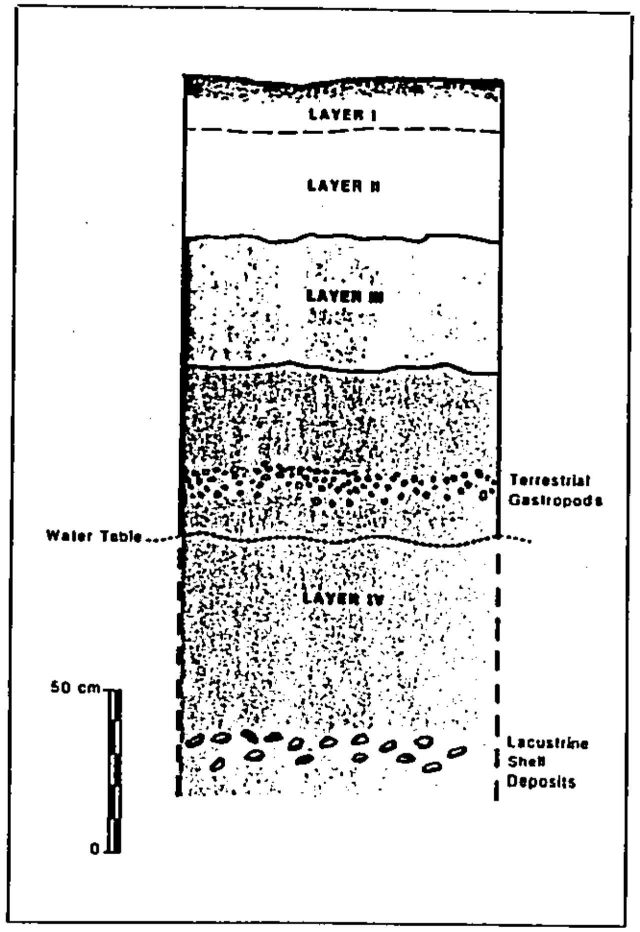

FIGURE 16. PROFILE OF BACKHOE TRENCH 8 IN SURVEY AREA 4. TYPICAL OF AGGRADED FISHPOND DEPOSITS.

Table 4.

SUMMARY OF SITES NEWLY IDENTIFIED WITHIN THE WEST LOCH ESTATES – GOLF COURSE AND PARKS PROJECT AREA

HRHP Site 50-12-xx- & Feature	Formal Site/Feature Type	Tentative Functional Interpretation	*Significance Evaluation R	I	C	#Field Work Tasks DR	SC	EX	Comments
AREA 2									
3321	Cultural deposit	Habitation/ burial	H	L	L	+	–	+	Two cultural layers (min.); human burial
AREA 4									
3322	Buried fishpond	Agricultural	H	L	L	–	–	+	Shown on 1878 and 1897 maps
3323	Historic fishpond	Agricultural	L	M	L	+	–	–	Created in 1890s by OR & L-RR construction
AREAS 1-4									
3324	Buried pond-field system	Agricultural	H	L	L	+	–	+	Limits undetermined; entire system buried
AREA 5									
3318	Surface historic artifact concentration	Habitation	M	L	L	+	–	+	Poss. remnant cult. deposit
3319	Complex (7) A-Rock pile B-Rock pile C-Rock pile D-Rock pile E-Rock pile F-Rock pile G-Burial	Habitation/ burial	H	L	H	+	–	+	Remnant cult. deposit; poss. hist. church and cemetery site; human burial
3320	Cultural deposit	Habitation	H	L	L	+	–	+	Prehist. and hist. deposit

*Significance Evaluation—Nature: R = scientific research, I = interpretive, C = cultural; Degree: H = high, M = moderate, L = low.

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

SITE DESCRIPTIONS

SITE 3318 – Surface Historic Artifact Concentration

Site 3318 is located in Survey Area 5 near the east end of Hoaeae Point (Figure 7); it consists of a surface concentration of 19th century artifacts distributed over an area of approximately 375 sq m. The surface of Site 3318, in contrast to the surrounding area of soil deposits, consists of exposed reef rock with scattered pockets of alluvial sandy loam. Examination of the site suggested that there was only a low probability that the site contained much in the way of intact subsurface deposits. The historic artifacts present were on a deflated surface; this indicated that they were either part of an original landscape that had largely eroded away--leaving only shallow discontinues pockets of soil, or were transported into place--perhaps from the nearby upland margin of the Ewa Plain. In addition, the site was less than 25 cm above sea level, suggesting it would have been unsuitable for habitation.

To define with more certainty the limits of Site 3318, Shovel Units 8, 10, and 11 were excavated in the immediately adjacent area containing soil deposits. Coral-shell reef was encountered at 10 cmbs in SU-10 and at 35 cmbs in SU-11. Shovel Unit 10 consisted of light brown sand and marine and brackish water shell. The soil recovered from SU-8 and -11 was comprised of a loose, brown sandy loam, probably alluvial in origin. Shovel Unit 8 contained shell and flecks of charcoal. Given the conditions at the site, no further subsurface testing was conducted.

Surface artifacts collected at Site 3318 included a variety of historic period ceramics and bottle glass. Although no detailed analysis of the artifacts was undertaken, and thus a more definite time-frame for the site is lacking, preliminary analysis indicated that at least some of the artifacts date to the 19th century and may be associated with early historic settlement in the area.

SITE 3319 – Habitation Deposit and Possible Cemetery

Site 3319 is located in the upland margins of the Ewa Plain, in Survey Area 5, on a narrow ridge-nose which overlooks the shoreline of West Loch (Figure 8). It is bounded to the south by the lower valley section of Honouliuli Gulch and is separated from Hoaeae Point, located to the north, by a wide ravine. The crest of the ridge-nose on which Site 3319 is located stands approximately 20 feet above the surrounding lower valley section, and the ridge west of the site merges with the main expanse of Ewa Plain. The margins of the ridge-nose are steep, near-vertical bluffs of exposed, weathered bedrock. A small talus has formed at the base of the bluffs. At the foot of the easternmost extension of the ridge-nose is an elevated occasionally used dirt road. This road, which runs north--south across the eastern boundary of the project area, was originally the grade-bed of the Oahu Railway & Land Company (OR & L) railroad bed, which was constructed in the early 1890s. Across the neck of Hoseae Point is a grade-cut for the railroad bed which transects the point. These two sections originally formed a continuous railroad corridor. Apparently the ridge-nose on which Site 3319 is located originally extended further eastward, but was removed to accommodate the railroad corridor.

Site 3319 is presently covered with relatively dense vegetation. Large trees indicate that the site has not been cleared for a considerable period of time. At the western end of the site is a series of small livestock pens (pigs) associated with the currently occupied residential structure somewhat further inland.

Site 3319 was first identified during the surface reconnaissance of the upland portion of the project area. A number of small rock piles or cairns comprised of loosely piled waterworn basalt cobbles and boulders were observed on the apex of the ridge-nose (Figure 8). Inspection of the immediate area of the piles revealed a human burial (Feature G) eroding out of the upper face of the cut overlooking the railroad bed at the eastern end of the site (Figure 8). Marine, brackish-water, and terrestrial shell midden was observed scattered across a wide area at the eastern end of the ridge, as well as being exposed to a depth of several centimeters in the eroded face of the cut overlooking the railroad bed.

Limited shovel testing at Site 3319 involved recording surface features and excavating shovel units to assess the depth and extent of the cultural deposits (Figure 8). Six surface features (A-F) and a single human burial (G) were recorded and mapped. All six surface features were relatively small, and appeared to be distributed in no discernible pattern. Feature A, the largest, measured 2.17 m (NW/SE) by 1.21 m (NE/SW) by a maximum 35 cm high (Figure 17). Feature E, the smallest feature, measured approximately 0.85 m in diameter by 30 cm high. Lying on the ground near Feature D was a small wooden cross constructed of two narrow slats of wood. The cross was obviously not of appreciable age, but it suggested that the cairns may have functioned as grave markers. This seemed especially likely in the light of the exposed human burial noted earlier.

Thirteen 0.5 m sq shovel test units (SU-1 thru -11, -23, and -24) were excavated on the ridge-nose. In addition to testing the top of the ridge-nose, a series of eleven 1.0 by 0.5 m shovel test units (SU-12 thru -22) was excavated the talus around the base of the ridge. One early historic period map (1825, State Survey Office Reg.Map No.437) had indicated that several apparent habitation structures were once present within the vicinity of the talus. The precise locations of the structures was not known; however, it seemed likely they could have been buried under the talus. The test findings for all 24 shovel units are summarized in Appendix D, and their locations indicated on Figure 8, which also shows the apparent inland extent of the cultural deposit present on the ridge-nose. As two age determinations are available from one of the shovel units in this deposit, SU-1 is described in some detail below.

Figure 17. SITE 3319, FEATURE A. Rock pile. View to S. (PHRI Neg.640-30a)

SU-1 was located immediately adjacent to Feature A. The first layer encountered in SU-1 measured five centimeters thick and was comprised of a thin overburden of decomposing forest litter and other unconsolidated organic debris; within this debris were a number of marine shell fragments. The second layer, which extended from five to 50 cmbs, consisted of a compact, dark brown loamy soil which contained large amounts of shell, marine invertebrates, and scattered waterworn basalt pebbles and cobbles. At 30-38 cmbs, a thin ashy deposit and a concentration of fire-cracked rock, the apparent remains of a hearth, was discovered. A sample extracted from the concentration yielded a radiocarbon age determination having two probable ranges, AD 1681-1741 and AD 1800-1940 (PHRI Sample No.RC-357). A single piece of volcanic glass recovered immediately below the hearth, at 40-50 cmbs, yielded a hydration-rind age determination of AD 1788-1828 (PHRI Sample No.VG-720). At 50 cmbs a hard, compact reddish-brown clay loam was encountered; this loam appeared to be sterile. SU-1 was terminated at 55 cmbs.

Two test units (SU-23 and-24) were excavated in the rock piles atop the ridge-nose, one each in Features A and B. As mentioned previously, the piles or cairns were suspected to be possible grave markers, perhaps markers associated with a 19th-century cemetery and church which were said by several local informants to have been located somewhere in the area of Site 3319. Both tests yielded cultural debris from the deposit on the ridge, but neither were found to overlie graves.

The results of the limited testing at Site 3319 were inconclusive in terms of determining the function of the six cairns. Local informants had indicated that in the early 20th century a church had stood slightly to the west of Site 3319. Another church was rumored to have been located near the end of the ridge-nose, within the immediate vicinity of Site 3319. Informants also suggested that a historic cemetery was once located within the site area, although a search and inspection of early maps and records of the area produced no such evidence of this. The exposed human burial (Feature G), the crude wooden cross (grave marker), and the two human teeth recovered from the test units, however, gave credence to the comments of the informants.

The cultural remains encountered at Site 3319 also yielded evidence that it may have functioned as a habitation site, possibly during the prehistoric period. Shovel Units-6, -8, -10, and -11 all yielded marine and brackish-water shellfish remains, fish bone, and charcoal; the hearth-like feature in SU-1 also suggests the site was used for habitation. Although the test units yielded few artifacts, a single volcanic glass flake in SU-1 at least suggests habitation.

The subsurface feature discovered in SU-5, a large coral boulder packed in a tight matrix of waterworn basalt cobbles and pebbles at a depth of c. 18 cmbs, is something of an enigma. Because it was mainly constructed of basalt cobbles and because it lies beneath the ground surface, it may have been some kind of structure foundation, possibly for a structure associated with the possible church. With the limited amount of testing conducted thus far, however, it would be presumptuous to

formulate a definite conclusion concerning the feature configuration, function, and age.

As mentioned previously, the early historic period maps of the project area indicates that there were a number of structures located in the vicinity of Site 3319. In particular, an 1825 map depicts a large number of structures and agricultural fields surrounding and possibly on the ridge-nose. Testing along the base of the upland escarpment, however, failed to produce any evidence of such features, or evidence of any other cultural remains. It appears that Site 3319 is restricted to the top of the ridge-nose, and the restricted inland extent of the cultural deposit further suggests it likely to be the inland remnant of a once larger site atop the ridge that was truncated by the construction of the OR & L grade immediately adjacent to the seaward side.

SITE 3320 - <u>Habitation Deposit</u>

Site 3320, located on the north side of Hoaeae Point in Survey Area 5, overlooks an inlet located on the west side of West Loch (Figure 7). The general area surrounding the site is primarily residential; the actual site area occupies, for the most part, a small clearing on the north face of a small knoll. East, west, and south of Site 3320 are residential houses; in the immediate vicinity of the site are a number of shacks and outbuildings. Activities associated with the construction of the shacks and outbuildings, and other recent activities, have probably destroyed or disrupted portions of the site. Midden was observed exposed on the ground surface and in eroded areas.

Site 3320 measures approximately 1,800 sq m, although its original extent was probably larger. Features present at the site included surface midden and artifacts, and two segments of stone wall. The stone wall sections are built into the west and east sides of the knoll. The sections do not appear to be structure foundations; they may have functioned as retaining walls.

Shovel testing at Site 3320 revealed several areas of buried intact cultural deposit. Eight shovel units (SU-59 thru -66) provided the basis for defining the approximate limits of Site 3320. The test findings for these shovel units are summarized in Appendix D, and their locations indicated on Figure 7, which also shows the estimated extent of the cultural deposit present.

The shovel testing indicated the subsurface configuration of Site 3320 to be relatively uniform. Shovel tests consistently encountered an A-horizon containing an upper midden deposit comprised of large amounts of shell and smaller amounts of charcoal, ash, fire-cracked rock, bone, and artifacts (both prehistoric and historic types). In every unit, the A-horizon rested on top of a well-defined subsoil characteristically upland plain in type. This subsoil was found to be consistently devoid of cultural remains.

Cultural remains on the surface of Site 3320 were similar to the remains observed in the shovel units—a large amount of shell material was present on open exposed areas, and surface artifacts were generally scarce. Of the surface artifacts collected, a stem and bowl fragment of a clay pipe found near the center of the site is potentially important. The small size of the fragment precludes dating it precisely, but the fragment probably dates to the early half of the 19th century.

Given the information provided by the present investigation, it is not possible to date Site 3320 precisely. The fact that few artifacts were recovered at the site and historic artifacts were generally absent perhaps supports a late prehistoric/early historic period occupation. An adze fragment recovered from SU-59 also supports a prehistoric age, as do the various prehistoric artifacts stated by local informants to have been recovered from the general area of the site. In contrast, the clay pipe fragment is obviously early historic, the wall segments are probably historic, and an 1825 map of Pearl Harbor indicates contemporary occupation on Hoaeae Point. Thus, the evidence indicates two time frames for the site—a late(?) prehistoric frame and an early historic frame. The integrity of and the stratigraphic separation of these two time frames remain to be demonstrated by additional work; however, on the basis of the present evidence, it would seem that perhaps a transitional occupation is indicated.

SITE 3321 - <u>Habitation Deposit</u>

Located in Survey Area 2 (see Figure 11), Site 3321 was discovered during the random backhoe trench testing. The backhoe trench initially exposed a substantial midden deposit. Once the deposit was verified, excavation with the backhoe continued in order to delineate the extent of the deposit. Based on the series of six backhoe trenches dug in the site area (BT-23 thru -28), the subsurface deposits were estimated to comprise an area approximately 450 sq m (Figure 18). In the process of excavation, a possible stone wall section and a human burial were found. Hand and backhoe excavation minimally expanded the area around these features so as to assess better their integrity and nature. Site 3321 was found to be a buried habitation site with at least two stratigraphic components, structural remains, subsurface features, at least one human burial, portable artifacts, and fairly abundant midden remains.

The terrain in the general vicinity of the Site 3321, typical of the upper valley segment, is comprised of abrupt upland margins which bound a level floodplain; through the flood plain runs deeply entrenched Honouliuli Stream (see Figure 11). The terrain specific to the site is a recently worked sugarcane field. The site is bounded on the north by steep bluffs of the upland plain, on the south by a narrow level floodplain which extends several hundred meters to Honouliuli Stream, and on the east and west by the level valley floodplain, which expands along the margins of the valley and gradually slopes eastward towards the lower valley section of the project area.

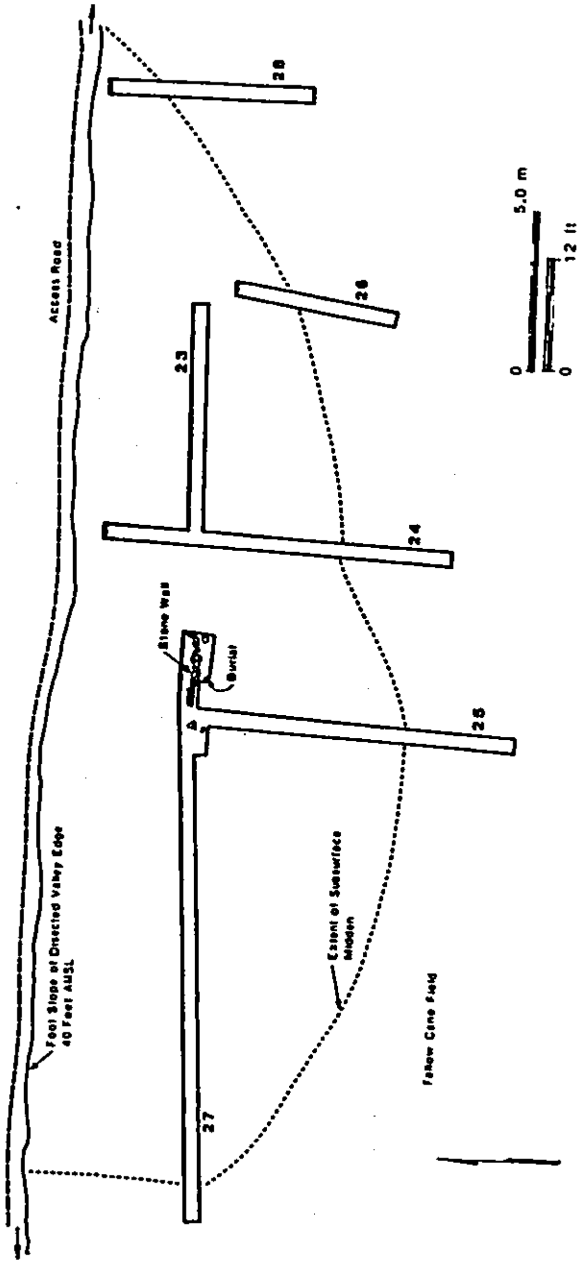

FIGURE 18. PLAN MAP OF BACKHOE TRENCHES AND MAJOR FEATURES OF SITE 3321.

Most of Site 3321 was buried beneath a thick overburden of recently deposited alluvium and colluvium. This overburden varied in thickness across the site, ranging from 1.0 to 1.5 m deep; thus, despite the optimum exposure of the site surface due to recent plowing, no artifacts directly related to the cultural deposits at the site were noted on the surface. However, there was present on the surface a relatively abundant scatter of mostly historic artifacts--probably from small settlements which occupied the immediate area and the peripheries of the adjacent upland margins during the late 19th and early 20th centuries. The few prehistoric artifacts found on the surface of the site area may have derived from the buried cultural deposits; there were indications that plowing had minimally disturbed at least one small area of the deposits.

The soil stratigraphy of Site 3321 is somewhat complex (Figure 19). Layer I, a thick mantle of compact reddish-brown clay, covers the site completely. The upper portion of this mantle has been altered by cultivation and plowing. The lower portion, however, is mostly intact. Layer I is probably mostly derived from the previously mentioned man-induced soil transportation effort which occurred in the Waianae Range during the late 19th century; the soil is therefore of recent colluvial and alluvial origin. Excepting the few predominantly historic artifacts recovered from it, the layer appears to be culturally sterile.

Layer II was a thin cultural deposit of very dark grey clay loam which contained variable amounts of charcoal, ash, bone, shell, fire-cracked rock, and artifacts. Discernible within the layer were features which intruded into the layer from underlying soil layers.

Layer III was a compact sterile reddish-brown clay nearly identical in appearance and composition to the undisturbed portion of Layer I. Layer III probably originated a way similar to Layer I.

Layer IV, a cultural deposit very similar to the Layer II deposit, occurs in restricted areas of the site. Layer IV is comprised of a dark greyish-brown loamy soil with a high organic content. It contains variable amounts of shell, bone, charcoal, ash, fire-cracked rock, and artifacts.

Layer V is a crumbly, sterile, very light grey silt-clay deposit. At the present level of investigation--without detailed chemical and physical analyses, it is difficult to determine the pedogenic origin of the layer. The layer is possibly the result of post-depositional eluviation and leaching, and natural accumulation of calcium carbonate.

Layer VI is comprised of highly consolidated, very old and weathered dark brown clay deposits. Layer VI may represent remnants of stream terraces. Backhoe excavation was terminated within Layer VI at a maximum 3.5 m below surface.

Trench testing revealed within stratigraphic sections a variety of subsurface features--a human burial, trash pits, firepits, possible earth ovens, post holes, ash lenses, charcoal concentrations, a possible living floor, and a number of other pits of indeterminate function. The majority

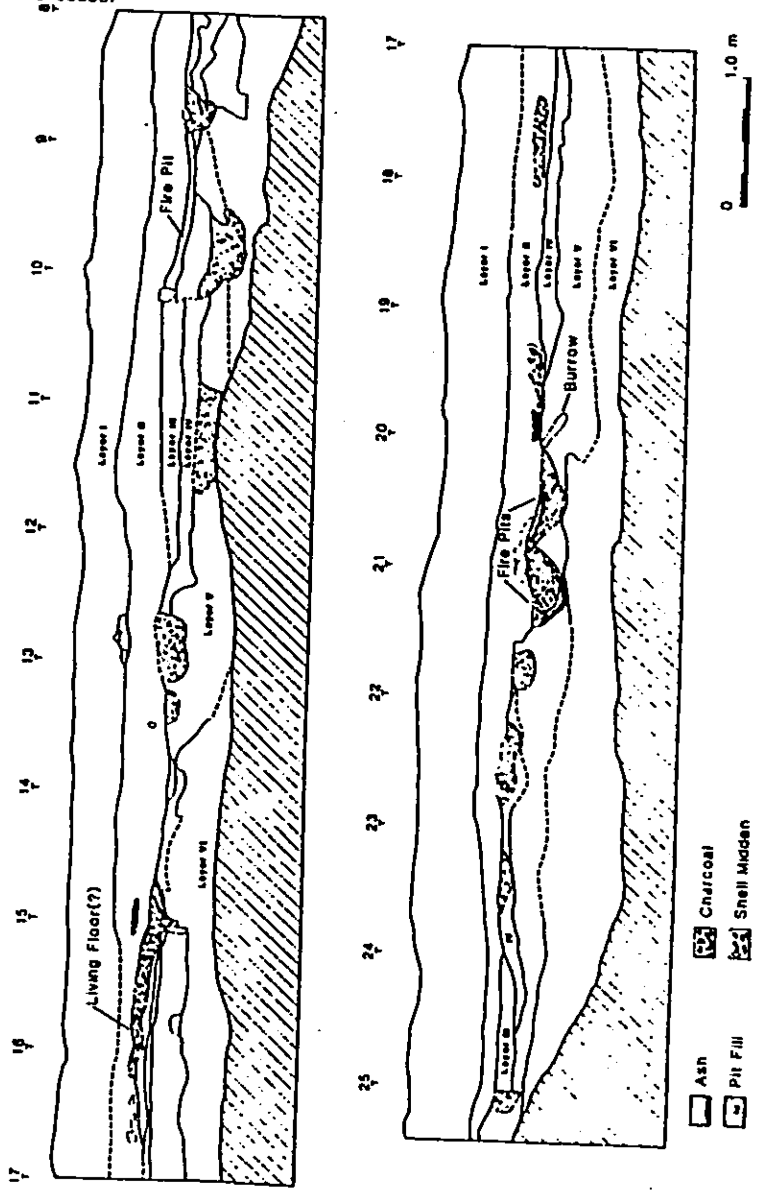

FIGURE 19. PROFILE (WEST FACE) OF BACKHOE TRENCH 27 AT SITE 3321.

of the subsurface features appear to originate in Layer II and intrude into Layers III and/or IV. A crude stone alignment—possibly a wall section—oriented roughly east-west was encountered at the easternmost end of BT-27.

Interpreting the depositional history and development of Site 3321 from available evidence is somewhat conjectural. However, it appears that three major events are represented in the stratigraphic soil profile of the site. These events (series) are described below.

Series I. Layers I and III represent the latest depositional series; they are products of natural and man-induced erosion. This erosion has been discussed in detail in the earlier Project Area Description section. The eroded/transported soils from the upland slopes have adrogate low-lying valley sections of the project area with alluvium and colluvium. The extent to which soils have been aggraded is dependent upon the slope and gradient of the individual areas. In upper valley segments of the project area, where Site 3321 is located, adrogate soils are 1.5 to 2.0 meters in thickness, depending on the extent the landscape has been culturally modified.

Series II. Series II includes Layers II and IV, which represent periods of site occupation. Layers II and IV are cultural deposits. It is commonly assumed that such deposits are primarily composed of organic residue and cultural artifacts which have accumulated on a surface; this is usually true of A-horizon midden deposits, which normally contain mostly organic constituents which only accumulate on a landscape surface. Subsurface cultural horizons, however, such as Layers II and IV at Site 3321, may be comprised of mixtures of materials. For example, there is every reason to believe that Series I processes did not stop during periods of occupation at Site 3321. Thus cultural layers II and IV of Site 3321 are comprised of both cultural deposition and natural/man-induced alluvial and colluvial deposition.

It has been suggested earlier that cultural activities bear directly on the rate of Series I deposition—an increase in activity would lead to an increase in deposition. If such is the case, then there should be measurable changes in the deposition rate throughout the valley landscape through time. Charcoal samples recovered from Layers II and IV have undergone radiocarbon age determination analyses. Layer IV yielded a calibrated range of AD 540-880. Layer II yielded a calibrated range of either AD 1327-1334 or 1390-1640. These dates can serve as chronological brackets, providing indications of the rates at which Layers I and III accumulated. Using mean dates, and assuming that the radiocarbon ages are correct, the Layer III deposits, which are c. 20 cm thick, accumulated within estimated periods of either 620 or 805 years. The time period involved may actually be longer since the contents of Layer II suggest that the radiocarbon dates may be too early. Layer II probably dates to the early 19th century. If Layer II does date to the early 19th century, this means Layer I has been formed in less than 200 years; yet Layer I measures 40-50 cm thick. This suggests a drastic increase in the rate of deposition during formation of Layer I, which in turn reflects a drastic increase in cultural activity. It is somewhat conjectural, but it may be that Series I processes are the direct result of human settlement of the islands, and their ratio of increase is in direct

proportion to expansion of cultural activities such as burning, land clearing, and harvesting.

Series III. Series III includes Layers V and VI; these layers are interesting because Layer V is leached—which makes for a great deal of speculation concerning the origin of the layer, and its relationship to the cultural use and modification of the immediate landscape. Layers V and VI are probably very old. Gradual aggradation in low-lying terrain around Oahu has been occurring for a considerable period of time—accelerated, and at times retarded, by tectonic-caused and eustatic changes in sea level. It is not known precisely when Layers V and VI were deposited; however, in situ weathering and the development of distinct horizons suggest considerable time depth was required for deposition of the layers. In situ weathering also suggests that the burial of these layers by Series I events was comparatively recent.

Investigation of upper valley segments by means of backhoe trenches revealed they contained varied and well-preserved subsurfaces. Within the segments were reflected discrete changes of pre-Series I topography over short distances; i.e., there is much horizontal variation in the pre-Series I landscape. The pre-Series I landscape probably was the original land surface upon which Site 3321 developed. By correlating pre-Series I soil deposits from subsurface tests at Site 3321 with information derived from backhoe trenching in adjacent upper valley segments, it should be possible to broadly reconstruct the original appearance of the Honouliuli Gulch prior to Series I deposition.

South of Site 3321—only slightly less than 100 meters away, backhoe trenching revealed beneath Series I layers meandering deposits associated with a former stream channel (see description of Area 2 BT-7, Appendix E). These deposits probably represent an earlier Honouliuli Stream channel quite different from the present one. The deposits are comprised of sorted stream boulders, cobbles, pebbles, and sand; little in the way of fine-grained alluvium was present. Characteristics of the soil profile of the deposits suggest the flow of the former stream channel was very active and dynamic. The former stream channel was probably broader and shallower than the present one. At times of extended rain fall, it probably overflowed its banks.

With the commencement of Series I erosion and deposition, the former stream channel undoubtedly underwent considerable change; it became silt-laden and its course at times was probably braided. After the massive aggradation ceased in the early 20th century, the silt load in the stream dropped considerably, and the stream began to revert back to its original configuration. Unlike the pre-Series I stream, however, the stream became entrenched—it cut down rapidly into the unresistant Series I clays and silts. Once the more resistant pre-Series I stream deposits of basalt boulders, cobbles and pebbles were encountered, down-cutting ceased or slowed considerably. At present, Honouliuli Stream, where it flows through the lower valley segment, is probably similar to what the upper valley segment course looked like during the Series I stage.

The horizontal variation observed in pre-Series I deposits located between Site 3321 and the backhoe trenches south of Site 3321 can be explained in terms of topographic differences within the buried landscape. As mentioned above, the remains of a former stream course was present in the backhoe trenches. The fact that such remains are absent at Site 3321, coupled with what is known about the Series III deposits, indicates that the area of Site 3321 was probably a prominent stream terrace which paralleled the relic stream course. The stream terrace may have been of Pleistocene origin. Sea-level fluctuations over extended periods of time have probably been accompanied by a continual down-cutting and aggrading of valley surfaces. This suggests that the terrace on which Site 3321 is located, though it may have been formed long before the Series II occupation of the site, may be geologically recent. The terrace also was probably much more extensive, before erosion and stream activity prior to Series I burial and aggradation reduced it somewhat. An attempt to discover the interface between the stream channel and terrace proved too time-consuming; it involved excavating a trench almost 100 meters long by two to three meters deep.

SITE 3322 - Buried Fishpond

Located in the lower valley segment of the project area (see Figure 15), Site 3322 was previously known from historic documentation, and based on vegetational changes and terrain, was easily discernible on aerial photographs. The site consists of the buried remnants of what was once an open fishpond (Figure 20). This pond is now covered by a thin mantle of alluvium and humus; it is presently fenced in and has been used as cattle pasture. The buried pond is clearly discernible as a low spot in the terrain. South and west of the pond are the low-lying fields which characterize the lower valley segment. These fields lie only slightly above the elevation of Site 3322; thus, like the site, the fields are generally wet and susceptible to flooding. North of Site 3322 is the edge of the upland plain, which is separated from the site by a narrow strip of land-fill that constitutes a portion of a large automobile salvage yard. To the east and northeast, the site is bounded by a narrow embankment that separates Site 3322 from Site 3323, an unused but still open historic period fishpond. The embankment stands approximately 1.0 meter above the surrounding landscape and is presently occupied by a narrow private road associated with the automobile salvage yard. Portions of the embankment are constructed of recent land fill.

Site 3322 is depicted on several historic maps; the earliest are several maps in the State Survey Office resulting from a series of 1873 government land surveys. An earlier 1825 map depicts a number of agricultural fields within the project area near the shore of West Loch, but no fishponds. The earliest written references to the site are several LCA claim descriptions. Site 3321 is referred to in several boundary descriptions as Nihola Pond, located in the District of Niukee (see listing at end of Appendix A for information about LCA 760: Kuhemu; and LCA 754: Kaunahi). The pond itself is located in LCA 11216, a huge tract of 43,260 acres awarded to the high-ranking chiefess M. Kekauonohi.

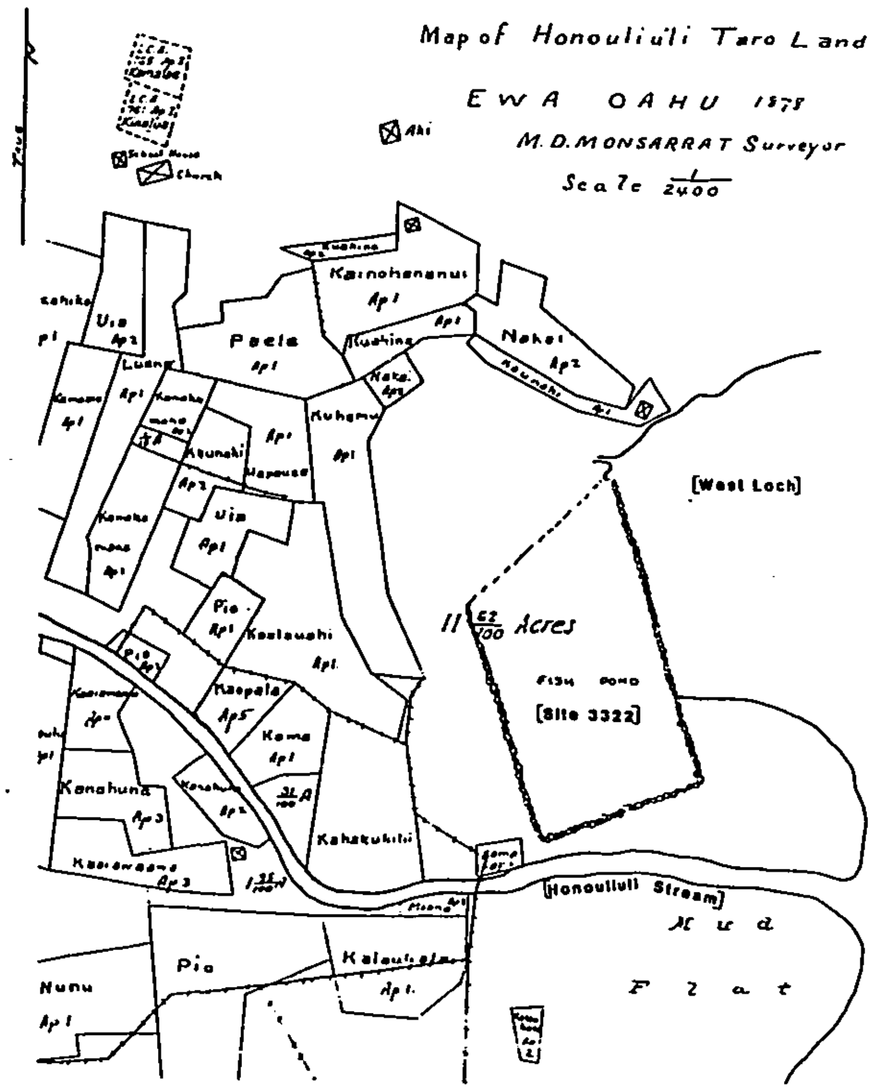

FIGURE 20. PORTION OF MONSARRAT 1878 MAP IN STATE SURVEY OFFICE (REG. MAP NO.360) SHOWING LOCATION OF BURIED FISHPOND (SITE 3322) IN SEAWARD PORTION OF SURVEY AREA 4.

Government Survey Registered Map No. 630, Territory of Hawaii (State Survey Office), provides a very detailed illustration of Site 3322. On this 1878 map, the fishpond appears as a rectangle. Three sides of the rectangle are bordered by stone embankments, and one side is bordered by the slope of an upland escarpment. The east embankment is shown bordering West Loch and an expanse of Honouliuli Stream delta mud flats. This eastern wall, which now lies buried below the surface, later comprised the western wall of Site 3323, a subsequent historic period fishpond located adjacent to and eastward of Site 3322. The 1878 map also shows precise dimensions for Site 3322. The east wall of the fish pond measures c. 200 meters in length. The west wall, facing inland, measures 150 meters in length, and the south wall, bordering Honouliuli Stream, measures 106 meters in length. The north wall, formed by what was probably the original shoreline of West Loch (the shoreline prior to the construction of the fish pond) measures 122 meters. The original depth of the fish pond is unknown, but based on the several backhoe trenches, it was probably less than 2.0 meters.

By 1928, Site 3322 had apparently been covered with silt and had disappeared. An unregistered 1928 map in the State Survey Office ("Honouliuli Taro Lands Showing Kuleanas Owned by Dowsett & Co., Ltd., Ewa, Oahu") does not show Site 3322; only the later Site 3323 is shown. On the previously referenced 1878 map, the mouth of Honouliuli Stream was shown located only a few meters from the south wall of Site 3322—which places Site 3322 within the active delta of the stream. During the second half of the 19th century, when the fishpond was being used, Honouliuli Stream probably carried a much higher silt load than at present. The high silt load, combined with seasonal flooding of the stream, probably contributed to the very rapid filling of the delta, and thus the fishpond.

Three backhoe trenches were excavated within Site 3322. The area of the trenches was extremely soft and wet and caused severe problems with working the heavy machinery. Ground conditions also hampered the investigations in general; the saturated, fine-grained soils in the trenches often collapsed, and water, resulting from a high water table, filled the trenches. Efforts to mechanically pump the water out failed because the amount of ground water was very high, and because lowering the water table rendered the trench walls even more susceptible to collapse.

Despite conditions, a cursory inspection of two trench profiles was made and a series of soil samples were taken. BT-8 was excavated to a depth of approximately 200 cmbs. Due to collapse of the walls and the high water level in the trench, only the upper 120 cm could be described in detail (see Figure 16). The upper 60 cm of the trench consisted of surface humus and the same reddish-brown clay that is present throughout the lower valley segment of the project area. The surface humus is derived from cattle grazing in the area; the reddish-brown clay has previously been described in detail in the Project Area Description section. Between 60 and 120 cmbs were two deposits clearly associated with the gradual filling-in of the pond field. These deposits were heavily gleyed and muck-like; they were both comprised of very fine, highly saturated, and extremely soft silty clays obviously lacustrine in origin—the clays were comprised of organic residue mixed with fine alluvial and colluvial silts and clays.

Separating the two deposits was a large horizontal concentration of terrestrial gastropods. These gastropods indicate there were intervals when the pond was dried out. The reasons for drying out the pond are uncertain; however, one possibility is that the ponds were intentionally dried to facilitate harvesting. Most fishponds had control gates built into the wall closest to the shore so that fluctuations in tides could be exploited. Water let in at high tide could be retained when the water level dropped, or the pond could be drained, or the water level lowered and adjusted, by opening the gates at low tide. At any rate, the the land snails do indicate that the bottom of the pond was dry long enough for the snails to become established. Certainly, the drying period was not sufficiently long to weather and oxidize the gley deposits—there is no evidence of such effects in the soil stratigraphy.

Three radiocarbon dates were derived from the deposits in BT-8. The uppermost gleyed deposit (Layer II) yielded a date of AD 1510-1955. Based on what is known about the age of the pondfield, the upper end of this age range seems the more correct. The upper boundary of Layer III yielded a date of AD 1160-1410, and the lower boundary of the layer yielded three date ranges—AD 1316-1348, 1390-1520, and 1564-1630. Prior to dating analysis, it had been assumed that Layers II and III were both related to the filling-in of the fishpond; however, Layer III dates seem to suggest a different possibility. It may be that Layer III is not associated with the fishpond at all; the layer may be comprised of fine sediment which accumulated along the submerged portion of the West Loch shoreline prior to construction of the fish pond. This sediment, heavily gleyed, may be the same deposit as described in BT-9, discussed below.

BT-9 collapsed and filled with water before it could be closely examined. However, a cursory inspection revealed a deep, gleyed deposit approximately 2.0 meters below surface (see description in Appendix E). This deposit contained numerous remains, including whole shells of shellfish belonging to the families Venerides and Melampidae, two families which are known to occupy shallow tidal flats similar to the flats at West Loch. The gleyed deposits could well be remnants of a former embayment buried beneath the alluvial and colluvial outwash of the Honouliuli Stream delta. A radiocarbon age determination derived from organic residue in the deposits produced a date of AD 70-610, which would generally support this possibility.

SITE 3323 - <u>Historic Fishpond</u>

Site 3323 is a historic period fishpond located immediately adjacent to Site 3322 (see Figure 15). Unlike Site 3322, this pond is not entirely silted; it includes a large expanse of open water. Site 3323 was formed when the OR & L grade was constructed in the early 1980s across the mouth of a small inlet. The grade isolated the inlet from the open expanse of West Loch and created the pond. East of Site 3323, across the grade, are mud flats of the Honouliuli Stream delta. Most of these flats, the result of alluvial aggradation, have been created since the building of the railroad grade.

Site 3323 is roughly triangular. Its east wall, the railroad grade, measures 275.0 m. Constructed into the railroad grade bed are two control gates. These gates, comprised of sliding slats set in vertical grooves, are built into the mouths of conduits which pass beneath the railroad grade and allows water flow between West Loch and the pond. The water flow is controlled by moving the slats up and down. It is not known whether the gates were originally built into the railroad grade, or if they were added later. The presence of the conduits suggest the gates are recent additions; they may have replaced earlier gates made of less durable material.

The southwest wall of Site 3323 is formed partly by the eastern wall of Site 3322. On early maps, this wall is depicted as extending 230 meters; however, landfilling in the area over recent years has shortened the wall length somewhat. As mentioned in the discussion of Site 3322, the southwest wall is located between Sites 3322 and 3323, and is presently occupied by a private access road associated with an automobile salvage operation.

The north side of the Site 3323 is bounded by the talus of the upland ridge located adjacent to the site. On early 20th-century maps, the north side measures approximately 213.0 meters long. However, the north side, now choked with dense mangrove thickets which extend into the open water of the pond, has been reduced somewhat by gradual natural accumulation of silts and organic residue.

SITE 3324 - <u>Buried Pondfield System</u>

Evidence of pondfield agriculture in the project area comes from several sources. Direct evidence consists of a few isolated, preserved remnants of actual pondfields, still visible within the lower portion of Honouliuli Valley. With one exception, these pondfields all appeared to have been unused, or fallow, for extended periods of time. Only one small field appeared to be currently in use for growing taro and watercress.

Further evidence for the pondfield system comes from cartographic data. Historic maps of the Honouliuli area depict numerous fields within the lower valley segment of the project area. Figure 21 is a composite based mainly on two maps in the State Survey Office dating to 1928 and 1932 which clearly depicts the location of individual pondfields in use at that time the area was surveyed. (These two maps are the previously cited 1928 map of Kuleanas Owned by Dowsett & Co. [unregistered], and Supplement Map Land Court Appl. 1069 [Supplementary Map A]). More than 150 pondfields are illustrated, providing a good indication of the extent and importance of this field type in the Honouliuli area. The entire complex of pondfields is no longer visible on the present landscape, as development and alluvial deposition has destroyed and/or buried almost all of them.

Further detailed information on the pondfield system can be found in the summary listing of Land Commission Awards (LCA), presented at the end of Appendix A, which details the allotment of individual parcels of land in the middle of the 19th century. Not only does this listing provide information

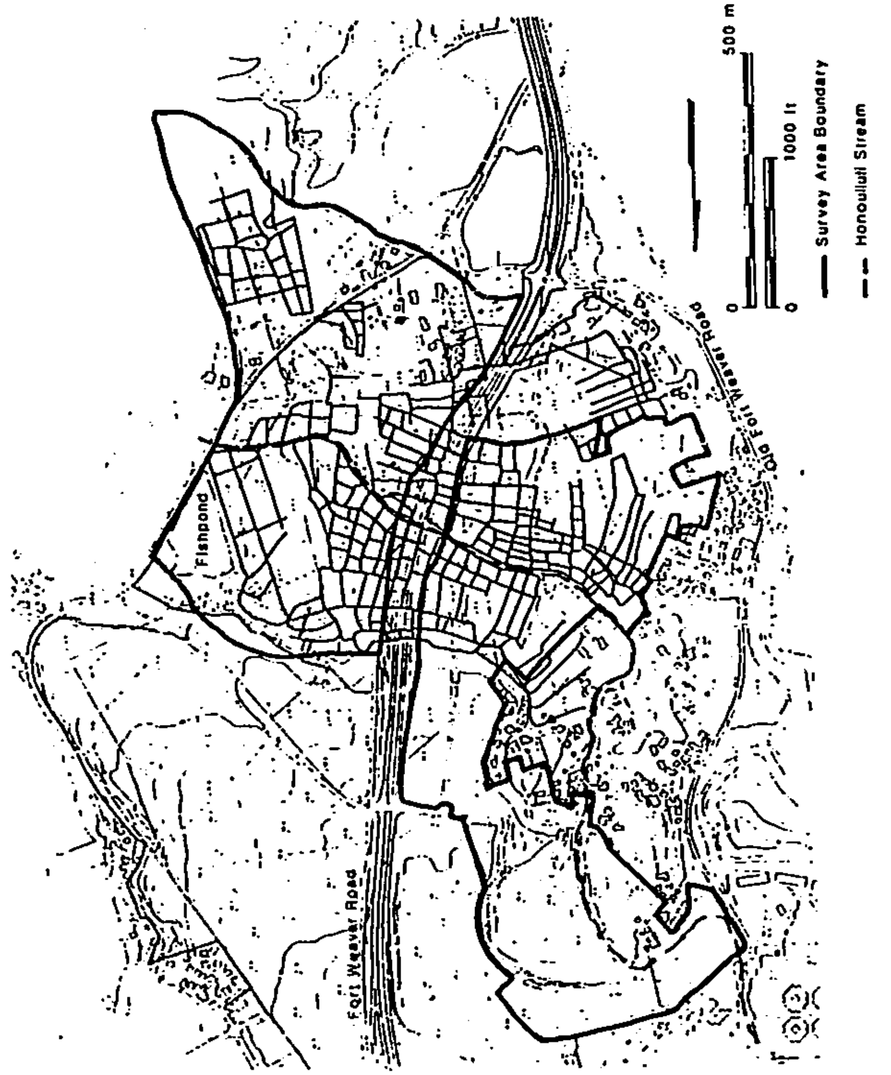

FIGURE 21. COMPOSITE MAP OF HISTORIC PERIOD (c. 1928-1932) HONOULIULI VALLEY PONDFIELD SYSTEM.

on the size and ownership of individual parcels, but it also provides a detailed description of actual land use, including specific references to pondfields and crops. The LCA testimonies indicate irrigated taro was grown in both upper and lower valley segments of the project area.

Deep subsurface auger hole and backhoe trench testing provided much information on the pondfield system. (Previously cited Table 3 summarizes the deep subsurface testing results for each survey area, while Appendix E provides detailed stratigraphic descriptions for backhoe trenches.) Testing included the recovery of stratigraphic data, and radiocarbon dating and pollen samples, all of which underwent subsequent analyses. As mentioned above, little visible evidence of the pondfield system remains on the surface of the project area. A primary focus of subsurface testing within the Honouliuli Valley floodplain was to identify and delineate the extent of buried remnants of pondfield agriculture. In general, the auger and backhoe testing was quite successful in delineating the overall extent of probable pondfield deposits; however, attempts to identify individual pondfield boundaries were not successful.

As expected, probable pondfield deposits were concentrated within the lower valley segment of the project area. The distribution of these deposits closely corresponds to the extents of pondfields depicted on Figure 21. In the lower valley segment, probable pondfield deposits typically occur as a buried A-horizon consisting of a gleyed silt clay loam, clay loam, or clay, which frequently includes charcoal flecks and terrestrial gastropods. This A-horizon overlies a B/C-horizon of homogenous, lighter-colored fine gleyed clay which occasionally contains oxidized root cast mottling (e.g., in BT-6 in Survey Area 1, see Figure 10). The probable pondfield deposits usually are buried beneath a meter or more of recently deposited alluvium, much of which has been mixed by cultivation. In several trenches, the above stratigraphic sequence also includes one or more layers of coarser, stream-deposited sands and gravels.

Extensive subsurface testing of the upper valley segment revealed pondfield deposits both similar to those in the lower valley, and another type of deposit. Deposits similar to lower valley deposits were found in Survey Area 2 (BT-10 thru -15) along the downstream, southeastern third of the broad, semicircular floodplain situated immediately below the New Saint Francis Hospital site. Another type of deposit was found in the remainder of the upper valley floodplain area, buried beneath 1.5 m or more of recent alluvium, much of which mixed by cultivation; this second type of deposit may represent either of two things. The deposits may represent former pondfield cultivation (BT-5, -7 thru -9, -16, -17, and -23 thru -40) (see Figures 12 and 13), as they appeared to be comprised of dried-out or leached pondfield soil consisting of a relatively homogeneous, light grey crumbly silt containing a few gleyed mottles. Another possibility is that the deposits represent a natural stream terrace which has been eroded and subjected to subsequent weathering. The deposits were usually underlain by coarse, stream-borne sand to boulder-sized material. In some profiles, the upper deposit boundary was abruptly and evenly truncated, perhaps reflecting an erosional event in which the top of the deposit was planed off.

Survey Area 2 subsurface testing in the uppermost lobe of the Honouliuli floodplain, situated immediately east of the intersection of Old Fort Weaver Road and Old Farrington Highway, did not identify any intact evidence of pondfield deposits (BT-1 thru -3). In this area, sugarcane cultivation appears to have disturbed all fill overlying a basal deposit of coarse stream-deposited materials.

Radiocarbon age ranges were determined for at least ten probable pondfield deposits. Most of the age ranges post-date c. AD 1100, and fit well within the generally accepted time frame for extensive pondfield agriculture in Hawaii (Kirch 1985:303). Radiocarbon age determination results are discussed in more detail in the Data Analyses section of this report.

Palynological evidence, also summarized below in the Data Analyses section and presented in detail in Appendix C, provides abundant evidence for a variety of cultigens. Plant taxa, notably taro and rice, were identified in fill samples from probable pondfield deposits. While palynological analysis results should be interpreted cautiously because the analysis represents only a preliminary effort, the results do confirm that pondfield crops were cultivated in the valley.

Pondfield deposits encountered within the project area generally are typical of those described by other investigators (Allen 1987, Kirch 1977, Riley 1973). Soils are usually gleyed, very fine textured, and sometimes contain oxidized root casts. Because of the proximity of the lower valley segment to sea level, most of the subsurface soil in the area is permanently saturated by the normally high ground water level; this creates a reducing environment, with little or no oxygen. Consequently, there is little opportunity for such deposits to dry or weather, and the characteristics of pondfield deposits encountered in more elevated settings elsewhere in Hawaii, as cited in the above references, do not appear to apply to most lower valley segment pondfield deposits.

As previously mentioned, subsurface testing failed to reveal any definite evidence of individual fields. Several explanations might be offered to account for this situation. One possibility is that pondfield boundaries were missed by subsurface testing; another possibility is that they simply were not recognized. However, both of these possibilities seem unlikely, given the intensity and nature of subsurface testing, and the expected visibility of such boundaries. Two backhoe trenching patterns that were designed to locate and identify the constructed boundaries of individual pondfields were used during the subsurface testing. Once suspected pondfield deposits were encountered, backhoe trenching proceeded outward, either in long continuous trenches, or in a staggered discontinuous fashion. Neither trenching technique succeeded in finding any subsurface boundary features. The sheer intensity of both backhoe and auger testing would tend to argue that if such boundaries were present, they would have been detected.

A third possibility relates to the nature of the environment, and the available water capacity. It seems unlikely that water supply and water retention were ever much of a problem for agricultural activities within the lower valley segment of the project area. Excessive amounts of water during periods of heavy precipitation would probably have constituted a more major concern. It may be argued that while some type of field boundaries may have been established, substantial field boundary construction was not necessary to pondfield agriculture within the lower valley segment because there was little need for controlling and retaining water within the fields. Such minimal boundary designations would not be readily apparent or manifested at all in the archaeological record.

A final possibility is that land modification activities which occurred since the early 1900s have largely obliterated field boundaries. This very likely happened in the portion of the lower valley segment situated inland of Fort Weaver Road, an area which has been in sugarcane cultivation for a number of years. The deep plowing associated with cane cultivation could easily have removed former pondfield boundaries.

OTHER MODERN/RECENT SITES

Two areas where fishponds of relatively recent or modern construction are present should be noted. These areas were not recorded in the field, and were not assigned HRHP site numbers. One area is situated on the mud flats on the west side of the mouth of Honouliuli Stream, seaward of the OR & L grade. Several rectangular ponds are shown in this area on the previously cited 1928 map showing Kuleanas Owned by Dowsett & Co. The ponds do not appear on an earlier 1897 map (State Survey Office, Reg.Map No.1919), and are therefore presumed to have been constructed sometime in the period between 1897 and 1928. Except for small openings in the center of the two largest ponds--visible on recent aerial photographs, this mud flat area is now overgrown with dense mangrove vegetation.

The other area is situated immediately adjacent to the OR & L grade (see Figure 9), along the inland side of the shoreline grade beginning at the intersection of the main route and a plantation spur. A series of five rectangular ponds are present, one of which has been recently filled. According to Mr. Chester Koga of RHTC, these ponds are owned by Mr. Richard Towill, and they were part of a recent aquaculture operation, which has since been discontinued. Inspection of the previously cited 1897 map indicates that these ponds were dug is an area that had once been the site of a salt works.

DATA ANALYSES

AGE DETERMINATIONS

Twenty-one (21) samples collected during the field work were packaged in aluminum foil and were submitted to Beta Analytic, Inc. for radiocarbon age determination and C13/C12 isotope ratio determination. Processing of the samples proceeded normally; however, special handling of the samples was necessary because most were bulk samples comprised of organic-rich sediments.

Age determination was not possible for two samples (PHRI No.RC-352 and -354) because they did not contain sufficient amounts of carbon. One sample each was processed from Site 3319 (RC-357), from the upper (RC-356) and lower (RC-355) cultural deposits at Site 3321, and from what was thought to be, in Survey Area 2 BT-30, a buried land surface (RC-359). Also processed were five samples (RC-340 thru -343, and -351) from the Site 3322 fishpond deposits and ten other samples from probable or possible pondfield deposits.

Radiocarbon age determination results are presented in Table 5, and are graphically depicted in Figure 22. Results are reported, according to currently accepted convention, as date ranges based on two sigma statistics. The dates are calibrated using tables contained in Stuiver and Pearson (1986). For eight samples (RC-342, -344, -348, -350, -353, -356, -357, -358), the tables indicate more than one possible age range. Multiple ranges are due to temporal fluctuations in the amount of radioactive carbon (C-14) in the atmosphere. Radiocarbon sample RC-345 from BT-6 in Survey Area 1 produced a modern result.

Three volcanic glass samples were submitted to MOHLAB for hydration-rind age determinations. One sample was from Site 3319, and two were from the lower cultural deposit at Site 3321. The three resulting hydration-rind ranges form an overlapping cluster spanning AD 1769-1828. Complete hydration-rind dating results are presented in Table 6, and are presented graphically in Figure 23. Results are reported as age ranges based on two standard deviations, to make the ranges comparable to the radiocarbon age ranges.

Site 3319, situated on the ridge overlooking the mouth of Honouliuli Stream, yielded two possible radiocarbon age ranges--AD 1681-1741 and 1800-1940. The single volcanic glass sample from Site 3319 yielded a range of AD 1788 to 1828. The fact that this sample came from a lower stratigraphic content than the radiocarbon sample indicates that the later radiocarbon age range is the more likely one. Total dating results for Site 3319 indicate occupation of the site probably occurred during the early historic period shortly after initial Western contact.

The Site 3321 habitation deposits yielded three radiocarbon age ranges--one range (AD 540-860) from the lower cultural stratum and two

Table 5.

SUMMARY OF RADIOCARBON AGE DETERMINATIONS
WEST LOCH, OAHU

PHRI Lab.No. RC-	Lab. No. BETA-	Provenience	C-14 Age Yrs. B.P. (one sigma)	C-13/C-12 Ratio	C-13 Adjusted C-14 Age Yrs. B.P.	*Calendric Range Yrs. AD
Site 3319 (Area 1)						
357	23735	SU-1, HF-1 25-40 cmbs	70±50	-26.7	50±50	1681-1741 1800-1940# 1955
Site 3321 (Area 2)						
356	23734	BT-27, IAB2 45-65 cmbs Upper Cultural Deposit	360±70	-20.1	440±70	1327-1334 1390-1640
355	23733	BT-27, IIAB1 85-97 cmbs Lower Cultural Deposit	1300±90	-22.0	1350±90	540-880
Site 3322 (Area 4)						
340	23718	BT-8, IIAGNB 80-90 cmbs Fishpond	690±90	-23.6	720±90	1160-1410
341	23719	BT-8, IIAGNB1 110-120 cmbs Lower Valley Fishpond	170±70	-22.0	210±70	1510-1955#
342	23720	BT-8, IIAGNB 130-140 cmbs Fishpond	430±70	-23.5	460±70	1316-1348 1390-1520 1564-1630
343	23721	BT-9 60-70 cmbs Fishpond	530±60	-24.0	550±60	1280-1450
351	23729	BT-9 200+ cmbs Fishpond	1680±120	-24.0	1690±120	70-610
Area 1						
345	23723	BT-6, IIAGNB2 150-160 cmbs	103.3±0.7% Modern	-20.09	102.5±0.7%8 Modern	--

*Calibrated according to Stuiver and Pearson (1986:805-838). Two-sigma range.

#1955 denotes influence of bomb C-14.

Table 5. (Cont.)

PHRI Lab.No. RC-	Lab. No. BETA-	Provenience	C-14 Age Yrs. B.P. (one sigma)	C-13/C-12 Ratio	C-13 Adjusted C-14 Age Yrs. B.P.	Calendric Range Yrs. AD
Area 1 (Cont.)						
347	23725	BT-12, IIIAGNB 130-140 cmbs Poss. Site 3324 Lower Valley Pondfield	750±70	-18.5	850±70	1020-1280
346	23724	BT-12, IIIAGNB 150-160 cmbs Poss. Site 3324 Lower Valley Pondfield	700±60	-21.0	760±60	1170-1300
350	23728	BT-14 130-140 cmbs Poss. Site 3324 Lower Valley Pondfield	640±70	-19.8	730±70	1170-1320 1339-1392
Area 2						
358	23736	BT-7 130-140 cmbs Poss. Site 3324 Upper Valley Poss. Pondfield	300±70	-22.6	340±70	1430-1670 1949-1952
344	23722	BT-7 140-150 cmbs Poss. Site 3324 Upper Valley Poss. Pondfield	100.7±1.0%	-20.2	30±80	1670-1780 1790-1950 1953-1955*
353	23731	BT-30, III 220-230 cmbs Poss. Site 3324 Upper Valley Poss. Pondfield	700±50	-24.2	720±50	1225-1307 1358-1380
359	23737	BT-30, IV 240-250 cmbs Original Surface Upper Valley	2070±150	-25.2	2070±150	BC 400- AD 240

*1955 denotes influence of bomb C-14.

Table 5. (Cont.)

PHRI Lab.No. RC-	Lab. No. BETA-	Provenience	C-14 Age Yrs. B.P. (one sigma)	C-13/ C-12 Ratio	C-13 Adjusted C-14 Age Yrs. B.P.	Calendric Range Yrs. AD
Area 3						
348	23726	BT-1 160-180 cmbs Poss. Site 3324 Lower Valley Pondfield	930±60	-21.3	990±60	899-906 950-1170
354	23732	BT-2 150-170 cmbs	--	--	--	Insufficient Carbon
360	24116	BT-7 70-90 cmbs Poss. Site 3324 Lower Valley Pondfield	180±70	-23.0	210±70	1510-1955*
352	23730	BT-7 90-110 cmbs Poss. Site 3324 Lower Valley Pondfield	--	--	--	Insufficient Carbon
Area 4						
349	23727	BT-4, IIAGNB3 105-115 cmbs Poss. Site 3324 Lower Valley Pondfield	610±60	-23.6	630±60	1270-1420

*1955 denotes influence of bomb C-14.

possible age ranges (AD 1327-1334 and 1390-1640) from the upper cultural layer. In addition, two volcanic glass samples from the lower stratum also yielded dates (AD 1769-1817 and 1772-1800). While the radiocarbon results are stratigraphically consistent, the volcanic glass results, because they post-date the radiocarbon ones, are problematic. The many pit features and the sugarcane cultivation disturbance present at Site 3321 suggest the possibility that the volcanic glass samples could have intruded into the lower deposit; however, the problem cannot be resolved until additional samples from controlled excavations are collected and dated. A provisional interpretation of the dates indicates three possible time periods for site occupation: AD 540-860, 1327-1640, and 1769-1817.

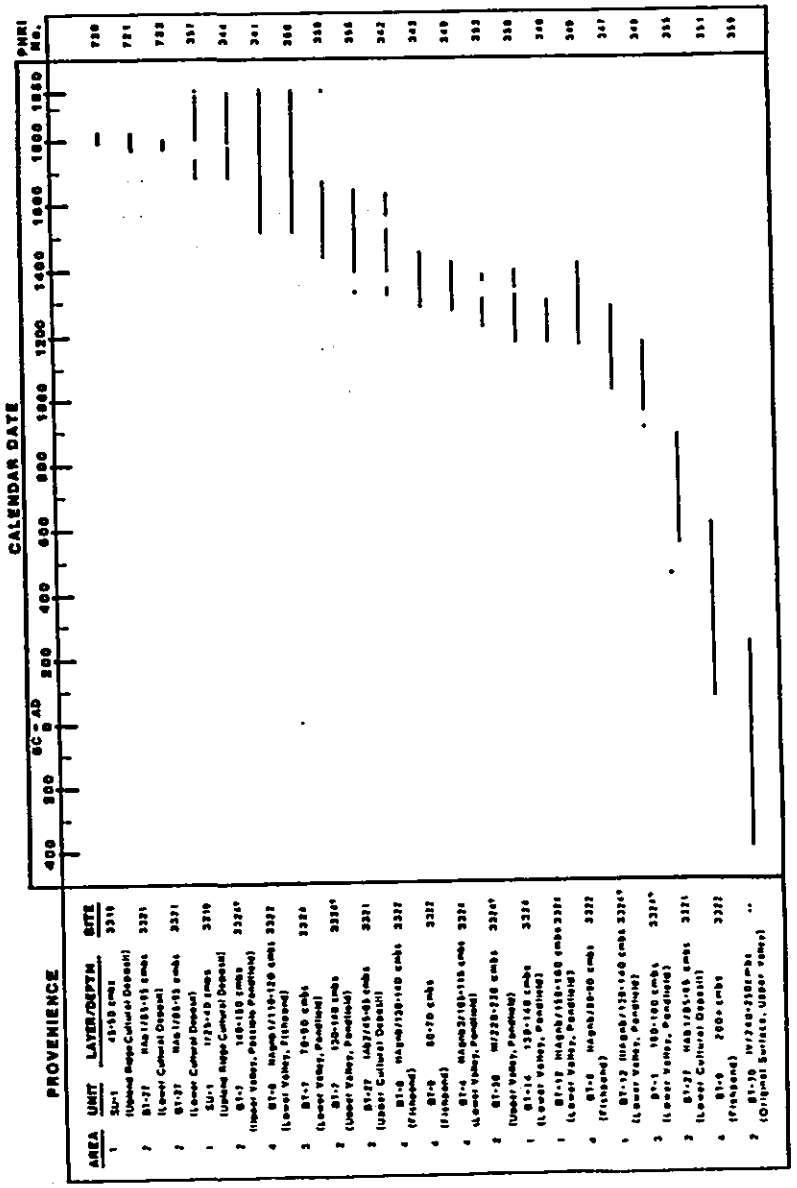

FIGURE 22. RADIOCARBON AND HYDRATION-RIND AGE DETERMINATIONS

Table 6.

SUMMARY OF HYDRATION-RIND AGE DETERMINATIONS

PHRI Lab. No. VG-	MOHLAB Lab. No. (439-)	Source*	Provenience	Hydration Rind (microns)	Calendric Date Yrs. AD	Calendric Range Yrs. AD (2 sigma)
Site 3319 (Area 1)						
720	9	67	SU-1 45-50 cmbs	2.49±0.07	1808±10	1788-1828
Site 3321 (Area 2)						
721	249	67	BT-27, IIAB1 85-95 cmbs	2.59±0.08	1793±12	1769-1817
722	250	67	BT-27, IIAB1 85-95 cmbs	2.64±0.05	1786±7	1772-1800

*Hawaii glass source: 67 = Oahu "B" (Michels 1986).

Five radiocarbon samples from Site 3322, a buried fishpond, were processed. A basal sample from BT-9 yielded an age range of AD 70-610. This sample most likely represents underlying lacustrine sediments which are presumed to have been deposited when the area was still part of the open West Loch embayment. Another sample from Layer III in BT-9, taken from between 60-70 cm below surface, produced an age range of AD 1280-1450. Three radiocarbon samples from BT-8, which is adjacent to BT-9, yielded a number of ranges. RC-342 (Layer IV, 130-140 cm) yielded three age ranges: AD 1316-1348, 1390-1520, and 1564-1630. RC-341 (Layer IV, 110-120 cm) yielded a range of AD 1510-1955; RC-340 (Layer III, 80-90 cm) yielded a range of AD 1160-1410. These radiocarbon results are stratigraphically consistent within each layer; however, the age ranges for the layers are inverted. Layer III has an overall range of AD 1160-1450, while the upper part of Layer VI has an overall potential age range of AD 1316-1955. The inversion may be due to the fact that the dated sediments have eroded from inland locations of varying age; however, without additional evidence it is not possible to resolve the inconsistency.

Age determination age ranges for samples from probable pondfield deposits in the lower valley segment include: AD 899-906 or 950-1170 (RC-348), AD 1120-1280 (RC-347), AD 1170-1300 (RC-346), AD 1170-1320 or 1339-1392 (RC-350), AD 1270-1420 (RC-349), AD 1430-1670 or 1949-1952 (RC-358), and AD 1510-1955 (RC-360). Taken as a whole, these ranges fall between AD 899 and AD 1952. The majority of the ranges cluster between the mid-1100s and the 1600s. This time period corresponds very well with the probable time period for the development of extensive pondfield systems in Hawaii (Kirch 1985:303-306).

Radiocarbon age ranges for samples from possible pondfield deposits in the upper valley segment of the project area include: AD 1225-1307 or 1358-1380 (RC-353), AD 1430-1670 or 1949-1952 (RC-358), and AD 1670-1780 or 1790-1950 (RC-344). If the later possible ranges for RC-344 and RC-358 are omitted--because they are improbably late, then the remaining ranges form a cluster spanning from the 1200s to the late 1700s. While the age ranges for the possible pondfield deposits in the upper valley should be viewed very cautiously because their association with pondfield deposits is not certain, they do fit in well with the expected time frame for the development of extensive pondfields in Hawaii. They also suggest that upper valley segment pondfields were developed somewhat later than those in the lower valley.

A single sample, taken from what is interpreted as a possible natural stream terrace surface in the upper valley segment, yielded a radiocarbon age range of 400 BC to AD 240 (RC-359, Layer III, BT-30). This age range fits well with other later dates from the vicinity--which date subsequent cultural activities, including habitation activities and pondfield agriculture, that occurred on the preexisting stream terrace surface.

PORTABLE ARTIFACTS

One hundred eighty-one (181) artifacts were recovered at the West Loch Estates - Golf Course and Parks project area. Recovered artifacts included 19 (10.5%) indigenous (prehistoric) artifacts and 162 (89.5%) non-indigenous (historic) artifacts. Fourteen (7.7%) artifacts were from Area 1, 91 (50.3%) were from Area 2, and 76 (42.0%) were from Area 5. A summary of the portable artifact collection is presented in Table 7, and a detailed distribution of the artifacts is presented in Table 8.

Area 1 yielded no indigenous artifacts. Area 2 yielded 11 artifacts; of the 11, two (adze fragments) were recovered from the general area and six (three volcanic glass flakes, two basalt flakes, and a basalt ulu maika) were found on the surface of Site 3321. The other three artifacts from Area 2 were two volcanic glass flakes and one polished basalt flake (from BT-27 at Site 3321). Area 5 yielded eight indigenous artifacts--single volcanic glass cores from SU-5, SU-17, and SU-53; volcanic glass flakes from SU-15 and SU-1 (Site 3319); an adze fragment from SU-9; a modified shell from SU-2; and a roughed-out bone tab from the surface of Site 3319.

As a whole, the indigenous artifact assemblage recovered in the project area was somewhat limited, being comprised primarily of flaked stone and tool artifacts. Volcanic glass flakes and cores alone made up 52.6% of the total assemblage. Barrera and Kirch have suggested probable uses for volcanic glass artifacts:

> The possible functions...are many and varied. Basaltic glass holds a fine, sharp edge and the tools make excellent cutting and scraping implements. They may have been used in

Table 7.

SUMMARY OF PORTABLE ARTIFACTS

CATEGORY	AREA 1	AREA 2		AREA 5				TOTAL
	AHs	SURF	SITE 3321	SURF	SUs	SITE 3318	SITE 3319	
INDIGENOUS								
FISHING GEAR	-	-	-	-	-	-	1	1
Roughed-out tab (bone)	-	-	-	-	-	-	1	1
TOOLS	-	1	1	-	1	-	-	3
Adze fragment	-	1	1	-	1	-	-	3
FLAKED STONE	-	-	7	-	4	-	1	12
Volcanic glass	-	-	5	-	4	-	1	10
Basalt flake	-	-	2	-	-	-	-	2
MISCELLANEOUS OTHER	-	-	2	-	-	-	1	3
Ulu Maika	-	-	1	-	-	-	-	1
Modified shell	-	-	-	-	-	-	1	1
Polished basalt	-	-	1	-	-	-	-	1
SUBTOTAL INDIGENOUS	-	1	10	-	5	-	3	19
NON-INDIGENOUS								
Building materials	3	-	-	-	-	-	-	3
Ceramics	-	18	13	1	2	43	-	77
Glassware	5	20	28	-	-	20	-	73
Glass sherd w/ edgewear	-	-	-	-	1	-	-	1
Metal fragments	-	1	-	-	-	1	-	2
Plastic fragments	6	-	-	-	-	-	-	6
SUBTOTAL NON-INDIGENOUS	14	39	41	1	3	64	-	162
TOTAL PORTABLE ARTIFACTS	14	40	51	1	8	64	3	181

food preparation, for cutting and scraping plant materials, or for delicate woodworking.... [T]hese tools are extremely common, being found in virtually every type of [Hawaiian] site. The suggestion, then, is that the ubiquitous basaltic glass flakes functioned as a prehistoric "pocketknife," to use a modern analogy (1973:185-186).

Non-indigenous artifacts recovered in the project area totaled 162 items. The majority (92.6%) of non-indigenous artifacts was comprised of ceramics (77 items, 47.5%) and glassware (73 items, 45.1%). Area 1 yielded 14 non-indigenous artifacts (8.6%)--three building items (nails

Table 8.

DETAILED DISTRIBUTION OF PORTABLE ARTIFACTS

CATEGORY	AREA 1							AREA 2					SUB GRAND TOTAL
	AH-2				AH-3	AH-5	AREA TOTAL		SITE 3321			AREA TOTAL	
	II	IV	V	SUB-T	IV	I		SURF	SURF	BT-27	SUB-T		
INDIGENOUS													
FISHING GEAR													
Roughed-out tab (bone)	-	-	-	-	-	-	-	-	-	-	-	-	-
TOOLS													
Adze fragment	-	-	-	-	-	-	-	1	1	-	1	2	2
FLAKED STONE													
Volcanic Glass													
Core	-	-	-	-	-	-	-	-	-	-	-	-	-
Flake	-	-	-	-	-	-	-	-	3	2	5	5	5
Basalt													
Flake	-	-	-	-	-	-	-	-	2	-	2	2	2
SUBTOTAL FLAKED STONE	-	-	-	-	-	-	-	-	5	2	7	7	7
MISCELLANEOUS/OTHER													
Ulu Maika (basalt)	-	-	-	-	-	-	-	-	1	-	1	1	1
Modified shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Polished basalt	-	-	-	-	-	-	-	-	-	1	1	1	1
SUBTOTAL MISC/OTHER	-	-	-	-	-	-	-	-	1	1	2	2	2
TOTAL INDIGENOUS	-	-	-	-	-	-	-	1	7	3	10	11	11
NON-INDIGENOUS													
BUILDING MATERIALS													
Nails	-	-	1	1	1	-	2	-	-	-	-	-	2
Ceramic tile	1	-	-	1	-	-	1	-	-	-	-	-	1
SUBTOTAL BUILDING MATERIALS	1	-	1	2	1	-	3	-	-	-	-	-	3
CERAMICS													
Bowl	-	-	-	-	-	-	-	6	5	-	5	11	11
Pipe stem	-	-	-	-	-	-	-	-	-	-	-	-	-
Plate	-	-	-	-	-	-	-	3	6	-	6	9	9
Teacup	-	-	-	-	-	-	-	1	-	-	-	1	1
Miscellaneous:													
Vessel sherds	-	-	-	-	-	-	-	8	2	-	2	10	10
Other sherds	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL CERAMICS	-	-	-	-	-	-	-	18	13	-	13	31	31

Table 8. (Cont.)

CATEGORY	AREA 1							AREA 2					SUB
	AH-2				AH-3	AH-5	AREA		SITE 3321			AREA	GRAND
	II	IV	V	SUB-T	IV	I	TOTAL	SURF	SURF	BT-27	SUB-T	TOTAL	TOTAL
GLASSWARE													
Beverage	-	-	-	-	-	-	-	9	18	-	18	27	27
Patent/Propriety Medicine	-	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous Sherds	-	1	3	4	-	1	5	11	10	-	10	21	26
SUBTOTAL GLASSWARE	-	1	3	4	-	1	5	20	28	-	28	48	53
MISCELLANEOUS/OTHER													
Glass sherd w/edgewear	-	-	-	-	-	-	-	-	-	-	-	-	-
Metal													
Fragments	-	-	-	-	-	-	-	1	-	-	-	1	1
Wire	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastic	2	-	4	6	-	-	6	-	-	-	-	-	6
SUBTOTAL MISC/OTHER	2	-	4	6	-	-	6	1	-	-	-	1	7
TOTAL NON-INDIGENOUS	3	1	8	12	1	1	14	39	41	-	41	80	94
TOTAL PORTABLE ARTIFACTS	3	1	8	12	1	1	14	40	48	3	51	91	105

Table 8. (Cont.)

CATEGORY	AREA 3												AREA	GRAND
		SU-5	SU-15	SU-17	SU-33	SU-56	SU-59	SITE 3318	SITE 3319					
	SURF	ALL	ALL	ALL	ALL	ALL	ALL	SURF	SURF	SU-1	SU-2	SUB-T	TOTAL	TOTAL
INDIGENOUS														
FISHING GEAR														
Roughed-out tab (bone)	-	-	-	-	-	-	-	-	1	-	-	1	1	1
TOOLS														
Adze fragment	-	-	-	-	-	-	1	-	-	-	-	-	1	3
FLAKED STONE														
Volcanic glass														
Core	-	1	-	1	1	-	-	-	-	-	-	-	3	3
Flake	-	-	1	-	-	-	-	-	-	1	-	1	2	7
Basalt														
Flake	-	-	-	-	-	-	-	-	-	-	-	-	-	2
SUBTOTAL FLAKED STONE	-	1	1	1	1	-	-	-	-	1	-	1	5	12
MISCELLANEOUS/OTHER														
Ulu Maika (basalt)	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Modified shell	-	-	-	-	-	-	-	-	-	-	1	1	1	1
Polished basalt	-	-	-	-	-	-	-	-	-	-	-	-	-	1
SUBTOTAL MISC/OTHER	-	-	-	-	-	-	-	-	-	-	1	1	1	2
TOTAL INDIGENOUS	-	1	1	1	1	-	1	-	1	1	1	3	8	19
NON-INDIGENOUS														
BUILDING MATERIALS														
Nails	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ceramic tile	-	-	-	-	-	-	-	-	-	-	-	-	-	1
SUBTOTAL BUILDING MATERIALS	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CERAMICS														
Bowl	-	-	-	-	-	-	-	23	-	-	-	-	23	34
Pipe stem	1	-	-	-	-	-	-	-	-	-	-	-	1	1
Plate	-	-	-	-	-	2	-	-	-	-	-	-	2	11
Teacup	-	-	-	-	-	-	-	8	-	-	-	-	8	9
Miscellaneous:														
Vessel sherds	-	-	-	-	-	-	-	7	-	-	-	-	7	17
Other sherds	-	-	-	-	-	-	-	5	-	-	-	-	5	5
SUBTOTAL CERAMICS	1	-	-	-	-	2	-	43	-	-	-	-	46	77

Table 8. (Cont.)

CATEGORY					AREA 5									
		SU-3	SU-15	SU-17	SU-33	SU-54	SU-59	SITE 3318	SITE 3319				AREA	GRAND
	SURF	ALL	ALL	ALL	ALL	ALL	ALL	SURF	SURF	SU-1	SU-2	SUB-T	TOTAL	TOTAL
GLASSWARE														
Beverage	-	-	-	-	-	-	-	1	-	-	-	-	1	28
Patent/Propriety Medicine	-	-	-	-	-	-	-	1	-	-	-	-	1	1
Miscellaneous sherds	-	-	-	-	-	-	-	18	-	-	-	-	18	44
SUBTOTAL GLASSWARE	-	-	-	-	-	-	-	20	-	-	-	-	20	73
MISCELLANEOUS/OTHER														
Glass sherd w/edgewear	-	-	-	-	-	1	-	-	-	-	-	-	1	1
Metal														
Fragments	-	-	-	-	-	-	-	1	-	-	-	-	1	2
Wire	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastic	-	-	-	-	-	-	-	-	-	-	-	-	-	6
SUBTOTAL MISC/OTHER	-	-	-	-	-	1	-	1	-	-	-	-	2	9
TOTAL NON-INDIGENOUS	1	-	-	-	-	3	-	64	-	-	-	-	68	162
TOTAL PORTABLE ARTIFACTS	1	1	1	1	1	3	1	64	1	1	1	3	76	161

and ceramic tile), five glassware sherds, and six plastic fragments. Four of the plastic fragments were recovered from Layer V of Auger Hole 2; this indicates that the auger hole deposit was disturbed.

Area 2 yielded a total of 80 non-indigenous artifacts (49.4%). Of the 80, 39 artifacts--18 ceramic pieces (six bowl fragments, three plate fragments, one tea cup, and eight vessel sherds), 20 glassware pieces (nine beverage fragments and 11 glass sherds), and one metal fragment--were recovered from the general ground surface. The other 41 artifacts were found on the surface of Site 3321; these 41 artifacts were comprised of 13 ceramic fragments (five bowls/fragments, six plates/fragments, and two vessel sherds) and 28 glassware items (18 beverage bottles/fragments and 10 glass sherds)--artifacts which are primarily utilitarian household items.

Area 5 yielded 68 historic artifacts. Of the 68 artifacts, 64 were located on the surface of Site 3318 (Site 3318 was designated a site on the basis of its surface artifact concentration). The Site 3318 surface collection is comprised of 43 ceramic items (23 bowls/fragments, eight teacups/fragments, seven vessel sherds, and five ceramic sherds), 20 glassware items (one beverage bottle, one medicine bottle, and 18 glass sherds), and one metal fragment. Additional Area 5 artifacts include a ceramic pipe stem from the surface of Area 5 and two plate fragments and a glassware sherd with edgewear from SU-54.

ECOFACTUAL REMAINS

Table 9 presents a summary of the variety and distribution of midden remains recovered from the West Loch Estates - Golf Course and Parks project area. Ecofactual remains analysis focused primarily on determining the species present and their relative quantities within excavation units (primarily shovel units). A factor which limited the ecofactual analysis was the disturbed nature of the deposits, especially in Areas 1 and 2.

Marine vertebrates comprised 89.6% of the overall ecofactual remains, with bivalves accounting for 86.9% of the overall total. Brachidontes crebristriatus, Isognomonidae, and Tellinidae made up 94.6% of the bivalves and 82.2% of the overall ecofactual remains. The greatest concentrations of marine vertebrates were present in SU-1 and SU-2 in Area 5 on Hoaeae Point. This is probably due to the favorable environment (brackish water, silty sand, and proximate limestone shorelines) in the area.

Since marine vertebrates are natural to coastal areas in Hawaii, it is not possible to determine from an examination of the midden collection which marine invertebrates were exploited, to what extent, or if they were exploited at all in the project area. However, the fact that there are charcoal, Aleurites moluccana (kukui), and bone material present in association with marine invertebrates suggests food preparation and consumption activities took place in the project area.

Table 9.

QUANTITATIVE DISTRIBUTION OF ECOFACTUAL REMAINS
FROM VARIOUS SUBSURFACE TEST UNITS

MATERIAL*	AREA 1	AREA 2 SITE 3321	AREA 3													
					SITE 3319											
	AM-12 I	BT-27	SU-1 ALL	SU-2 ALL	SU-1	SU-2	SU-3	SU-4	SU-5	SU-6	SU-8	SU-10	SU-11	SUB-7	AREA TOTAL	TOTAL
MARINE INVERTEBRATES																
GASTROPODA																
Trochus intextus	-	-	-	0.22	-	-	-	-	-	-	-	-	-	-	0.22	0.22
Nerita picea	-	-	-	-	-	-	-	-	-	-	-	-	0.38	0.38	0.38	0.38
Littorina pintado	-	-	-	0.33	-	-	-	-	-	-	-	-	-	-	0.33	0.33
Nipponicidae	-	-	-	3.67	-	-	-	-	-	-	-	-	-	-	3.67	3.67
Unidentified gastropods	-	-	-	20.19	0.61	0.17	0.06	-	-	0.58	-	-	0.25	1.67	21.06	21.06
SUBTOTAL GASTROPODS	-	-	-	24.41	0.61	0.17	0.06	-	-	0.58	-	-	0.83	2.25	26.64	26.64
BIVALVIA																
Brachidontes crebristriatus	-	-	12.39	193.92	2.24	10.53	6.96	0.34	0.56	0.39	-	-	57.17	86.19	292.50	292.50
Isognomonidae	-	-	118.05	38.66	16.39	33.03	16.23	6.10	0.14	9.61	-	-	42.91	123.41	300.12	300.12
Tellinidae	-	-	35.35	167.59	4.76	6.67	9.06	1.61	4.01	2.20	0.96	-	11.88	41.15	244.09	244.09
Veneridae	-	-	34.41	3.10	7.36	-	-	1.37	-	-	-	0.40	-	9.13	46.64	46.64
Unidentified bivalvia	-	-	-	-	-	-	-	-	-	-	-	0.89	-	0.89	0.89	0.89
SUBTOTAL BIVALVIA	-	-	200.20	423.27	30.75	57.23	32.25	9.42	4.71	12.20	0.96	1.29	111.96	260.77	884.24	884.24
OTHER																
Crustacea	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-	0.13	0.13
TOTAL MARINE INVERTEBRATES	-	-	200.20	447.81	31.36	57.40	32.31	9.42	4.71	12.78	0.96	1.29	112.79	263.02	911.03	911.03
OTHER INVERTEBRATES																
Non-marine gastropods	-	-	-	-	-	-	0.23	-	-	-	-	-	0.25	0.48	0.48	0.48
VERTEBRATES																
Bone	2.21	72.09	-	2.02	-	-	-	-	3.80	0.38	-	-	0.74	4.92	6.94	81.24
VEGETAL																
Aleurites moluccana	-	-	-	2.29	-	-	-	-	1.03	-	-	-	-	1.03	3.32	3.32
Charcoal	-	-	0.30	19.94	-	-	-	-	-	-	0.78	-	-	0.78	21.02	21.02
TOTAL VEGETAL	-	-	0.30	22.23	-	-	-	-	1.03	-	0.78	-	-	1.81	24.34	24.34
TOTAL NON-ECOFACTUAL	-	130.62	194.80	900.10	1.20	3.48	15.97	3.65	9.90	5.77	2.83	0.13	11.63	54.56	1,131.46	1,282.08
GRAND TOTAL	2.21	202.71	395.30	1,372.16	32.56	62.88	48.31	13.07	19.44	18.93	4.57	1.42	125.41	326.79	2,094.25	2,299.17

*Weight in grams.

POLLEN SAMPLES

In order to ascertain the crops which may have once been grown in the fishpond/pondfield areas in the present project area, palynological analysis of pollen samples recovered from these areas was conducted. Twenty-four samples recovered from eleven trenches located in Survey Areas 1-4 were submitted to Dr. Linda Scott Cummings of PaleoResearch Laboratories in Denver, Colorado. Her analysis (Appendix C) indicated that a number of crops—including taro (Colocasia esculenta), sugarcane (Saccharum officinarum), sweet potato (Ipomoea batatas), rice (Oryza sativa), corn (Zea mays), and radish (Raphanus)—were probably grown in the fishpond/pondfield areas.

An abundance of taro and sugarcane pollen was present in the pollen record; this indicates these crops were probably once cultivated in several sections of the project area, and were probably cultivated over a long period of time. However, because wind can carry sugarcane pollen a long distance, it is possible that the area the pollen was recovered from was not actually cultivated. The rice pollen was recovered from BT-6 and -12 in Area 1 and from BT-8 in Area 4. Identification of rice pollen is difficult because the pollen closely resembles other types of grass pollen; however, historical research has indicated that rice was grown in the project area. Sweet potato pollen was recovered in Area 1, BT-14, and in Area 2, BT-7. Because sweet potato is insect pollinated and can be transported only by man, insects, or water, there is a strong possibility this crop was cultivated in the project area. Because of the crop requirements, cultivation was probably limited to a few of the drier sections. Further testing is needed to determine the extent of radish pollen in the project area; it is expected that this further testing will indicate that a number of additional vegetable crops were grown in the area. The recovery of corn pollen was somewhat unexpected; again, further testing is needed to determine the crop extent.

As a whole, the palynological analysis indicates that more extensive testing is needed in the project area to define further the nature and extent of crops grown. The present study indicates that palynology is a viable tool in defining and describing historic/prehistoric cultivation in the project area: large quantities of identifiable pollen were recovered and a number of cultivated crops were identified. Based on her initial analysis, Dr. Cummings strongly recommended that the project area undergo further palynological study.

CONCLUSION

DISCUSSION

Soils and Geomorphology

Subsurface and surface investigations within the project area produced a wealth of information concerning the relationship between the depositional history and cultural historical development of Honouliuli Valley. An understanding of this relationship had been deemed essential to interpreting the archaeological remains within the project area--soil pedogeny and specific depositional events are often closely related to the cultural occupation and utilization of an area. Natural and culturally initiated changes in local environments are often reflected in the pedogenic record, making it worthwhile to document and describe such changes. Geomorphological processes can greatly affect the way in which cultural remains become manifested in the archaeological record, and can greatly affect methods of detecting, retrieving, and interpreting archaeological remains.

Riverine settings generally are the most complex, and potentially most significant environments for studying the relationships between geomorphology and culture, and the relationship between geomorphology and the archaeological record. Alluvial processes in riverine settings are complex and variable, and the relationships between such processes and cultural adaptation and change, and archaeological interpretation, are all the more complex. Extensive riverine environments are very few in the Hawaiian Islands. Consequently, very few archaeological studies have been conducted on such environments. Although Honouliuli Valley is a rather minor stream system, the alluvial and geomorphological processes evidenced within it are similar to riverine environments elsewhere in the world; it is hoped that the present study minimally demonstrates the need for further investigation into Hawaiian riverine environments.

A summary of the depositional and topographic products--soil deposits and features of the terrain--of Honouliuli Valley may prove useful in understanding the complex formation of valley substratum. In the following discussion, soil deposits and features of the terrain are grouped into soil units, which in the project area possess definite vertical and horizontal extents, and which relate specifically to features of the terrain.

The significance of these soil units, and their relationship to the archaeology of the project area, has to a large extent, been previously discussed. The following section attempts to refine the definition and interpretation of these depositional units on a broader scale, commensurable with the project area as a whole. Discussed below are four soil units--natural gleyed soils (Soil Unit Gn), gleyed agricultural soils (Soil Unit Ga), leached gleyed soils (Soil Unit K), and historic/prehistoric-induced erosional deposits (Soil Unit K).

Natural gleyed deposits (Gn) are located in the lower valley segment of the project area. They consist of deeply buried, fine-textured sediments which develop within a non-oxidizing, reducing environment to form gley-colored soil compounds. In appearance, these deposits are very similar to those which form in association with pondfield agriculture (Soil Unit Ga described below). The difference between the two is slight. Ga soils form as a consequence of pondfield agricultural activities while Gn soils are purely natural phenomena. The precise extent of the Gn Soil Unit in the project area is unknown, but the unit appears to constitute part of the gradual in-filling and aggrading of the shallow margins of West Loch. As discussed in a previous section, the lower valley portion of Honouliuli Gulch probably represents a filled-in embayment of the adjacent West Loch. Filling of this embayment has been a long-term process that has gradually advanced the shoreline between West Loch and Honouliuli Valley in an eastward direction. Evidence of this advancing shoreline is afforded by a comparison of historic period maps, which clearly depict newly formed lands advancing eastward over a period of little more than 100 years.

The rate at which the lower valley embayment filled to its present configuration has undoubtedly varied considerably through time. Also variable are the kinds of deposits that have served to advance the shoreline. A normal, simplified sequence of filling would entail an initial period in which coarse-grained materials accumulated, followed by a period in which an overburden of very fine-grained sediments accumulated. Deeply buried coarse-grained deposits lying beneath an overburden of predominantly fine-textured materials have been detected by sample boring in the western end of the lower valley section (Geolabs-Hawaii 1987). The textural variation between the coarse and fine-grained layers--which can be expected to also manifest horizontally--in the project area is manifested by the coarse-grain deposits which have accumulated primarily along the original shoreline of the embayment (i.e., adjacent to the fossil sea bluffs near the west end of the project area)--deposits which gradually grade eastward towards West Loch into progressively finer-grained and thicker deposits.

Initial, large-scale deposition of the finer-grained materials probably began with the development of a classic deltaic system at the braided mouth of Honouliuli Stream. Such a deltaic system would account for the predominance of very fine-textured silts and clays present in subsurface deposits in the lower valley section of the project area. It would also account for the fact that the gradual eastward advancement of the shoreline is without a concomitant newly aggraded landscape far above the water level of adjacent West Loch. The Gn deposits, coupled with an absence of an appreciable grade and relief within the lower valley, would ensure that subsurface drainage in the lower valley remains negligible. The present mouth of Honouliuli Stream, where it enters West Loch, is just such a feature--subsurface drainage is negligible, thereby providing the area with an abundance of virtually impounded fresh water. Deposits equivalent to the Gn Soil Unit are presently still forming along the shoreline of West Loch.

The gleyed agricultural soils (Soil Unit Ga) in the project area are believed to have formed in pondfield environments. The horizontal distribution of these soils within the project area is probably quite similar to the horizontal extent of the Gn Soil Unit. Backhoe testing revealed that Ga deposits are present in the lower valley segment and in the lower portion of the upper valley segment of the project area. Ga deposits in the project area appear to be superimposed over the Gn deposits. Ga soils appear to occur on top of, and to some extent within the upper boundary of the Gn Soil Unit. Early historic maps and descriptions of the lower valley indicate it as being excessively marshy or swampy, and being comprised of mud flats. It would appear that farmers took advantage of the wet conditions and developed agricultural fields on this landscape.

Leached, gleyed soils (Soil Unit K) in the project area are confined to the upper valley segment of the project area; these 25-50 cm thick deposits are found buried beneath Soil Unit Eh (described below), and also are found beneath Layers II and IV (cultural layers) at Site 3321. Soil Unit K consists of a single leached layer of crumbly silt, relatively homogenous and containing a few gleyed mottles. The soil unit has been tentatively identified as representing the oxidized remnant of a drained, upper valley pondfield deposit. Radiocarbon and palynological analysis of Unit K layers in Survey Area 2 BT-7 and -30 indicate the layers date to between the 1200s and 1700s, and that pollen in the layers are from both prehistoric and historic cultigens.

Throughout the upper valley segment, Soil Unit K directly overlies stream-deposited coarse material, which becomes increasingly coarse--from sand to horizontally bedded cobbles and boulders--with depth. These underlying, very permeable coarse deposits allow overlying layers such drainage, and thus probably account for the dried-out, leached appearance of Soil Unit K. In some profiles, the upper boundary of Soil Unit K is abruptly and evenly truncated; this truncation clearly reflects an erosional event in which the top of the deposit was planed off. Where this truncation occurs, Soil Unit Eh directly overlies Soil Unit K. This stratigraphic non-conformity implies the removal of a previously established A-horizon from above Soil Unit K. Occasionally, a preserved A-horizon is present, juxtaposed between Soil Unit K and Soil Unit Eh; this may indicate that Soil Unit K is a remnant of a natural stream terrace, the surface of which was subsequently used for pondfield agriculture.

Prehistoric/historic-induced erosional deposits (Soil Unit Eh) are perhaps the most easily identifiable deposits in the project area. They are also the most visible--the deposits are extensively exposed on the ground surface. Soil Unit Eh is comprised of deposits which are believed to be closely, but not exclusively, related to cultural disturbance of the landscape; the unit is comprised of a massive, homogenous clay deposit, which has been transported from the upland interior terrain of the project area to the low-lying coastal plain region. In general, these redeposited upland soils have not been in place long enough to undergo substantial development on the coastal plain; thus the distinctive reddish-brown color of the unit--the result of long-term upland weathering and development.

Two aspects of Soil Unit Eh are particularly relevant to the archaeology of the project area. The first aspect concerns the hypothesized relationship between human impact on the environment and rate of deposition of the soil unit. The second aspect relates to the burial and preservation of archaeological remains within the lowlands of Oahu beneath the soil unit. Erosion of upland terrain, and the transportation and redeposition of weathered, unconsolidated material onto low-lying surfaces are natural phenomena which in any environment may be taken as a given, ongoing process. Changes in the rates at which these processes occur can be related to either specific events, or to natural, gradual changes in the landscape that affect the agents of erosion, transportation and redeposition. Occasionally, the geomorphological record will reveal evidence for events that are, in geomorphological terms, catastrophic in proportion to normally expected rates. Such changes in rates can often be equated with a specific causal event that served to trigger an acceleration of geomorphological processes. Soil Unit Eh appears to represent just such an accelerated event; evidence for this event is manifested within both the archaeological and stratigraphic record of the project area, and to some extent is also documented by historical, written accounts.

Soil Unit Eh, which constitutes the last major depositional event within the project area, forms a mantle over the entire valley portion of the project area. This mantle, which varies in thickness, completely obscures the former landscape, making for a situation that possesses important implications for archaeological study and interpretation of the area. First of all, the buried original landscape necessitates survey methods which include extensive subsurface testing. Secondly, the buried landscape enhances the chances that archaeological remains will be found preserved.

Culture-Historical Summary

Prior to the present project, little archaeological and historical research had been done in the Honouliuli Gulch area. Current project research has significantly added to knowledge of past use of the area. Seven new sites, historic and prehistoric habitation and burial sites situated on Hoaeae Point and on the slopes and uplands surrounding the Honouliuli Stream floodplain, were identified and documented. Perhaps the most significant sites identified are the remnants of a once extensive agricultural system which combined aquaculture (in fishponds situated on the shores of West Loch), irrigated pondfields, and dryland agriculture (on the slopes and uplands surrounding Honouliuli Valley). Agricultural use of the area spans over 1000 years, which surely makes the area the largest such system known on the leeward coast of Oahu.

Initially, the agricultural system in the project area was based on prehistorically introduced cultigens and technology; later the system underwent successive changes--historically introduced rice replaced taro in the pondfield system, and later, modern intensive sugarcane cultivation largely obliterated the earlier pondfields. Agricultural use of the Honouliuli Stream floodplain for pondfield cultivation of taro may have begun in the lower valley segment as early as AD 1000. Extensive evidence of pondfield cultivation in the lower valley dates from the 1100s to 1600s. As is documented by historic sources, pondfield cultivation continued into the early 1900s, by which time rice had largely replaced taro. Cultivation of upper valley pondfields may have begun as early as the 13th-14th centuries, although historical documentation goes only as far back as the 1800s.

Cultivation of dryland crops on the floodplain and in the upland areas surrounding the floodplain is documented historically. Also documented historically are fishponds along the shore of West Loch. Although no clear evidence of prehistoric fishponds was encountered, it is likely that prehistoric fishponds were constructed in the general area; these ponds were probably located inland of the historic ponds, and over a period of time, as the shoreline aggraded seaward, were converted to pondfields.

Habitation sites in the project area consist of surface and subsurface deposits containing artifacts and midden. Site 3318, located on Hoaeae Point, dates to the historic period. Occupation of Sites 3319 and 3320, situated on ridges overlooking West Loch and Hoaeae Point, respectively, appears to span late-prehistoric to early-historic times. Site 3321, which is located at the edge of the upper valley segment floodplain, may have been occupied as early as the mid-6th to mid-9th centuries, with subsequent occupations occurring between the 1300s and 1600s, and late 1700 to early 1800s. Two habitation sites in the project area (3319 and 3321) contained at least one human burial. While it is difficult to determine the nature and intensity of occupation at these sites, their location next to permanent agricultural fields and the presence of burials at the sites suggests they were permanently occupied.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

To facilitate State and County review, general significance assessments and recommended general mitigation treatments for all sites identified during the combined surface and subsurface reconnaissance survey of the West Loch Estates - Golf Course and Parks project area are summarized in Table 10. Significance categories used in the evaluation process are based on the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60, Section 4). The State Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) uses these criteria to evaluate eligibility for both the Hawaii State and National Register of Historic Places. Sites determined to be potentially significant for information content (Categories A and X, Table 10) fall under Criterion D, which defines significant resources as ones which "...have yielded, or may be likely to yield, information important in prehistory or history". Sites potentially significant as representative examples of site types (Category B, Table 10) are evaluated under Criterion C, which defines significant resources as those which "...embody the distinctive characteristics of a type, period, or method of construction..., or that represent

Table 10.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS
AND RECOMMENDED GENERAL TREATMENTS
WEST LOCH ESTATES - GOLF COURSE AND PARKS PROJECT AREA

HRHP Site	Significance Category				Recommended Treatment			
50-12-80-	A	X	B	C	FDC	NFW	PID	PAI
3318	+	-	-	-	+	-	-	-
3319	+	-	-	+	+	-	-	+
3320	+	-	-	-	+	-	-	-
3321	+	-	-	+	+	-	-	-
3322	+	-	-	-	+	-	-	-
3323	+	-	+	-	+	-	+	-
3324	+	-	-	-	+	-	-	-

General Significance Categories:

A=Important for information content, further data collection necessary (PHRI=research value);
X=Important for information content, no further data collection necessary (PHRI=research value, SHPO=not significant);
B=Excellent example of site type at local, region, island, State, or National level (PHRI=interpretive value); and
C=Culturally significant (PHRI=cultural value).

Recommended General Treatments:

FDC=Further data collection necessary (intensive survey and testing, and possibly subsequent data recovery/mitigation excavations);
NFW=No further work of any kind necessary, sufficient data collected, archaeological clearance recommended, no preservation potential (possible inclusion into landscaping suggested for consideration);
PID=Preservation with some level of interpretive development recommended (including appropriate related data recovery work); and
PAI=Preservation "as is," with no further work (and possible inclusion into landscaping), or minimal further data collection necessary.

a significant and distinguishable entity whose components may lack individual distinction."

Sites with potential cultural significance (Category C, Table 10) are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP) entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (ACHP 1985). The guidelines define cultural value as "...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth" (1985:1). The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value" (1985:7).

Based on the findings of the combined reconnaissance survey field work, the cultural remains identified within the West Loch Estates - Golf Course and Parks project area appear to range, for the most part, from limited to substantial significance in terms of potential information content. Four of the identified sites (Sites 3318, 3320, 3322, 3324) were determined to be significant for their information content only; appropriate mitigation for these four sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. The site-specific scope and scale of data collection and recovery work would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

Two of the identified sites (Sites 3319, 3321) were determined to be significant both for their information content and for their cultural value because of the presence of one or more human burials. With regards to their scientific research value (information content), appropriate mitigation for these two sites would involve variable degrees of further data collection (intensive survey level detailed recording and test excavations) and possibly subsequent data recovery excavations. With regards to their cultural value, appropriate mitigation would involve either continued in-place protection (preservation "as is"), or disinterment of skeletal remains according to current State Health Department regulations and procedures.

One site (Site 3323) was determined to be significant both for its information content, and as a good example of a site type. Appropriate mitigation for this site would involve some degree of further data collection (including historical documentary and local informant research) and continued preservation with some level of interpretive development. As with the other six sites for which further work has been recommended, the site-specific scope and scale of data collection work, as well as appropriate plans for interpretation, would be developed in consultation with staff archaeologists in DLNR-HSS, and contained within the written cultural resource management plan to be prepared and approved prior to any mitigation field work.

To evaluate the information content of sites located within the project area, they would be investigated in light of various research topics developed to further understand prehistoric and historic occupation and use of the project area. These topics include four general domains:

1. Period of use;
2. Nature and intensity of habitation site occupation;
3. Delineation of agricultural system development; and
4. Detailed definition of geomorphological processes and environmental change.

Finally, it is recommended that a qualified archaeologist selectively monitor initial grubbing activity and/or vegetation clearing within the project area. The general significance assessments and recommended general treatments presented here are based on the findings of the combined surface and subsurface reconnaissance survey field work, which involved relatively limited subsurface testing. Therefore, these evaluations and recommendations are given with the general qualification that during any development activity involving the modification of the land surface, there is always the possibility—however remote, that previously unknown or unexpected subsurface cultural features, deposits, or burials might be encountered. In such a situation, immediate archaeological consultation should be sought.

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APPENDIX A:

HISTORICAL DOCUMENTARY RESEARCH - WEST LOCH ESTATES PROJECT AREA

Historical Research Relative to the Land of Honouliuli, Ewa District, Island of Oahu

by

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Introduction

The primary intent of this research effort is to examine readily available sources for mythological, historical, cultural and in particular early land use data relative to Honouliuli. It is hoped that the highlights and general commentary which appear here prove serviceable in the development of broad cultural and historical impressions and that they shall provide a documentary context from which the archaeological findings may be better perceived and appreciated.

Native Traditions

Mythological References - Ewa District

Ewa was a land much-favored by the gods, chiefs and the general populace from ancient times. Some of the oldest traditions relate that of the four major gods, two had a particular interest in the area. These two gods of water sources, Kane and Kanaloa, singled-out the Ewa lands and blessed them with an abundance of rivers and springs for the cultivation of crops and constructed and maintained well-stocked fishponds for their use. They are also credited with fixing district boundaries which separate the various Ewa lands. (Handy 1972:472-3)

An ancient line of chiefs sprang from Ewa. According to some genealogies, this class of chiefs dated from ten to fourteen generations

before Kamehameha. (Kamakau 1961:1) It is easily understood how Ewa assumed the position of royal residence and resort; her resources were bountiful - fish and shellfish, starch, fruit and vegetable crops flourished. Ewa was noted for a special variuty of taro (kai koi o Ewa) which was quite popular among those of chiefly rank. (Pukui 1983:305) As a natural result of this fertility of land and sea, two royal compounds were located near the shore on the Waipio Peninsula. They were Lepau and Halaulani. (Sterling 1978:22) Puuloa also deserves mention as a royal residence and resort. Bingham recorded visits to this site by the King and his chiefly entourage well into the 1820's. (Bingham 1848:176-8)

The high-productivity of Ewa lands encouraged a sizeable population. By the time the first missionary census was tallied in 1831, Ewa's population was steadily declining. (Schmitt 1973 & 1977) Native historians such as Kamakau insist that "Oahu was then thickly populated. It is sad to see how in so short a time whole villages have vanished leaving not a man...(Kamakau 1961:424) In traditional times, it would seem, a substantial labor force would be necessary to maintain Ewa's taro patch and fishpond systems; however, because no statistics are available, we can only posite approximate size based on the scant literary and physical evidence which remain.

In assembling mythological references relative to Ewa, I became aware of a definite spiritual significance associated with this district. This may result from several factors: long-term connections of chiefs and royalty with the area, battles fought within the district which necessitated the construction of temples of human sacrifice to the war gods (outcasts were even drowned in Ewa waters prior to their being laid upon these altars), and the presence of agricultural heiau and fishing shrines which were essential in guarantying the continuance of fertility and plenty. (Kamakau 1961:173, Pukui 1983:47, McAllister 1971:108)

Thus, it can be said that Ewa occupied a position of some prestige in traditional times due to its relationship with the gods and chiefs and its reputation for productivity of both land and sea.

Traditional References - Honouliuli

Many of the traditional references relative to Honouliuli connect a particular character or an event with a land form or a site. Puu o Kapolei, which is situated in the center of Honouliuli plain, is preserved in tradition as the home of the grandmother and protectoress of Kamapuaa, Oahu's famed pig-god. (Sterling 1978:33) Kaihuopalaai, a name which eventually became assigned to the whole of West Loch, was the name given to a pond where, in season, mullet would spawn and swim to Oahu's North Shore. Upon arriving there, they turned and retraced their path along the Koolau and Kona coasts, their destination being West Loch. (ibid. p.34)

There is a particular land area located in the project site known as Poohilo. It received its name indirectly from a battle fought between Oahu and Hawaii forces. Although the actual sites of warfare were Waikakalaua and Kipapa Gulches, a retreating warrior Hilo had the misfortune of being slain nearby. His head "was cut off and carried in triumph to Honouliuli, and stuck up at a place still called Poo-Hilo." (ibid. p.31) Literally, this is translated as "Hilo's head."

At least six heiau have been recorded for Honouliuli. Many are poorly located, if at all and they appear to fall outside of the project boundaries. One fishing shrine is mentioned and it falls within these boundaries. It is situated on Kapapapuhi Point and was known as Kalanamaihiki. (ibid. p.32-5) A solitary mention of a holua slide surfaced in a document settling the boundaries of Honouliuli ahupuaa in 1873. It is described as "ancient" and it sat on the boundary between Hoaeae and Pouhala in the vicinity of the Manawaielu gulch. (Hawaii State Archives, Interior Dept. Land File) Holua sliding was a sport for chiefs; its existance in Honouliuli-Hoaeae further verifies occupation of the area by those of rank.

Brief Historical Chronology

Early. Handy cites extensive taro cultivation due to the abundance of springs and rivers; sweet potato cultivation was common to fishermen of the area who tended patches close to their houses. Other crops found here include yams, bananas, awa, wauke, olona, mamake and the popular "kai" taro variety. (Handy 1971:81, 155 and Handy 1972:469-72) Coconut and breadfruit trees were also plentiful in the district. (Handy 1971:190, 193)

The following ponds were found in the vicinity of West Loch: Laulaunui, Kaihuopalaai, Kapamuku, and Okiokilepe. Numerous fish traps and some fishing shrines also existed here. (Sterling 1978:32-42) The waters of Puuloa in particular, abounded with shellfish such as pearl oysters. (Pukui 1983:34)

An extensive and antiquated system of salt works operated on the shore of the Honouliuli lobe of West Loch. Another salt works was situated further seaward at Puuloa. The Puuloa Salt Works had beginnings that were traceable to the 1820's and possibly even much earlier. By 1861, 100 acres had been devoted to the production of salt. (Pacific Commercial Advertiser 4/18/1861:1)

1823. The Rev. Hiram Bingham accompanied Kamehameha II and the chiefs to Puuloa where they went into temporary residence in native fashion. In his remarks about his visit there, Bingham mentioned seeing the home of a shark god and contributed his observations on taro and fish which he must have found in abundance.

> I one day accompanied the king and others by boat to see the reputed habitation of a Hawaiian deity, on the bank of the lagoon of Ewa. It was a cavern or fissure in a rock, chiefly under water, where, as their traditions teach, and as some then affirmed, a god, once in human form, taking the form of a shark, had his subterraqueous abode. Sharks were regarded by the Hawaiians as gods capable of being influenced by prayers and sacrifices, either to kill those who hate and despise them, or to spare those who respect and worship them....
>
> ... Their usual mode of cooking is to excavate a place in the ground, sufficiently large for a bushel or two of the large bulbous roots of arum or kalo, which are brought fresh from the patch or field, for the occasion; procure and put down at the bottom of the pit, the requisite amount of fuel, wood, or other combustibles, and raise upon it a heap of small stones, which are heated thoroughly, as the fuel burns out. The arum roots, or whatever articles are to be baked there, are placed compactly upon the heated stones, and covered with leaves and grass, to keep them clean, and prevent the heat from escaping into the air. A little water is then thrown upon the mass, and the whole covered quickly with earth, like a little coal-pit, as closely as three or four inches' depth of earth will make it. The water coming gradually in contact with the hot stones and coals, is converted into steam, which, with the radiating heat

> of the stones, in the course of two or three hours, accomplishes the object. Then this hemispherical little mound or ground oven is opened, the covering of earth, leaves and grass, is carefully removed, and the contents taken out. The arum roots are washed and peeled, and usually are pounded on a large thick wooden platter, with a stone pestle, some four or five inches in diameter. When thoroughly beaten, the mass resembles dough....This has long been the principal article of daily food for the mass of the Hawaiian people. The article of food next in importance with them, is fish, raw, dried, roasted or baked. It is eaten in moderate quantity, with the arum paste. Fowls, ducks, turkeys, goats, hogs and dogs, are, like the arum, baked in the ground-oven occasionally.
>
> Such cooking and preparing food being obviously unsuited to the sacredness and duties of the Sabbath, that labor was required to be done previously. The unusually numerous smokes rising from different parts of a village or valley, on a Saturday morning, became at length a pleasing, noiseless signal of the approach of the sacred day, and of preparation for it, as the people came to recognise its authority. (Bingham 1848:177-8)

1825. An early map of this date (with a variation in 1857) by Lieut. Malden plots a "Watering Place" in the cove inland of Laulaunui Island. This is the same vicinity where the old salt beds were located. A sizeable settlement of dwellings and coconut trees are concentrated on Kapapapuhi Point; other groupings of houses and trees are scattered along the shore and border on a fragment of a road which appears to run mauka-makai (parallel to the cove shore). (Survey Reg. Map 437)

1836-40. The missionary Artemas Bishop found upon his arrival that his predecessor Lowell Smith had constructed an adobe house and church. An adobe school house is also erected; as these structures are mentioned in passing, none of them are given specific locations. However, land records of the late 1840s and early 1850s mention a meeting house upland of Niukee and Kailikahi. These land records also placed a school house and Kapalani Catholic Church in Polapola. (Archives, Native and Foreign Registers and Testimonies and Bishop 1916:43-4)

1848-50s. The Great Mahele resulted in the ahupuaa of Honouliuli (43,250 acres) being awarded to M. Kekauonohi. 97 other awardees received land parcels ranging from .135 to 9.39 acres in size. (Indices 1929:765-9)

8/15/1848. In a letter of complaint to the Minister of Public Instruction, a school teacher named Naheana told of several "prisoners taro patches" at Honouliuli that had been overgrown and long neglected. This teacher and his students reclaimed these patches and made them productive again. Naheana asked that the patches remain under the care of the school as one of the chiefs is attempting to take the patches away from them. (Public Instruction Correspondence file)

5/6/1850. Another teacher at Honouliuli submitted a petition to the Minister of Public Instruction stating that he and the students of his school reclaimed four grassy fishponds and re-stocked them with fish in 1848. As the Tax Assessor of the district had confiscated the ponds, this teacher asked their return. Apparently a circular had gone out some time possibly in 1848, ordering schools to utilize undeveloped or neglected government lands in the vicinity for the upkeep and benefit of the district schools. (ibid.)

4/14/1851. The Privy Council Records indicate that the Minister of Public Instruction reported "disorders existing at Ewa." Nothing more could be located in official record to flesh out the details of the nature of these disorders. However, as a result of these problems, a resolution was passed instructing Gov. Kekuanaoa "to have the prison for women in Ewa enclosed by a secure fence,..." (Privy Council Record 6: 342) Due to the number of taro patches and fishponds set apart in Honouliuli for the prisoners, it appears that this prison for women should be in relatively close proximity to work areas. A district prison was situated at Waiawa; whether it was for males or females is unknown.

11/26/1851. Naheana again wrote the Minister of Public Instruction this time to state his reasons for the rejection of a teacher, Kepilina. He accused Kepilina of dancing and thieving while employed as teacher of Honouliuli school and of general improper conduct while teaching at Puuloa. Naheana also mentioned Catholic priests in the area who have been among the people for a while who do not recommend retaining Kepilina. (Public Instruction Correspondence file)

It is during the 1850s that I believe the Catholics construct another church which was described simply as "located close to Pearl Harbor." By the 1880s this church is abandoned because of its run-down and dilapidated state. It is replaced in the early 1890s by a simple structure situated very close to the mill. A land exchange occurs with Campbell Estate in the late 1920s in which the old land is given for the land close to the mill. As little data existed beyond what is given here in the sources consulted, I am only able to conclude that there is some indication that the old church property may have been on Kapapapuhi Point. A more careful examination of title records will have to be conducted to ascertain if this is so. (Schoofs 1978:110-3)

1/21/1852. Haalelea, the widower of M. Kekauonohi, asserted his privillege as owner of Honoluiuli by claiming all mullet as reserved for his sole use. (Interior Dept. files)

1853. Artemas Bishop commented that the population was in decay by the 1850s. Taro lands had fallen into disuse. The smallpox epidemic of 1853 killed more than half of the Ewa population in a matter of a few weeks. He also noted that the chiefs were rarely seen in Ewa anymore. (Bishop 1916:43-4)

In summarizing land use in 1853, Coulter wrote:

> Nearly all the remaining population of Oahu was scattered around Pearl Harbor, along the east coast of the island, and at Waialua near the center of the north coast.
>
> Pearl Harbor formed an excellent site for fish ponds. An irregular shoreline with a large peninsula jutting out from it and several smaller ones also, formed areas which needed little artificial construction to make them landlocked. There were 27 fish ponds there, one, with an area of 320 acres..." (Coulter 1971:18, 20)

1879. Relative to water sources and the development of Ewa Plantation the following was written:

> The discovery of artesian water on the nearly arid plain of the Ewa District of the Island of Oahu led to the establishment of Ewa Plantation. Located on the southwestern shore of the island, between the entrance to Pearl Harbor and Barber's Point, the plantation was originally promoted by Benjamin F. Dillingham of the Oahu Railway & Land Company fame, to further his railroad interests.
>
> Sugar cane was grown at Ewa long before the 1876 Treaty of Reciprocity or Annexation, as the Reverend S. E. Bishop operated a water-powered sugar mill on the lands in 1840. As a point of interest the cylinder of the good Reverend's mill, which he made himself, was made of hardwood and the machine was capable of grinding more cane than was necessary to produce one ton of sugar a day.
>
> However, sugar as a commercial venture was not considered for the plantation until the first artesian well was drilled at Honouliuli in 1879. In reality it was the eminent James Campbell, of previous Maui Island experience who broke the drought for Ewa in having more artesian wells drilled in the area. (Conde 1973:278)

1880-1. Bowser made the following observations:

> HONOULIULI ESTATE, Honouliuli, District of Ewa; James Campbell, Esq., Proprietor; postoffice address, Government Road, Honouliuli, 15 miles from Honolulu. Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. It is on this estate that Mr. Campbell's successful artesian boring has been made, as to which see the author's notes in his Itinerary. There are valuable fisheries attached to this estate. (Bowser 1880:489)
>
> My next halting place after leaving Nanakuli, was at Honouliuli, at Mr. James Campbell's. This gentleman owns, also, the Kahuku ranch, on the extreme north point of the Island, of which I have already spoken. The Honouliuli ranch is an extensive property. The main road runs through it for about twelve miles, and the general breadth is seldom less than four miles. The surveyed area is 43,250 acres. One large tract of this land is perfectly level, with the exception of a few acres near the centre, where there is a knoll of rising ground.
>
> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. In the far distance, some twenty miles away, you can see the range of mountains which form the backbone of the island. It was on the northeastern side of the mountains that the earlier part of my ride was taken. The chain runs from Mr. Campbell's place at Kahuku, away to the easternmost point of the island. The soil at Honouliuli is good, and, with the aid of irrigation, will grow anything. In the mean time, it is wholly pasture land, but the means of irrigation have recently been secured by Mr. Campbell, who has sunk an artisian well to the depth of 273

feet. This well has delivered a continuous stream of water equal to 2,400 gallons per hour, ever since the supply from which the present flow comes, was struck on the 22d of September, 1879. Besides Mr. Campbell's residence, which is pleasantly situated and surrounded with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts. (ibid. p. 495)

1882. From Frank Damon's "Tours Among the Chinese:"

...Towards evening we reached Honouliuli, where the whole valley is leased to rice planters...This was one of the largest rice plantations we visited. Sometimes two or three men only, have a few fields which they cultivate for themselves, and we often too came upon houses where there were eight or ten men working their own land. But the larger plantations are owned by merchants in Honolulu, who have a manager acting for them. The houses are destitute of all but the barest necessities of life, except those of some of the more wealthy planters. The wood-work is unpainted. The beds are arranged around the room like berths in a ship. Sometimes these are quite prettily ornamented with a border above the netting of Chinese silk, on which graceful sprays of flowers are painted and Chinese characters written. In the center of the room is a large table where the meals are taken in common. They never need lack for rice, and of this most excellent article of diet they seem never to weary....But on the rice and sugar plantations I was saddened by the sight of so many men, without women and children. It seemed unnatural inhuman, this herding together in 'quarters,' of scores of laboreres, as if they were so many animals. We speak of Chinese Immigration to these Islands. It is properly speaking no immigration, it is simply the transplanting of so many working machines to our fields and valleys. These same men would be better, more desirable laboreres, if they had their wives and little ones with them.... (Damon 1882:37)

1885. A description of James Campbell's Honouliuli Ranch appeared in the Pacific Commercial Advertiser. Only cattle and goats were pastured;

little in the way of crops was produced. However, the Chinese were credited with reclaiming the swamplands and former rice lands; for the use of these lands they pay very high rents. Approximately 200 acres were planted in rice and 50 acres were devoted to bananas. This banana plantation belonged to Mark Robinson who during the dry season, flumes water in from Waipahu Stream.

The flat coral plain of which the ranch is primarily comprised was covered with a scant verdure which has proven to be excellent in fattening stock. In fact, this coral pasture became the fattening paddock for both Honouliuli and Kahuku ranches as well.

The writer noted evidence of a considerable native population in former times. The remains of extensive taro and potato cultivation were visible. He attributed the smallpox epidemic of 1853 as the major cause of population decline.

The Honouliuli Ranch was originally the property of M. Kekauonohi; upon her death it passed to her husband Haalelea. Upon his death, his second wife sold it to J. H. Coney. J. Campbell purchased it from Coney in 1877. (Pacific Commercial Advertiser 8/15/1885)

1889. An article appeared in the Hawaiian Gazette in which it was stated that Honouliuli ranch was used exclusively for cattle up until 1889. After this date, ideas of a sugar plantation there begin to materialize. (Hawaiian Gazette 8/18/1891)

1891. The above article reported that in August of 1891 the mill was under construction. It was scheduled to open in November; grinding began that December. (ibid.)

1895. Whitney observed the following in his tourists' guide:

A SUGAR PLANTATION.--as an instance of a large enterprise rendered possible and profitable by the opening of the railway, the Ewa sugar plantation, eighteen miles from Honolulu, may be referred to. Where this plantation now is, was formerly a dry and barren plain, destitute of water or cultivation, the home of wild cattle. With the introduction of steam, and the aid of the artesian water, a splendid sugar plantation has been developed, capable of turning out annually from eight to ten thousand tons of the richest sugar, the cane crops being raised solely by artesian water. It is now really one of the largest and most profitable estates on these islands. All the produce and travel created by it are conveyed over the railway, which alone has rendered profitable such a vast undertaking as the Ewa plantation, with its dependent population of one thousand persons. And it is not improbable that other similar industrial enterprises will spring up along the route. When the road is completed to Kahuku, it well serve the travel and freighting of several sugar and rice plantations, not to refer to other minor industries.

COAL TRAFFIC.-Another outcome of the Oahu railway enterprise is the erection of a coal depot, on the west side of the harbor, where cargoes of coal are rapidly discharged by an apparatus known as the Boston coal elevator, which has been doing good work in unloading and loading ships during the past two or three years. The coal is stored in sheds erected for it, and can be put on board vessels in the same way, whenever required for coaling steamships or for shipment to other ports. For this improvement, the public are indebted to Mr. Dillingham, the general manager of the Oahu Railway Company. (Whitney 1895:39-40)

1898-1902. The following article on the Hawaiian Fiber Company appeared in the Paradise of the Pacific:

...The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. A few years before several hundred plants had been set out by the government on a part of this land for experimental purposes, but

no sisal industry was developed by the trial. They stand in the ground now waiting for the harvester. An expert in sisal culture would say at once that the soil is an ideal one for this hardy plant. The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. Five hundred acres are cleared and planted. Most of this has been weeded, only 50 acres remaining to complete all that is necessary to weed this year. There are also four miles of road ready. Three hundred thousand growing plants in the various fields testify to the activity of the manager and his helpers. The whole plantation is as level as a prairie. In a large field containing 130 acres, mauka of the Oahu Railway & Land Co.'s track, the first harvest is to be gathered in a few months. The plants were set out in December 1898, the old Ewa Plantation nursery furnishing the suckers. It was a remarkably dry winter and, though young plants require rain, they thrived well and are today past the harvest time, only awaiting the arrival of a decorticator to render returns in fiber. Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco... (Paradise of the Pacific March 1902:17)

1904. The Hawaiian Fiber Company increased its area of sisal cultivation from 750 to 1,000 acres. (Thrum 1905:173)

1939. An Ewa Plantation Co. map of this date plotted the locations of the following landmarks: field railroad lines, OR&L line and station, ditches, a park adjacent to 31.2, reservoirs, villages, Naval Reserve area, sisal and sandy inland areas. (Conde 1973:285)

1941-5. Relative to military activity in the area, the following extracts will serve as a summary of highlights:

The Marine Corps Air Station at Ewa - a great modern airfield -

was developed from what had been for 15 years merely a dirigible mooring mast. As the headquarters base of Marine aviation in the Pacific, it served as the springboard into forward areas. Every Leatherneck air unit going to or returning from Pacific action went through Ewa. (Allen 1950:225)

Re: the Pearl Harbor attack:

At about 7:57 a score of fighters swooped down from the clouds to within 20 feet of the ground at the Marine Corps Air Station at Ewa, riddling the 49 planes closely lined up on the field. Thirty-three aircraft went up in smoke, and the remaining 16 were too badly damaged to fly. The marines, in desperation, emptied their pistols at the departing Japanese. (ibid. p. 2)

At Ewa, after bombing the near-by Marine airfield, enemy planes machine-gunned the plantation's main street, the mill and power plant and some 30 houses, and started two cane fires. (ibid. p.7)
...On a Thursday less than two weeks after the bombing, farmers adjacent to West Loch at Pearl Harbor were ordered to leave their farms by sundown. The order was modified to allow two days to prepare, and the men were permitted to return to their farms during daylight until livestock could be moved and crops harvested. The displaced farmers, who had only recently been established at West Loch by the Farm Security Administration, were forced to seek temporary housing with friends and relatives or at Ewa plantation. Since they had invested in their enterprises practically all of their life's savings and considerable money borrowed from the FSA as well, several suffered heavy losses. (ibid. p.109)

<u>Analysis of early land records specific to the project site</u>

Appended to this report is a comprehensive accounting of land occupation and use pre-dating 1850. The data has been gathered from primary documents of all registered claims and from testimony rendered in behalf of these claims before the Land Commissioners during the Great Mahele. This effort thus takes advantage of the earliest and most complete body of land record available for study.

It is immediately apparent that although many of the claimants formally received their lands from the various konohiki in the 1830s and 1840s, a good number of them inherited use of these lands from their parents or ancestors who occupied the land since the time of Kamehameha I. As Kamehameha I died in 1819, some of these lands being claimed had generational occupation and use within a family.

The entire ahupuaa of Honouliuli was claimed by M. Kekauonohi who received 43,250 acres. Within her land, 97 claimants presented their letters of registration before the Land Commission for lands which they either had under actual residence or cultivation. Parcels being claimed and awarded ranged in size from .135 to 9.39 acres. Claims and testimony reflected extensive taro culture, upland potato cultivation and pasturage. House sites and clusters of houses were numerous and scattered. Also encountered in these records are references to taro patches reserved for paahao or prisoners. Regarding these, little else could be found in official record except that fishponds were also designated for them in the area. It is supposed that the maintenance of these patches and ponds were the responsibility of the prisoners as part of their "hard labor." The fruits of their travail probably went to the chief or toward their own upkeep.

Also worthy of note are the various physical features and landmarks mentioned as boundaries by residents of Honouliuli. Following is a listing by district of some of the more interesting points used by residents in describing parcels:

Kapapapuhi	houselots among which are listed a farmhouse, a vineyard, pastureland, a pond, trails, hog pens, salt beds. There appears to be a church and a cemetery on the rise which may date post-Mahele, as none of the testimony given refer to it.

Niukee	Kaakau cliff, Kaakau community, Nihola pond, Kihewamakawalu cliff, Kehewanakawalu pond, Kalokoiki pond, meeting house, prison plot, huluhulu (prickly pear?), cattle fences.
Kaaumakua	Panahaha fish pond, bulrushes, a high road from the sea inland, Naholowaa pond, salt beds, Kalahu pond.
Mokuneha	2 fishponds, salt beds of which the most westerly situated is called Kohumakahou.
Kamilomilo	extensive taro patches
Loloulu	taro patches, fishpond, a hala grove, a road toward Kaopala's house, pig pens, breadfruit, bulrushes.
Polapola	school house, prison plot, Kapalani Catholic church.
Hiwalalo	kou
Kaulaula	Kaulaula cliff on which is set a wall
Poohilo	Makaakua cliff, Puehuehu stream, Aimea pond, Waianu pond, Kahui pond, taro lake, taro patch guard house, pupulu cave (wet cave?), prison plot, prickly pear, Kalokoloa taro pond, Kaaimano fishpond, Puehuehu road.
Kanookahi	bulrushes
Kailikahi	Highway/roadway, Kauhipuna cliff, lapalapa (panax) thickets, meeting house, prickly pear.
Kamoku	Kauhipuna cliff, kou and aila trees, prickly pear

Note: So far as possible, the approximate locations of the above local land units or areas have been plotted relative to each other on the appended copy of Monsarrat's 1878 map of Honouliuli Valley (State Survey Office, Reg.Map No.630).

Recommendations

It is recommended that additional research effort be expended toward the examination of records relative to early historic period sites such as cemeteries, churches, schools, and prisons within the district. As the information presented in the present report is intended more as an overview based oin readily available sources and often specific information regarding site locations were not found, it is hoped that a more concentrated effort will determine whether any of the above sites are situated within the project area.

Specific research relative to Ewa Plantation and military use of Honouliuli would also be valuable in assessing historical and archaeological sites.

It is also recommended that oral histories be gathered from various individuals associated with the area who are familiar with the details of historic period land use and site locations. As this kind of primary data is too recent to be encountered in the historical literature, it is of definite importance.

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EARLY HISTORIC PERIOD OCCUPATION AND LAND USE - HONOULIULI VALLEY

LCA Awardee	Term of Residence	Land Uses	Comments/Description
748 Kalauhala	since 1837	unfenced houselot and 2 taro patches in Panahaha	bound N. Makaii (Kea) stream, E. Panahaha fish pond, S. & W. bulrushes
749 Mahina	since c. 1838	taro land (a long strip) & houselot in Kaulaula	bound N. Naaa's irrigated terraces, E. Puuhu's land, S. houses of Opala/Opoopu, W. fenced land of Kaulaula & Kaulaula cliff 2nd bound N. Kei's land, E. Puuhu's land, S. Naaa's irrigated terraces, W. Kauhikaula's land (a wall site atop Kaulaula cliff)
751 Kalauli	since 1837 or 8 however, considered an old resident	1) taro land at Kanoku 2) kula land at Kanoku 3) houselot at Kailikahi 4) houselot at Kailikahi; Kalauli lives makai	1) bound N. Kauhipuna cliff, E. Puniawa's land, S. Makaii stream, W. Makue's land. 2) bound N. Kauhipuna cliff, E. Manuwa's land, S. Kanoho's land, W. Naaa's land. 3) bound N. Kekua's and Kaihoopalaai's houses, S. Nealuai's house, W. Pakukae. 4) bound N. highway & Kaiapilau kula land, E. Puniawa's house, S. & W. Kailikahi fence
752 Naaa	since 1842	houselot and 16 taro patches situated next to those of Kekauonohi (possibly her poalima); all in Kailikahi.	bound N. Puhipaka, E. Kauhipuna cliff & Kanoho, S. Makaii stream, W. Puhipaka
753 Manuwa	since 1843	6 taro patches and pasture land in Kanoku; a taro patch site in the middle of the land. Konohiki also has 1 patch here	bound N. Kauhipuna cliff, E. Makue, S. Makaii stream, W. Kanoho & Kahalewai
754 Kaunahi	since 1838	1) houselot 2) taro patches 3) houselot, pasture, 5 taro patches 4) 2 patches 5) 1 patch 6) 1 patch 7) 1 patch 8) upland parcel cultivated with potatoes, also a house where clt. & konohiki live. All parcels appear to be situated in Niukee.	1) bound N. Kaakau cliff, E. Kapoo ose, S. Nihola pond, W. Aaron Nakai & Kauwahine mowai. 2) bound N. Aaron Nakai & Kauwahine auwai, S. Nihola pond, W. Aaron Nakai. 3) bound N. Kinolua, W. river, S. Kawahamana, E. Mapaues 4) bound N. Mapaues, E. Kapio, S. Uia, W. Kawahamana 5) bound N. Kalauwai, E. Kalauwai, S. Naakuia, W. Pio 6) bound N. Nakai, E. Nika, S. Kawahamana, W. Hapaues 7) bound N. Nakai, E. Nika, S. Nakai, W. Kuuhine, 8) ---
755 Kainohanaui	since 1820's, 1830	1) taro/pasture/house- Niukee 2) houselot in Kailikahi	1) bound N. pali & Kuahine's taro patch, E. Kuheou's kula & A. Nakai's land, S. by Kuahine's land, W. Kaluanaao & Paala. 2) bound N. by fence, E. fence, S. Kuahine's houses, W. lapalapa thicket.
756 Kauono	since 1846 as a gift from Kanpe the konohiki	taro land without a house or a fence except the general one belonging to the district situated in Kaumakua	bound N. Pio's land, E. Kapahi's land, S. district fence, W. Kilea's land.

LCA Awardee	Term of Residence	Land Uses	Comments/Description
758 Nihua	before 1839	4 taro patches, pasture and a house in Niukee	bound N. pali (house site near this boundary), E. Kinolua's & Kanalea's lands, S. Kinolua's land, W. Nohunohu's land.
760 Kuheou	since 1839	5 taro patches in Niukee; an upland parcel and a house was not awarded to him as it was claimed by the konohiki Honaunau. It was in Kailikahi.	1) bound N. Kawahamana's land and Nihola pond, E. Kalokoeli, S. & W. Kaalauahi's land 2) bound N. Paala's and A. Nakai's lands, E. Kaunahi's land, S. & W. Mapaues's land 3) bound N. Kaalauahi, E. also, S. Naakuia's fence, W. Kaunahi's land
761 Kinolua	since Kamehameha I, officially since 1839	taro lands, pasture lands & house sites; lands at Niukee & house at Kailikahi.	1) 6 taro patches bound N. by Nihua's land, E. Kanalea's land, S. Makaii stream, W. a poalima and Koolaulu's land 2) bound N. Kukahiko's land, E. Kanalea's land, S. poalima taro patch, W. Kanalea's land 3) kula land bound N. Kaluanano pali, W. Kanalea, E. Honaunau, S. Kaluanano 4) kula land bound N. pali, E. Kanalea, S. Nihua, W. Nihua 5) kula land bound N. pali, E. Nohunohu's kula, S. Nohunohu, W. Kauhi - this is a house lot in Kailikahi 5) housesite bound N. district fence, E. Kanalea's and Nakai's lands, S. pali and Paala's house, W. meeting house with rough lumber and a prickly pear fence/lapalapa thicket. Clt. lived on this parcel.
762 Kalana	from his parents during the time of Kamehameha I	houselot and taro lands in Kaumakua	1) unfenced house site bound N. Naholowaa's lot, E. Paakane's houselot, S. lots, W. Laulii 2) taro land bound N. gov't. patches of Alae, Waa and Lolomia, E. Kuaihee poalima and Paakane's land, S. Kaumakua district fence, W. Naholowaa's and Laulii's lands.
763 Keliiaa	from his father before Kamehameha I	4 houses on a lot at Niva and another houselot and 13 taro patches there. 2 taro patches at Poohilo and cultivated land at Moakapuaa.	1) bound N. Oni, E. Puuhu, S. Kuhiana and Kei, W. pali; Niva 2) 2 taro patches in Poohilo bound N. Opuuui, E. Opiopio, S. Kaeva, W. Kauinui. 3) 13 taro patches and a house lot occupied by Clt. in Niva bound N. Hapahi, E. Kaaui, S. Kalaoa, W. pali 4) Moakapuaa parcel bound N. Kuupoho, E. Laulii, S. Kupopo, W. pali
765 Kanalea	from his father	a houselot, 5 taro patches and 1 pasture in Niukee. Houselot is in Kailikahi.	1) houselot bound N. & E. by Honouliuli district fence, S. road, W. Lapalapa thicket.

LCA Awardee	Term of Residence	Land Uses	Comments/Description
			2) 5 taro patches & 1 pasture bound N. pali, E. Kekukahiko & Kamaala, S. Makaii stream, W. Kinolua
766 Paele	since 1837	2 houses & 6 taro patches in Niukee; a houselot in Kailikahi.	1) taro land bound N. Kaluamano, E. Kainohananui, S. Hapausa, W. Kamaala 2) houselot bound N. Kinolua's houses, E. & Nakai's houses & pali of Kihemaakamalu, W. by "the meeting house for worshiping Jehovah."
767. Kopaues	before Kinau's death	2 taro patches & a houselot in Niukee	1) taro land bound N. Paele, E. Kaunahi, S. Waikala 2) unenclosed houselot on a separate parcel of land; description not given.
768 Pio	from father in 1836	1) 4 patches at Kaumakua - no or fence; from wife 2) 2 houses, hog sty, some growing trees & 2 taro patches at Niukee 3) fenced houselot at Waiohe	1) bound N. Kalaihopu, E. Kalauhala, S. Kaunuo & gov't. fence, W. Nuna & Kaumauma 2) bound N. Kaunahi, Uia & Makai, E. Kaluahi, S. Kaunahi & Makuia, W. Hoaaulituli stream 3) bound N. Kaumauma, E. Honoulituli stream, S. & W. waste land of Ope
827 Kauakahilau	since 1834	1) taro land in Poohilo 2) houselot	1) bound N. a stream and above Kopeaui's land, E. Hinaa & Oni, S. Oni, W. the stream and across Kaku's land. 2) bound N. by "a land fence erected for Cattle" E. Kopeaui, S. stream than Kopeaui's land then Kaumakua
828 Kamahana	from Kainaina, the first konohiki, before 1834; Kahakai become the next konohiki in 134	1) kula land consisting of "one large Kalo lake" of which the taro belongs to the claimant and the fish belongs to Kekauonohi 2) houselot Both are situated in Poohilo	1) bound N. Oni, E. Kapule, S. Kekua, W. Oni 2) bound N. Kauakahilau's houses, E. Kaiziuui, S. Oni's houses, W. Makakua pali
831 Kaakuna	from Kapule in 1834	1) 2 taro patches and kula land 2) 2 new taro patches & 2 houses, one of which is on an enclosed lot Both situated at Poohilo	1) bound N. Aimea pond, E. a pasture, S. Kaaiaana, W. Kaauhau 2) bound N. common cattle fence, E. Manaole, S. Kopeaui, W. Kekua
832 Opiopio	from his father Oni in 1839	1) taro land (3 patches) 2) taro land (separate patch) 3) cultivated plot All are situated in Poohilo	1) bound N. Kauakahilau, Kaakuna, Oni, E. Oni, S. Kaaea, W. Solomon Kolilaa 2) bound N. Oni, E. Kaaiawaawa, S. konohiki, W. Naui 3) bound N. Oni, E. Kaaiawaawa, S. Kuailau & Pehu, W. Koi
834 Oni	from ancestors during Kamehameha'I's time	Makaakua pali, Waiaau & Kahui ponds and Puahuahu stream is mentioned by Oni as boundaries of one of his parcels; this was not verified by other testimony.	1) Poohilo houselot bound N. Kaaiawaawa, E. gov't fence, S. Kekauonohi W. Kuailo & Kaakuna

LCA Awardee	Term of Residence	Land Uses	Comments/Description
		1) houselot in Poohilo - 2 houses for Oni and 2 houses for his father Kuailau 2) 17 taro patches and some upland area 3) 4 taro patches and some upland area 4) a taro patch 5) 2 taro patches & upland 6) upland parcel without a house or fence 7) a taro patch All claims appear to be situated in Poohilo	2) bound N. Kauakahilau, Manaole, Kaaea, E. Hinaa, S. Kekuahilo & Kealana, W. Kapule 3) bound N. gov't. fence, E. Kumupopo, S. Nika, Kaaiawaawa, Opiopio, W. Koi & Nika 4) bound N. Hinaa, E. Manaole, S. Kuahilo, W. Hinaa 5) bound N. Manaole, E. gov't. fence, S. Puniawa 6) bound N. Kauakahilau, E. Manaole & Kapule, S. Hinaa, W. Mauele & Kapule 7) bound N. Kamahana, E. stream, S. Opiopio, W. Kauakahilau
839 Kaaiawaawa	parents lived here during the reign of Kamehameha I	1) houselot contains 2 houses which are unenclosed 2) a taro patch 3) patches 4) patches 5) patches 6) pasture All parcels appear to be situated in Kamilomilo; testimony claims that the konohiki Kalaihopu has a right to all of Kaaiawaawa's taro patches.	1) bound N. lot, E. Oni & Kuailau, S. Kekuahilo, W. Punivai 2) bound N. river, E. Kalaihopu, S. Kanahuna, W. Kaula 3) bound N. Kaula, E. Kanahuna, S. Aamaikai, W. Kahik'ula 4) bound N. Oni, E. Nika, S. Kaailau, W. Opiopio 5) bound N. Kekuahilo, E. Kahakai, S. Pula, W. Kahanana & Kahakai 6) pasture bound N. Oni, E. kula land, S. Punivai, W. Oni
845 Kekukahiko	from parents during Boki's time; Kekukahiko lived there as a child	1) houselot containing a farmhouse, a pasture, vineyard (?) at Kapapapuki. It has been fenced but is falling apart. 2) taro lands	1) bound N. Kealani's houselot, E. pali, S. ocean, W. Kamaala's houses (Kealani's pond is also listed as a eastern boundary) 2) bound N. pali & church, E. Ulia/Uaia?, S. irrigation ditch & Kinolua, W. Kamalae & Nonaunau
847 Hinaa	from the time of Gov. Adams	1) 14 taro patches, a kula land and a guard house; land is enclosed and situated in Poohilo	1) bound N. Manaole, Oni, Kauahilau and Kauhailepa, E. Oni & Kekuahilo, S. Kauakahilau, a river and Oni, W. fence and Hinaa's guard house for his patches
848 Kapule	acquired parcels at various times from the 1790's to 1845	1) houselot with 4 houses where Kapule and his children live; partially enclosed by a fence 2) 6 taro patches 3) 3 taro patches 4) a taro patch 5) 3 taro patches & a pasture. All appear to be situated in Poohilo	1) bound N. Oni & Kahanana, E. Kekua & Kumupopo, S. Kumupopo, W. kula & pali, 2) bound N. Kaakuna, E. Nika, S. Nika & river, W. Kauakahilau, Kahanana, Kaaiawaawa & Kahakai 3) bound N. Oni, E. Kelesana & Moano, S. Manele & Keliiahonui, W. Kekua 4) bound N. Kauakahilau, E. Oni, S. & W. Hinaa 5) bound N. "pupulu cave", E. Manaole, S. Oni, W. Kauakahilau
669 Pue	since 1842	1) houselot with 2 houses - one for Pue and one for his father-in-law Puali 2) kula land, pasture 3) 2 taro patches All appear to be in Naui	1) bound N. Koe, E. Koe, S. Kuhiana, W. Koi 2) bound N. Puali, E. Koe, S. fence, W. Pue's houselot 3) bound N. Koe, E. Koe, S. Kuhiana, W. Koe

LCA Awardee	Term of Residence	Land Uses	Comments/Description
872 Kahakuliliʻi	from Kaope in c. 1814	1) 1 taro patch in 2 halves, one-third of a fishpond and an unfenced houselot; situated in Loloula	1) bound N. Kalauahi, E. Kaloheli & Kekauonohi, S. Naakiki stream and hala grove, W. Nakaili stream, Puanoni & Kapa
874 Laanaikahiki	since 1836	1) houselot with 2 houses - 1 for Laanaikahiki, 1 house and the lot itself for Kaneaola. Situated at Polapola. 2) 5 taro patches	1) bound N. school house, E. Kaneaola's house, S. Kapiioho's house, W. land fence. 2) bound N. Laulii & Kaneaola E. Kekauonohi, S. Laanaikahiki Anilinae, W. Laulii & Kapiioho
876 Kohunohu	since the time of Kamehameha I	1) houselot unenclosed, taro patches (2) and pasture which is unfenced; situated at Niukee	1) bound N. auwai, pali and Kohunohu's houses, E. Nihua, auwai and "hulubulu", S. auwai & Kealani, W. Aoao & Kinolua
881 Kikala	since mid-1830s	1) houselot unfenced with 1 house in Polapola 2) 10 taro patches and some pasturage (1 testimony: 7) 3) 5 taro patches	1) bound N. Nika, E. Kalama, S. Kaope, W. fence (gov't.) 2) bound N. Kaope, E. Nika & Kuaupapa, S. gov't. land, W. Naie 3) bound N. Nilinae, E. Ohai, S. Kukae, W. Kalama
886 Kahalewai	since 1843	1) houselot, taro lands & pasturage (4 taro patches) In the vicinity of his house stood kou & aila trees and auwai. Another houselot is bound by the sea on the east and on the north, Kealani's house site to the south.	1) bound N. gov't. land, E. Aoao, S. small stream then Kaope's land, W. Puniawa
887 Kaihikapu	since 1825	1) houselot, 5 taro patches and pasturage Clt. also mentioned other houses of his in Hoaeae and a vineyard at Pakai in Hoaeae.	1) bound N. gov't. land, E. Aoao, S. a river, W. Puhiawa other testimony gives: 1) bound E. Keihunau, S. Kaneikawaiola, W. Kaumalei & Kukahoe.
892 Samuela Aoao	since Kamehameha I	1) houselot fenced with a single house 2) 5 taro patches Both appear to be in Niukee	1) bound N. road & sea, E. Kaaala, S. sea, W. trail 2) bound N. gov't. fence, E. Kealani & Kohunohu, S. Kinolua, W. Kahalewai
898 Kaneaola	since 1834	1) houselot with 3 taro patches and 2 houses - 1 for Clt., 1 for Laanaikahiki who lives under him. 2) kula land with 2 taro patches 3) a taro patch 4) 2 patches and some upland area	1) bound N. Laulii, E. Kapiioho & Kaope, S. gov't. fence, W. Kekauonohi 2) bound N. Kapiioho & Laulii, E. Upai, S. Nika, W. Laulii 3) bound N. Kaope, E. Laanaikahiki, S. Laulii, W. Mahina & Kaheananui 4) bound N. Honouliuli stream, E. "high road from the Sea inland, S. Pushu, W. Koe
901 Kushina		1) houselot 2) cultivated land 3) cultivated land	1) bound N. Keinohananui's houses & fence, E. Kaakau community, S. pali, W. Kuhemu's house & gully 2) bound N. Keinohananui, E. Nakai, S. Kuhemu, W. Paale 3) bound N. Honaunau kula & the pali, E. Keinohananui, W. Honaunau

LCA Awardee	Term of Residence	Land Uses	Comments/Description
905 Kaimuana	from Kaope in 1835	1) houselot unfenced with 2 houses 2) unfenced taro land Both appear to be in Kaaumakua	1) bound N. Kaholewaa, E. S. & W. Kekauonohi 2) bound N. Nuno, E. & W. Kekauonohi, S. Kalaa ...
906 Kanoho for Abrahama	since 1844	1) 7 taro patches and some kula land in one lot situated in Kanoku	1) bound N. Kaao, E. Manuwa, S. Kekauonohi, W. Kaao
907 Luana	from father-in-law Kamaala in 1842	1) 3 taro patches and a strip of kula land which is unfenced and situated in Niukee 2) small kula in Niukee	1) bound N. auwai & Kamaala's patch E. Kanahamana, S. "pashao" prison & stream, W. Kamaala 2) bound N. pali & meeting house, E. Kinolua's kula, S. Kamaala's patch, W. kulas of Kamaala & Uwia
910 Kuna	from the konohiki Kamae in 1835	1) houselot fenced with 2 houses upon it 2) 4 taro patches and some kula Both appear to be in Kaaumakua	1) bound N. gov't. fence, E. Kekauonohi, S. Kanahana, W. Amaikai 2) bound N., E. & W. Kekauonohi, S. Kaimuana
911 Kauhailepa	from Kinau before 1839	1) 4 taro patches & a strip of kula on which a house sits in Poohile 2) a taro patch	1) bound N. gov't. fence & prison patch & Kinau, E. stream & across Kinau, S. Kauakahilau, W. Kauakahilau & Manaole 2) bound N. Manaole, E. Kauakahilau, S. Kopanui & Kauka, W. Kawahaea
914 Kamaala	from the time of Kamehameha I & Kaahumanu	1) fenced houselot with 4 houses makai of Kapapapuhi 2) 2 taro patches & some kula 3) 3 taro patches & some kula All appear to be at Niukee	1) bound N. Kealani, E. Kekukahiko, S. hog pen & shore, W. Aoao's house 2) bound N. Kinolua, E. Luana, S. Kauaunau, W. Kinolua 3) bound N. Ohia, E. Mokumakuaole, S. Luana, W. Ohia
916 Kane	from Kaope in 1842	1) unfenced houselot with 2 houses 2) 2 taro patches	1) bound N. Nika, E. Nika, S. Kalauhala & stream, W. Kuanani 2) bound N. Kalauahi & auwai, Kuhemu, E. Kalauahi & Kahakuliilii, S. Kuanani, W. Nakaii stream & Maakula
917 Kaulu for Kaalike	from his father in 1848	1) 6 taro patches 2) a taro patch 3) 2 taro patches 4) a taro patch The above lands appear to be in Kaaiiomilo & Kaauwaekua	1) bound N. stream, E. Kalaihopu, S. Kalaikuila, W. Kaope 2) bound N. Kalaihopu, E. Kaaiewaawa, S. Kaaiewaawa, W. Kualkeula 3) bound N. Kaneula & Niau E. Kalaihopu, S. Kepio, W. Amaikai 4) bound N. "winding branch of the sea", E. hill & Nahoiowaa pond, S. "salt bed kula" W. Pia's house
947 Kaopele	His grand-father rec'd it during the time of Kamehameha I	1) houselot 2) 14 taro patches	1) bound N. Pushu, E. Nika, S. Kalana, W. Nika

LCA Awardee	Term of Residence	Land Uses	Comments/Description
	Kaopala got it from his father in 1841	3) 3 taro patches 4) 2 taro patches 5) 3 taro patches	2) bound N. Nika, E. Kauhi, S. Kanaaola, W. Poopuu 3) bound N. Kaope, E. Keakua, S. gov't land, W. Kauhi 4) bound N. stream separating Kanaaola's land, E. Nika, S. & W. Nika 5) bound N. Leubala, E. Nika, S. gov't. fence, W. Kanoue
960 Poopuu	resided here a long time; land acquired from ancestors	1) houselot unenclosed with one house; situated at Loloulu 2) 3 taro patches also at Loloulu	1) bound N. road to Kaopala's house, E. pig pen & Kaopala's land, S. kula & Naulu's house, W. breadfruit 2) bound N. Kihewapuu koele, E. Kaopala, S. Kanaaola, W. Kaopala
1565 Kaaleuahi	since 1841	1) 6 taro patches & a houselot in Kiukeaulinuli	1) bound N. Kekauonohi, Kuheau, Kayahanana, E. Kahakuliilii, Kana, Meakuea, S. Pio, Nakoi, Nia, W. Kapanaa
1570 Kekua I	from the time of Kaahumanu	1) a taro patch & kula land called Aihonu in Waiamu, Poohilo 2) a taro patch called Kaalolemui in Waiamu, Poohilo 3) a cultivated field called Kaluanonomoku in Aihonu, Poohilo 4) 2 taro patches called Kaaiodelu & Kalokoloa in Waiamu, Poohilo	1) bound N. Hopemui koele, E. Nooiki patche belonging to Kauhailepa, S. Kuamulu patch belonging to Manaola, W. land fence 2) bound W. by Kauhailepa's patches Kanaluo & Kaloiiki, E. konohiki's koele, W. Manaole patch & kula, W. Nooiki patch 3) bound N. Kauhailepa's pasture land, E. Manaola's patch called Poepoe, S. Kaekuna's pasture land, W. land fence 4) bound N. Ooni's parcel of land called Poopoo, E. Kuhlesa's patch called Kalokoloa, S. Kumupopo's parcel of land called Kapoe, W. Kekiaha's pasture called Maleokane
1570B Paakana	from the time of Kaahumanu	1) 3 sections of land in a single piece called Maniauu within this is Nooiki & Kuaihaa which are 10 taro patches and a housesite. 2) 2 fishponds in Mokumeha Both are situated in Kaaumakua	1) bound N. Kumuulu land, E. land fence, S. Kalama's land called Kanaoopa, W. Hiilea's land called Kaaookahi 2) bound N. sea shore, E. field of salt beds, S. konohiki lands called Mokumeha, W. Kohumakahou salt beds
1570C Maholowa	from the time of Kaahumanu	1) 1 taro patch, 2 fish ponds & cultivated kula in Kaauewai, Kaaumakua 2) a houselot in Mokumeha	1) bound N. konohiki's land called Kaleuleula, E. land fence, S. konohiki's pond called Kalahu, W. konohiki's land called Polapola 2) bound N. seashore, E. Kaimuena's group of houses, S. Mokumeha kula, W. Mokumeha kula
1573 Kamahamana	from the time of Kamehameha II	1) houselot at Kapapapuhi 2) 5 taro patches in Niukee	1) bound N. sea, E. Kaaleuahi's house, S. sea, W. salt bed 2) bound N. Paala, E. Kaunahi, Kaapeuea, Honaunau, S. Nika, W. Luana & Kanaala

LCA Awardee	Term of Residence	Land Uses	Comments/Description
1580 Kanahuna	from his father in the time of Kamehameha I	1) 3 taro patches in Kaaileaila named Kalawaha, Puina & Palakai 2) houselot	1) bound N. Nakaii stream, E. Kaaumakua land, S. Kumuulu koele, W. Amana koele 2) bound N. Kumuulu koele, E. Kaaumakua land, S. Kealawaaua's land called Palakai, W. Kalawahaiki's koele
1580B Kapiioho	from Kalaoa in the time of Kinau	1) 2 land sections named Nanoealua in Kaahupalaai. 2) 1 taro patch in Niwalale, Kaahupalaai	1) bound N. Alae & Kikala patches/kou koele, E. Palakai land, S. Kumupali kula of Kikala, W. Lopanui land 2) bound N. Alae auwai, E. Kapalakai land of Maio, S. konohiki's poalima, W. Lopanui land of Kalaoa
1598 Kekua	houselot very old; other lands received during Kuakini's time	1) houselot enclosed at Kapapuhi 2) 3 taro patches in Loloulu 3) 1 taro patch in Loloulu	1) bound N. sea, E. Kahalewai's house & the sea, S. & W. houselots 2) bound N. poalima & Moano's patch, E. Moano, S. bulrushes, W. Kumupopo 3) bound N. Kaope & poalima, E. Kumupopo & bulrush patch, S. bulrushes & gov't patches, W. poalima & Kaopala
1605B Nakai	from Kuakahia in the time of Boki	1) 3 taro patches named Nakala, Mahuna, 2 small ones called Kanahupu, Kapaihi 2) a taro patch named Kalolii, and a kula land 3) houselot All are in Niukee	1) bound N. konohiki kula & Kihewanakawalu pond, E. Kaunahi's houselot, S. Nihola pond, W. Kaunahi's patch called Kapaihi and a part of Kihewanakawalu pond 2) bound N. taro pond of Nihola, E. Lokoela pond, S. Pio's pond, W. Niukee auwai 3) bound N. land fence, E. Kaunahi & Manua house complexes, S. Kihewanakawalu pali, W. Kanalua's houselot
1666 Mauwala	from Kauakahilau in 1843	1) 4 taro patches called Kaluaaoo in Poohilo	1) bound N. Kapule's land called Palaau, E. Kaope's land called Puehuehu, S. Kahui land, W. Waiamu koele (Kahui & Waiamu ponds)
1666B Kuahilo	from Kahakai in the time of Kaahumanu	1) 3 patches & a kula land called Kaleipuaua in Poohilo	1) bound N. Kahakai's kula & the prickly pear, E. Aiea koele, S. Kaleipuaua koele, W. Kalokoloa taro pond
1670 Moano	from Kaope during Kinau's reign	1) 1 large taro patch & a housesite at Loloulu 2) cultivated land in Puehuehu 3) housesite in Kalauhala	1) bound N. Kaope & the estuary, E. Kaope's land, S. Pio's land and the bulrushes, W. Kekua's land 2) bound N. Kapule, E. Kaope, S. Kelemana & the estuary, W. Kelemana & the estuary 3) bound N. Aikakana's house & the estuary, E. Pond, S. Kalauhala land, W. Kalauhala taro pond

LCA Awardee	Term of Residence	Land Uses	Comments/Description
1672 Kahua	from Kahalewai during the time of Kalaimoku	1) 6 taro patches, 1 pasture and a housesite at Kauoku 2) cultivated land 3) houselot at Kapapapuhi	1) bound N. prickly pear & auwai, E. Kalauli's land, S. Puniawa pond, W. Manuwa's land 2) bound N. Puniawa land, E. Kalauli, S. koele, W. Manuwa 3) bound N. sea, E. Kelekele, S. kula land, W. Kealani & Keakua
1699 Lalaiaupa		1) parcel situated at Maui 2) parcel situated at Maui	1) bound N. Koi, E. Kanaaola, S. Mahina, W. Koi 2) bound N. Kuhiana, E. Koi, S. Kua, W. Koi & Puali
1701 Alauka	from Kauakahi-lau in 1845	1) 4 taro patches at Poohile	1) bound N. Oni, E. stream, S. Kekaunoohi, W. Kauakahilau
1703 Aaaaikai	from his father-in-law Kaulu/Kahulu in Kinau's time	1) fenced houselot 2) a taro patch Both situated in Kanilomilo	1) bound N. Nuno, E. Kekaunoohi's waste land, S. Kekaunoohi, W. gov't. fence 2) bound N. Nunu & Haapanea, E. Haapuuea, S. & W. Kaope
1713 Kealani	from Nohunohu in the time of Kaahumanu	1) 3 taro patches called Kahui in Kiukea 2) a pond seaward of Kapapapuhi (small sea pond) 3) houselot at Kapapapuhi	1) bound N. konohiki koele, E. Makali stream, S. Aoao's land called Kaloilea, W. auwai & pond called Kaloiiki 2) bound N. salt bed, E. sea shore, S. sea shore, W. Kapapapuhi kula 3) bound N. Kanekawaiola's houselot, E. Kekukahiko's houselot, S. Kekapa's houselot, W. Kekua's houselot
1719 Kiilua	from Kawaa in the time of Kaahumanu	1) 5 patches, a pasture/kula and a houselot in Kaaumakua 2) a patch called Kamookahi in Kaaumakua	1) bound N. Maui patch, E. land fence, S. konohiki koele, W. Kaimuena's land in Kumunlu 2) bound N. bulrushes of Kaaumakua, E. Kaaumakua auwai, S. bulrushes of Kamookahi, W. Kanilomilo land section
1720 Kilinae	from his father Kaio during the time of Kamehameha I	1) 4 taro patches 2) houselot Both situated in Polapola	1) bound N. prison & Kikala's land, E. Kikala, S. Kawaakele, W. Kapiioho -- bound N. Kekai, E. Laanaikahiki, S. Kawaakele, W. Ohai pond 2) bound N. Upai, E. houses of Kanaaola & Laanaikahiki, S. land fence, W. Kapalani Church.
5204 Kalaea 2		1) a taro patch & a "dry kula" in Polapola	1) bound N. Nika's & Kalaoa's patches, E. Kakala's patch, S. 2 houses belonging to Kalaoa & Laanaikahiki, W. Kaope's boundary fence
5653 Kua	occupancy from ancient times; received land as an inheritance from parents	1) 2 patches & a kula land called Kahui at Maui 2) 1 patch called Kamalua at Polapola	1) bound N. Koi's patch called Kahakuaaka, E. land fence, S. konohiki's patch called Puowaikale, W. Lalaiaupa's patch called Iao

LCA Awardee	Term of Residence	Land Uses	Comments/Description
			2) bound N. Kikala's patch called Kapoopoo, E. Ohai's patch called Lopanui, S. Kikala's patch called Kamalua, W. Laanaikahiki's patch called Kapooleiele
5653B Kanehekili	from his father Hapauea in the time of Kamehameha I & Kaahumanu	1) 3 patches & 1 pasture in Kamookahi, Poohile	1) bound N. land fence, E. Kailikahi land, S. Kaalaane fish pond for the konohiki, W. Kaakuna's land called Kupuhau
5654 Kuhiana	from Koi in the time of Kamehameha I	1) Paaohiha taro land in Maui 2) 2 taro patches in Kalokoloa, Poohile 3) a house site in Maui	1) bound N. river, E. konohiki's patch called Kapahupu, S. Koi's land called Ohikeili, W. Pue's land called Kupupali 2) bound N. Puehuehu & a patch, E. Kekiaha's patch called Palaau, S. Kalookane's patch, W. banks of Puehuehu road 3) bound N. Puehu's house & the stream, E. Pue's land called Kumupali, S. Koi's house, W. pali
5670B Kaohai	from his parent in the time of Kaahumanu	1) 3 patches in Lopanui, Kaimupalaai which was later claimed and awarded to the konohiki 2) taro land called Kuamane in Makawela 3) house site in Polapola, adjoining the Catholic chapel yard.	1) bound N. Laanaikahiki's taro patch called Puehuehu, E. Kapiioho's land called Kanaihiili, S. 2 patches - Kumupali, W. Makawela 2) bound N. Kuamanu, E. Kualapuu, S. Pulehu, W. Panaiaui 3) bound N. land fence, E. Catholic chapel, S. road/land fence, W. houselot & kula
5670C Kumupopo	from Kaope in the time of Kinau	1) 7 patches & 1 pasture & house site in Kapoi, Poohile 2) 1 patch called Kamooiki in Loloulu 3) 2 patches & other small patches in Puaalua	1) bound N. Waianu pond, E. Kahui pond, S. Opiopio's land called Kaluakanaka, W. land fence 2) bound N. Kekua's patch called Kapalaho, E. akaakai plants (bulrushes) in Mooiki, S. Keolaaa's & Kekua's patch, W. konohiki's plot 3) bound N. Mooiki akaakai plants, E. Kahaumui's land called Kanakaruaa, S. land fence, W. Kikala's patch
5950 Pihana	from Puniawa in the time of Kaahumanu	1) 3 patches and a kula in Kahui 2) 2 patches named Kalua in Kekee, Kauoku 3) house site in plains of Kailikahi	1) bound N. Kahui ditch & Kailikahi plain, E. Kahalewai's land in Kahui, S. Makali river, W. Kalauli's land called Kaoomuku 2) bound N. Kekua's patch Kekee, E. Kalauli's patch, S. Kalauli's land, W. Kahui patch 3) bound N. & E. Kailikahi pasture, S. land fence, W. prickly pear & Kailikahi kula
10933 Uia	from the time of Kinau, Ola moved to Honolulu & gave land to Kaikaina	1) cultivated land in Kuaiahinaloa, Kiukee 2) 3 patches in Kanoomuku, Kiukee	1) bound N. Kaaeale, E. Kaaeale & watercourse, S Kalokoloa watercourse, W. kula & meeting house

LCA Awardee	Term of Residence	Land Uses	Comments/Description
		3) houselot in Kapapapuhi	2) bound N. Kaunahi & Mapaea, E. Kaalauahi & pig, S. Kuaikee keele, W. konohiki & Kaunahi lands
			3) bound N. konohiki kula, E. Apan's house site, S. beach, W. Mapaua's house
11216 Kekauonohi	owns entirely	43,260 acre ahupuaa	

LOCAL LAND UNITS AND AREAS IN HONOULIULI VALLEY

Copy of 1878 Monsarrat Map of Honouliuli Valley (State Survey Office, Reg.Map No.630), with approximate locations of local land units or areas plotted relative to each other. Based on analysis of LCA documents and testimonies.

between 1913-1917. It was not there after the war. There was also an associated cemetery; the graves did not have headstones, but were just earth mounds.

Fishpond by the railroad was run by the Japanese. The fish were sold at Honouliuli Railroad Station Depot. Some of the Japanese possibly had fishing rights offshore.

There were two houses on Hoaeae Point--Japanese were on the end of the point; they had fishing rights from Campbell Estate. Both houses were on the SSE side of point, located by the brackish well and old windmill.

A Chinese cemetery was mostly located on the present Yoshida lot and also on Mizumoto and Mau lots. There were numerous graves with headstones or monuments.

1942 - During WWII, the army came to Hoaeae Point to put an underground communication cable from the main Waianae Road to the army camp on the point. The army had already modified the area, with antiaircraft gun emplacements. There was a fairly large camp with many wooden buildings. Army bulldozed much of the point area, and apparently leveled the cemetery areas.

1955 - Moved to Hoaeae Point.

1957 - Built a small boat ramp into West Loch. Several artifacts were found during this work, and included a small basalt ulu maika, blade of medium-sized rectangular cross-section basalt adze (tanged), and a small coral knobbed pounder which was found in a small cavity (mortar) in boulder at shore.

INFORMANT "C"

Male, c.80 years old.

1917 - Born at Honouliuli, in home near the old railroad station depot. Attended Ewa School for elementary school, and later St. Louis High School in Honolulu. At approximately 20 years of age, he moved to the inland portion of Honouliuli.

1940 - Enlisted in the Army at the age of 23 years old, served on mainland and many overseas posts, and returned in 1945.

For the next two years, he worked for his brother in Honolulu. He took off for approximately one year.

1950 - Started working at the Ewa Plantation Store, and remained there for the next 32 years, retiring in 1982.

While he had not returned to Hoaeae Point since before WWII, he remembered such things as the Chinese cemetery on the point, and that the ridge above the historic fishpond (Site 3323) was a "spooky place" for children. He also was able to name many of the families that had resided in the seaward part of Honouliuli Valley, and to point out the approximate former locations of their residences on a recent aerial photograph.

APPENDIX B:

NOTES ON LOCAL INFORMANT INTERVIEWS WEST LOCH ESTATES PROJECT AREA

by

Paul H. Rosendahl, Ph.D.
PHRI
Hilo, Hawaii

Informal interviews with several knowledgeable local informants were carried out as part of the overall West Loch Estates reconnaissance survey project. Initial local contacts resulted in a list of numerous potential informants, of whom three were selected on the basis of both familiarity with the Honouliuli area and practical availability. In line with the concluding recommendation made by Silva in her historical documentary research report concerning the gathering of oral histories, it is apparent that it would most likely be productive to consult other individuals from the initial list of potential informants, as well as conduct more formal interviews with the three informants that were visited.

All three informants provided information about 20th century occupation and land use within the project area. Of particular value was the information relating to Hoaeae Point--to the limited pre-WWII habitation, the extensive WWII utilization and modification of the area, and the more recent post-WWII period of occupation--and information relating to the apparent early presence of an old church and associated cemetery on the low ridge just inland of Hoaeae Point, overlooking the OR&L-ROW railroad grade (Site 9417) and the adjacent fishpond (Site 3323) that had been created by the railroad causeway in the early 1890s.

The following information was obtained in a series of informal interviews with three older residents of the Honouliuli area. Individual informants have not been identified by name here in because the interviews were not formal ones, and the information obtained has not been confirmed or checked by means of repeat visits.

INFORMANT "A"

Male, c. 84 years old; married.

1903 - Born 6/6/1903 in Kula, Maui; both parents Chinese.

1912 - At the age of ten, his family moved to the Kahua Ranch area in Honouliuli. A horse stable was located where there is now a large mango tree (between the two lanes of Fort Weaver Road). His father had a store and was also a tailor. He attended Ewa School through the eighth grade.

c. 1918-1919 - Recalled that when he was 15 or 16 years old, he used to go down to Hoaeae Point, along the shoreline as there was no road. There was only the railroad bed. There was a foot trail located along the south side of the point, along the shoreline. Also present at Hoaeae Point were two houses; one at the end of the point, and the other was more inland and seaward of the well. Japanese fishermen had fishing rights to the area. No oysters were in the area; only plenty of clams and crabs. Near the railroad bed was a fishpond [Site 3323] operated by Japanese named Masuda or Matsuda, who lived near the pond.

1920 - Started work at Ewa Plantation. After one year, he went to work in the plantation laboratory, where he stayed for about 20 years.

1941-1945 - During WWII, he worked nights in Office of Civil/Civilian Defense (OCD) for five years.

1945-1967 - After WWII, worked as warehouse supervisor for Ewa Plantation, and retired in 1967.

1947 - Got lease on lot on Hoaeae Point from Campbell Estate. The area was covered with kiawe trees, no army structures remained--only holes [including gun emplacements] from army activities.

c. 1947-1948 - Hardly any mangroves present, mostly along shore.

c. 1950 - Acquired a house and had it moved to Hoaeae Point. Well on Spillner lot was used as a water source (brackish).

c. 1953 - Connection to County waterline extended to Hoaeae Point by residents.

Informant "A" lived in the Kahua Ranch area from 1912-1972. In 1972, he moved to Hoaeae Point, onto the leased lot he had acquired in 1947, and on which he had planted several fruit trees.

Concerning the cemetery previously located on the inland portion of Hoaeae Point, he stated that numerous good-sized tombstones had been present. During the war, soldiers removed tombstones and threw them into the water on the south side of Hoaeae Point. He remembered visiting a cemetery on the ridge overlooking the historic fishpond [Site 3319 vicinity], and that there were tombstones but no church structure present.

He remembered that all land seaward of new road [Fort Weaver Road] had rice fields, and that the fields stretched all the way up the valley to Asing Park. Also, that salt works were operated by Chinese where the National Wildlife Refuge is now located.

INFORMANT "B"

Male, c. 80 years old; married.

1907 - Born in Waikiki in November of 1907; is half Hawaiian (mother), and one-quarter Scotch and one-quarter Irish (father).

1913 - Moved to Pipeline Camp, also referred to as Spanish Camp [on bluffs above old Fort Weaver Road]. Went to Ewa School through 6th grade; and then to Aiea for seventh and eighth grades.

Informant's father became a policeman in 1898, and worked in the Ewa, Waipahu, and Pearl City areas. In 1913, he moved to Ewa, when Mr. Renton was the plantation manager.

1913-1917 - Lived at Pipeline Camp from 1913 to 1917; in 1917, moved to Pearl City, near the court house, until his father retired in 1927.

1913-1917 - At six to ten years of age, went fishing with his father in the shallow waters beyond Honouliuli Stream. There was a wooden house and pier at Johnson's Bar, on the flats to the south of the stream mouth.

Old fishpond area (up to present Fort Weaver Road) was in rice. Old rice mill (Hip Sang Wai Co.) was located between Honouliuli Stream and new polo field. Chinese operated the mill.

Salt works in area of five small ponds [recent ponds].

1922 - Worked on the Farrington Highway road construction as an employee of McCandless Construction.

1926-1940 - Worked for federal government. US Army-Corp of Engineers; initially lived in Waikiki.

1928 - Moved to Kalihi.

1940 - Transferred employment to FCC (Federal Communications Commission). Retired in 1966.

1955 - Moved to Hoaeae Point in 1955, after selling residential lot in Waikiki. As of 1955, there were only a few mangrove trees in Hoaeae Point vicinity of West Loch; dense groves grown up since then.

When young, he remembers Chinese were living in the seaward part of Honouliuli Valley, and raised rice. Hawaiians lived in the inland part; they were mostly fishermen and plantation workers. There was still some taro raised. Chinese grew lotus root in the spring-fed area in back of Johnson's parcel (presently area of Harry Akana's auto parts yard).

Remembers there was a Hawaiian church on the ridge above the historic fishpond [Site 3319 vicinity], a small building that was still in use

between 1913-1917. It was not there after the war. There was also an associated cemetery; the graves did not have headstones, but were just earth mounds.

Fishpond by the railroad was run by the Japanese. The fish were sold at Honouliuli Railroad Station Depot. Some of the Japanese possibly had fishing rights offshore.

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INFORMANT "C"

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While he had not returned to Hoaese Point since before WWII, he remembered such things as the Chinese cemetery on the point, and that the ridge above the historic fishpond (Site 3323) was a "spooky place" for children. He also was able to name many of the families that had resided in the seaward part of Honouliuli Valley, and to point out the approximate former locations of their residences on a recent aerial photograph.

APPENDIX C:

POLLEN ANALYSIS OF AGRICULTURAL DEPOSITS NEAR WEST LOCH, OAHU

by

Linda Scott Cummings
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Denver, Colorado

INTRODUCTION

Pollen samples were collected in conjunction with the archaeological survey of an historic settlement on the edge of West Loch in the flood plain of the Honouliuli Stream. Pollen samples were collected from trenches through areas that displayed probable fishpond or pondfield sediments. These locations have been identified with the assistance of both historic information and examination of the sediments. Pollen analysis was oriented toward the recovery of pollen types that would indicate what, if any, crops were grown in these areas.

METHODS

Pollen was extracted from samples submitted by Paul H. Rosendahl, Ph.D., Inc. from the West Loch area of Pearl Harbor. Hydrochloric acid (10%) was used to remove any calcium carbonates present in the pond deposits, and Lycopodium tablets were added to the samples at this stage, after which the samples were screened through 150 micron mesh. All samples received a short (10 minute) treatment in hot hydrofluoric acid to remove inorganic particles. The samples were then acetolated for 5 minutes to remove organic matter. The samples were examined microscopically at this time, and a single reference slide was made. The samples were then acetolated for an additional 30 minutes to remove more of the voluminous organic matter present. The samples were processed at an elevation of 5,400 feet above sea level, where the acetolysis reaction is considerably slower than at sea level. The samples were rinsed until neutral, at which time two to three drops of 5% KOH were added to the distilled water rinse, to put remaining humic acids into solution. Basic fuschin stain was added to the samples at this time. When the samples rinsed clear with distilled water, microscope slides were made with glycerol to facilitate counting.

A light microscope was used to count the pollen to a total of 100 to 200 pollen grains at a magnification of 500x. Pollen preservation in these samples varied from good to fair. Comparative reference material collected at the Bishop Museum Herbarium was used to identify the pollen to the family, genus, and species level, where possible.

Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen, and may be interpreted to represent pollen dispersal over short distances, or the actual introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram.

DISCUSSION

The project area was divided into four survey areas. Areas 1 and 4 lie closest to the West Loch of Pearl Harbor, while Areas 2 and 3 represent upland areas. The pollen diagram has been organized to reflect these divisions. The majority of the pollen samples analyzed were collected in Areas 1 and 4 (Table 1). Three trenches are represented in each of these areas.

Pollen analysis for this project has identified six pollen types which may represent agricultural activities in this area. These include cf. Oryza (rice), Saccharum (sugar cane), Colocasia (taro), Ipomea (sweet potato), Zea (corn) and Cruciferae (cf. Raphanus - radish).

Probable Oryza (rice) pollen was distinguished from other grass pollens by size and surface texture. The pollen are relatively small, ranging from approximately 20 to 30 microns in size. The pore and annulus combine to measure approximately 6 - 8 microns in diameter. The exine is approximately 1 micron thick and the surface is smooth. Frequently these pollen stained a uniformly dark brown within the trench samples. These grains were separated from small grasses with scabrate surface textures and medium and large grasses during identification It is probable that other grasses occurring naturally in this area overlap the size range of Oryza pollen and have been included in this pollen type.

Saccharum (sugar cane) is a large grass pollen that varies in size from 40 - 65 microns in diameter. The pore plus annulus varies from 10 - 12 microns in diameter. The exine is 2 microns thick and is finely reticulate. Although some grasses overlap sugar cane in size, few if any also have a finely reticulate surface.

The Zea (corn) pollen recovered measured 95 microns in diameter and exhibited a pore plus annulus of 18 microns in diameter. This pollen grain was clearly outside the size range of all other grasses and well within that expected for cultivated corn.

Table 1.

PROVENIENCE OF POLLEN SAMPLES

Sample No.	Depth in cm below pgs	Deposit	Layer	Pollen Counted
Area 1 - Trench 6				
195	140-150	Pondfield deposit	V	100
207	150-160	Pondfield deposit	V	100
189	160-170	Pondfield deposit	V	200
Area 1 - Trench 12				
186	110-130	Pondfield deposit	V	100
187	130-140	Pondfield deposit	VI	100
184	140-150	Pondfield deposit	VI	100
188	150-160	Pondfield deposit	VI	100
Area 1 - Trench 14				
174	130-140	Pondfield deposit	VI	100
Area 2 - Trench 7				
223	130-140	Pondfield?	III	200
232	140-150	Pondfield?	III	200
Area 2 - Trench 30				
303	240-250	Buried old land surface	IV	100
Area 3 - Trench 1				
225	160-180	Pondfield deposit	III	200
Area 3 - Trench 2				
154	150-170	Pondfield deposit	II	Insuff
Area 3 - Trench 7				
163	90-110	Pondfield deposit	III	50
Area 4 - Trench 4				
200	105-115	Pondfield deposit	V	200
Area 4 - Trench 8				
245	60-70	Fishpond deposit	II	200
243	70-80	Fishpond deposit	II	100
234	89-90	Fishpond deposit	II	200
264	90-100	Fishpond deposit	III	100
255	100-110	Fishpond deposit	III	200
252	110-120	Fishpond deposit	III	100
262	120-130	Fishpond deposit	III	100
254	130-140	Fishpond deposit	III	100
Area 4 - Trench 9				
246	60-70	Fishpond deposit	II	200

<u>Pandanus</u> (hala) and <u>Colocasia</u> (taro) pollen are very similar to one another. Both pollens are spherical, echinate, and approximately the same size. Identifiable differences include a single pore in <u>Pandanus</u>, which is occasionally indistinct, and a single culpi (furrow), which is frequently indistinct in taro. All pollen identified as taro were scrutinized for the presence of pores or furrows. No pores were noted in any of these pollen grains included in this category. While furrows were observed in several of the pollen grains, they were not always visible. There were some grains that exhibited no apparent sign of apertures. These grains were included in the taro-type pollen.

Both spiny and smooth <u>Urtica</u>/Moraceae pollen were recovered and were combined into a single category. Breadfruit belongs to the Moraceae family and is a small reticulate pollen grain with two pores. Breadfruit pollen was not recognized specifically as the pollen was counted.

All pollen samples were scanned following the original 100 or 200 grain count, in an effort to recover additional large pollen grains which may provide clues to the cultivation of plants in these areas. It was in this man*** that pollen from sweet potato and corn were recovered in multiple samples. Only a single fragment of sweet potato pollen was recorded within the standard pollen count.

Taro was the most prized cultivated plant among the native Hawaiians. Taro requires 9 - 18 months to mature, and requires complicated and arduous labor to produce a good crop. Areas with finer soils and adequate fresh water are required, and are frequently terraced for cultivation. Drought adversely affects this crop. In contrast, sweet potato provided a common food, that matured quickly in a few months, was easy to tend, and flourished in less favorable locations. Potatoes were not as highly prized as food, however. Sweet potato was frequently planted in areas around houses or dwellings, while taro required prepared, terraced fields for growth. The varieties of taro being grown in Hawaii took advantage of both wet lowlands and drier upland habitats. Taro prospers under a great variety of conditions of soil and soil moisture. Numerous ways of preparing taro existed including steaming, mashing, and pressing into cakes which when dried kept almost indefinitely (Handy and Handy 1978:75).

Taro (<u>Colocasia</u>) is a semiaquatic plant that requires a fresh supply of flowing water. Where sufficient water is not available "dry taro" may be cultivated under mulch. In preparing the soil for taro planting, grasses and weeds were pulled and stamped into the mud. Old taro leaves and weeds were also stamped into the mud at each weeding. These activities may well have introduced an abundance of weed pollen into the soils of taro fields. Large volumes of "green manure" were commonly used to enrich taro soil, whereas animal or human manure, seaweed, and fish were not used as fertilizer. When the soil was exhausted large quantities of hau and kukui branches were pressed into the mud and allowed to rot prior to preparation for the next planting. The important subsidiary crops such as banana, sugar cane, arrowroot, and ti plants were frequently planted on the banks of wet-taro fields. The lo'i or flooded, terraced taro fields also functioned occasionally as fishponds to raise and breed fish. The taro fields remain

flooded throughout most of the growing season, and are drained only when harvest is imminent. The old Hawaiians normally harvested only a portion of the taro from the fields, leaving mature taro corms flooded in the fields where they were preserved for future harvest. Taro corms may be left flooded in the fields for several months before they begin to rot. Taro blooms shortly before the corms have matured (Handy and Handy 1978:81, 89, 94, 101).

Taro, sugar cane, and bamboo are associated with one another through mythology and are thought to have been introduced to the Hawaiian Islands early in the Polynesian occupation. Sugar cane (<u>Saccharum</u>) is noted to grow on the banks separating taro fields, as well as the drier upland areas. Sugar cane requires 12 - 15 months to mature in the lowlands and must have irrigation if rainfall is not sufficient. Just prior to harvesting the cane field is burned to remove the leaves, after which the cane is cut (Handy and Handy 1978:186-187; Neal 1965:78).

Sweet potato (<u>Ipomea</u>) was second only to taro as a dietary item for the Hawaiians. Numerous varieties exist in Hawaii with varying times for maturity. Sweet potato ('uala) requires between 3 and 6 months to mature, whereas taro requires 6 - 12 months in the lowlands. Little labor is required for the planting or cultivation of sweet potato. Sweet potatoes may be grown in any soil except clay and were frequently planted in mounds. The ground is frequently cleared by burning, then mixing the soil thoroughly. The soil is ready for planting when it is thoroughly moist. Sweet potatoes may be planted in terraces which have been levelled for taro, particularly if the season was dry. Like taro, sweet potatoes were never dug completely from an existing bed (Handy and Handy 1978:127-149).

Rice (<u>Oryza</u>) was introduced to Hawaii, probably from China, in 1856. Additional seed was introduced from South Carolina in 1860 and proved to be more suitable. Rice became an important agricultural crop in Hawaii, surpassing coffee in 1862 and becoming second only to sugar in importance (Neal 1965:70-71). Rice is a swamp grass that is usually grown in terraced, irrigated fields. These fields remain flooded until the grains begin to ripen, at which point the water is drained from the fields to hasten the harvest.

Corn (<u>Zea</u>) has been grown in Hawaii for more than a century, placing its introduction at or prior to the same time as the introduction of rice. Corn was attacked by both insect pests and diseases until the introduction of a more resistant form (Neal 1965:82).

Myrtaceae pollen was not identified to genus, and may represent any number of trees, including guava. This pollen was widely scattered through Areas 1 and 4.

Loulu palms are noted to grow in the vicinity of this project area, as their pollen was recorded in small quantities throughout these samples.

All spores were held outside of the pollen count so that pollen frequencies would be directly comparable between samples. The relative frequencies of fern spores are presented at the right side of the pollen diagram, and are calculated on the same base as the pollen frequencies. Fern spores are most abundant in the areas of Trenches 8 and 9 in Area 4, probably indicating wet ground. Sample 303 representing a buried old land surface from Trench 30 in Area 2 is the only other area to exhibit large quantities of spores. This area may also have been rather wet, as both rice-type and taro pollen are noted.

The Honouliuli Stream runs through the project area and provides a constant source of fresh water to these lands. The stream was used as the division between Survey Areas 2 and 3 in the upland and Survey Areas 4 and 1 at the edge of West Loch. The location of this stream is probably very important in the upland section with regard to potential irrigation of farmlands. The entire project lies within the floodplain of this stream, therefore the entire area may be subject to periodic flooding. Trenches in all four survey areas were sampled for pollen to identify crops grown in the various fields. Pondfield deposits were sampled in all four areas, while fishpond sediments were sampled only in Area 4.

Survey Area 2 is farthest upstream, and was sampled in Trenches 7 and 30. Trench 7 is located just east of the banks of Honouliuli Stream and yielded rice-size grass, sugar cane, taro, radish, and sweet potato pollen (Figure 1, Table 2). Because the fields in this area were located so close to the stream they may have been easily irrigated and both rice and taro cultivation, which require considerable amounts of water, may have been possible. It is unlikely that sugar cane, radishes, and sweet potato were grown in the same fields at the same time as rice and taro due to differing water requirements. It should be noted that both rice and sugar cane pollen is wind transported and may, therefore, occur in areas adjacent to fields where these crops were grown. The presence of sweet potato (Ipomea) pollen in both of these samples from Trench 7 suggests that sweet potatoes were cultivated in this portion of Area 2. Taro, radishes, and sweet potato are all insect pollinated. Additional sampling in this area should assist in clarifying which portions of Area 2 were used for cultivating specific crops. Trench 30, represented by a single pollen sample, yielded rice-size grass, sugar cane, and taro pollen. The sugar cane frequency was very small and in all probability represents wind transport of the pollen, not growth of sugar cane in this vicinity. The rice-size grass and taro pollen suggest that this area may have been flooded to allow the growth of these two water-dependent crops, or that the pollen was transported by wind and water to this location. This sample represents a buried old land surface and appears to have been in or near a cultivated field.

Downstream Survey Area 3 is represented by single pollen samples from Trenches 7 and 1. Sample 154 representing Trench 2 did not contain a sufficient concentration of pollen for analysis. The remaining two samples were dominated by Cheno-am pollen, possibly representing weedy annuals. Trench 7 yielded only sugar cane-type grass pollen, suggesting that sugar cane was grown locally in this area. Trench 1, however, yielded a larger frequency of sugar cane pollen, as well as small quantities of rice-size

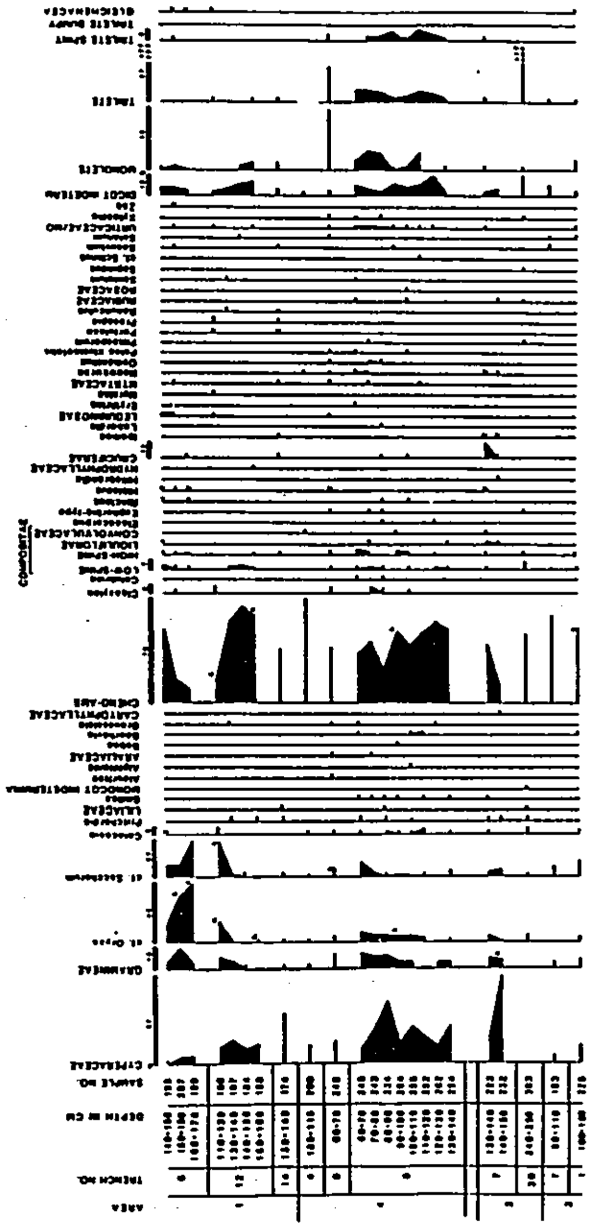

FIGURE 1. POLLEN DIAGRAM FROM AGRICULTURAL DEPOSITS NEAR WEST LOCH, OAHU.

Table 2.

POLLEN TYPES RECOVERED FROM THE WEST LOCH AREA

Scientific Name	Common Name
MONOCOTS:	
Cyperaceae	Sedge family
Gramineae	Grass family
Oryza	Rice, laiki
Saccharum	Sugar cane, ko
Colocasia	Taro, kalo
Pritchardia	Loulu palm
Liliaceae	Lily family
Smilax	Hoi-kuahwi, smilax
Monocot Indeterminate	
DICOTS:	
Aleurites	Kukui nut
Alphitonia	Toi, kauila tree
Araliaceae	Panax family
Bobea	'Ahakea
Boerhavia	Alena
Broussaisia	Kanawao
Caryophyllaceae	Pink family
Cheno-ams	Pigweed family and amaranth
Claoxylon	Po'ola
Colubrina	Anapanapa kukuku
Low-spine Compositae	Sunflower family, includes ragweed, and cocklebur, kikania
High-spine Compositae	Sunflower family
Liguliflorae	Sunflower family, includes cichorium tribe
Convolvulaceae	Morning glory family
Elaeocarpus	Blue marble tree, blue fig
Euphorbia-type	Spurge
Rincinus	Castor bean
Hibiscus	Hau, hibiscus
Hillebrandia	Pau-maka-nui, aka'aka'awa
Hydrophyllaceae	Water leaf family
Cruciferae	Mustard family
Ipomea	Sweet potato, 'uala
Labordia	Kamakahala
Leguminosae	Legume or pea family
Erythrina	Wiliwili
Myrsine	Myrsine
Myrtaceae	Myrtle family
Neowawrae	Mehamehame
Osmanthus	Kwai-fah
Pelea clusiaefolia	Mokihana
Pittosporum	Pittosporum

Table 2. (Cont.)

Scientific Name	Common Name
Portulaca	Purselane, 'akulikuli-kula
Prosopis	Mesquite, kiawe
Ranunculus	Buttercup
Rubiaceae	Coffee family
Rosaceae	Rose family
Santalum	Sandalwood, 'ili-ahi
Sapindus	Soapberry, Manele, a'e
Schinus	Christmasberry
Sesuvium	'Akulikuli, ice-plant
Solanum	Kikania-lei, nightshade, etc.
Urticaceae/Moraceae	Nettle or fig family
Xylosma	Maua
Zea	Corn, maize, kulina
Dicot Indeterminate	
Spores:	
Monolete	
Trilete	
Trilete Spiny	
Trilete Bumpy	
Gleicheniaceae	Vine fern family

The common Hawaiian and English names are given, when known.

grass and taro pollen. It is probable that sugar cane is also a dominant crop in this area, although it is also possible that this area immediately adjacent to the Honouliuli Stream was flooded to allow the growth of rice and taro. Additional pollen samples should be collected from trenches both immediately adjacent to the stream and far removed from the stream in an effort to identify both the actual field components and crops in this area, and to identify a potential diversity in land use or cropping occurring farther from the stream banks. The lack of variety in pollen types representing cultivated crops in Area 3 may be due in part to the few samples representing this area. Additional sampling should clarify which crops were indeed grown in this area, and may substantiate the use of this area for a few specific crops.

Areas 2 and 3 represent the upland sections of this study. Considerably less variety was noted in the pollen record from these two areas than were recovered in Areas 1 and 4. This suggests less diversity in the vegetation. Cheno-ams continue to be the dominant pollen type in most of the samples, with the exception of Trench 7, where Cyperaceae was dominant in the lower sample, indicating wet conditions. Trench 7 is the only portion of this area that exhibits pollen frequencies similar to those recorded in the pondfields from Areas 1 and 4.

Survey Area 4 to the north of Honouliuli Stream and west of the West Loch of Pearl Harbor is represented by samples from Trenches 4, 9, and 8. Trench 4 was closest to the stream and exhibits very small quantities of rice-size grass, sugar cane, and taro pollen. The sample is dominated by Cheno-am pollen, probably representing the growth of weeds in this area. The pollen record provides very weak evidence that this level represents a cultivated field. Sample 246 representing Trench 9, several hundred feet north of the Honouliuli Stream, yielded rice-size grass, sugar cane, and taro pollen. This trench is fairly close to Trench 8, and this large area appears to represent fishpond deposits. Kukui nut (Aleurites) and hau (Hibiscus) pollen were also recovered suggesting the growth of Kukui nut trees and hau in the vicinity or the use of kukui and hau branches to rejuvenate the soil. Mention of this technique is made in Handy and Handy (1978:89) as a common use of "green manure."

The stratigraphic samples collected from Trench 8 exhibit their largest frequency of sugar cane pollen towards the top of the column. Rice-size grass pollen is observed fairly consistently throughout the sediments suggesting the possibility that rice was grown in this flooded area. Taro pollen was associated with the recovery of rice-size grass pollen in all samples except 243, which contained no taro pollen, suggesting that these fields were used at least sporadically to grow taro. Both taro and rice, which require inundation, may be grown in fishponds where fish are being raised or bred. Sugar cane pollen distribution mirrors that of rice, occurring sporadically in the lower portion of the trench, and more regularly in increasing frequencies in the upper portion of the trench. This suggests that sugar cane cultivation may have been more important in this area in more recent times. Small quantities of Cruciferae pollen were also observed in samples from this trench, suggesting that a member of this family was cultivated or grew as a weed in this area. Sugar cane and taro represent crops that were introduced to the Hawaiian Islands early during the Polynesian occupation, whereas rice was a relative latecomer.

Area 1 to the south of Honouliuli Stream and to the west of the West Loch of Pearl Harbor is represented by three trenches in the pollen record. Trench 14 is removed from Honouliuli Stream by approximately 1,000 m., but is within a few hundred meters of West Loch. Fishponds are noted between this pondfield area and West Loch. A single pollen sample was collected from Trench 14 and yielded a very small quantity of rice-size grass pollen, a relatively small frequency of sugar cane pollen, as well as small quantities of both Cruciferae and sweet potato pollen. The Cruciferae pollen is consistent with radish pollen, and may represent the growth of radishes in this area. It is doubtful that the rice-size grass pollen represents the cultivation of rice in this area, as the frequency is very low and rice pollen is wind transported. The presence of sugar cane, sweet potato, and possibly radish pollen is interpreted to be more representative of local crops.

Trench 12, a few hundred feet to the south of Trench 14, is represented by a series of four pollen samples from pondfield sediments. The uppermost pollen sample from this column displays relatively large

frequencies of both rice-size grass and sugar cane pollen, as well as taro pollen. It appears that this level (110 - 130 cm) represents the possible growth of rice and taro in an inundated field, and possibly sugar cane either along the pond margins or during drier years in the same field area. The lower samples contain very small frequencies of rice-size grasses and sugar cane pollen suggesting that these may have been worked down into the lower sediments during the process of working "green manure," which consists of leaves and weeds, into the soil to enrich it. This would provide mixing of pollen from the upper cultivated levels with lower levels. These lower levels also exhibited large Cheno-am frequencies, similar to those observed in Trench 4. It is possible that these very high frequencies of Cheno-am pollen and low quantities of agricultural crop pollen represent fallow periods for these fields. Many members of the Cheno-am group which are noted to be edible include pigweed or lambs quarters, which was used for its greens; Mexican tea, used for greens, tea, and medicine; garden beet; swiss chard; and spinach. Several amaranths were grown as ornamentals although the greens may also be eaten (Neal 1965:331).

Several pollen samples were very black and dominated by small black fragments under the microscope. These samples emitted a foul odor similar to burning rubber when the microscope slides were made using an infra-red lamp. Pollen samples 184, 187, and 188 from Trench 12 in Area 1 were noted to display these characteristics. This may have resulted from burning vegetation in the fields, such as sugar cane. A few other samples scattered throughout the trenches also were noted to have similar characteristics, although not to as great a degree.

Trench 6 is the closest to the fishponds and West Loch of Pearl Harbor. All three samples examined from the pondfield sediments in this trench yielded large frequencies of rice-size grass pollen suggesting that rice was, in fact, grown in this area. A small quantity of taro pollen was recovered from the upper level (140 - 150 cm, sample 195). Moderate to large frequencies of sugar cane pollen were also recovered from these samples, suggesting that sugar cane was grown in this general vicinity. A small quantity of Cruciferae pollen was recovered from the lowest sample examined from this trench, suggesting that a member of this family may have been grown at the edge of this field. The only corn (Zea) pollen recovered in this project was observed in sample 207 from a depth of 150 - 160 cm in this trench. This indicates that corn was also grown in this general vicinity. Corn pollen is relatively heavy and does not travel farther than a few hundred feet on the wind. Most corn pollen, in fact, travels only a few tens of feet beyond the edge of the field. Corn pollen may have been transported by water from the edge of the pondfield represented by sediments in these trench. Small quantities of hau (Hibiscus pollen) were recovered from all of the samples from this trench, indicating that either hau grew along the field boundary or that hau branches were used as "green manure" to enrich the soil.

SUMMARY AND CONCLUSIONS

The pollen record from this examination of sediments from several trenches in the project area indicates that pollen analysis is a valuable tool for identifying crops grown in these fields, as well as identifying probable field locations. Much more extensive and intensive sampling is recommended, based on the recovery large quantities of identifiable pollen from these sediments, and the presence of pollen representing several cultivated crops including sugar cane, sweet potato, corn, taro, and possibly rice and radishes.

The pollen record suggests that rice cultivation was most probable in the areas of Trenches 6 and 12 in Area 1. Rice cultivation is also possible in Trench 8 in Area 4. Due to the problematic identification of rice pollen, in that its size overlaps with other types of grass and the fact that there are no distinguishing characteristics on the surface of this pollen, identification of actual rice fields based on pollen data is tenuous. Sugar cane, on the other hand, has a relatively large pollen which does not overlap in size with many other grass types and the surface is reticulate, a characteristic that is uncommon in this family. Identification of this grass pollen is far more certain in the record. It should be noted, however, that sugar cane pollen is transported by the wind and may be recovered from sediments outside the areas where sugar cane is grown. Sugar cane pollen is ubiquitous in this pollen record, indicating that sugar cane was probably planted in several areas within the study area, and was planted over a long time period. Sweet potato pollen is insect transported and its presence is interpreted as representing sweet potato cultivation or transportation of this pollen by water to its present location.

Sugar cane-type pollen was recovered from Trench 6 in Area 1 in its largest frequency in sample 189 (160 - 170 cm). The frequencies declined slightly in the upper two samples. This suggests sugar cane cultivation in the general vicinity. It should be noted that all grasses are wind pollinated and the identification of actual fields of rice and sugar cane, as well as corn, would require considerable additional sampling in this area to provide a mosaic of samples capable of addressing fluctuating frequencies of pollen types.

Area 1 Trench 12 exhibited a large frequency of sugar cane pollen in the uppermost sample, suggesting sugar cane cultivation in this area. Much smaller quantities of sugar cane size pollen were recovered in samples 187 and 184 from this trench. Both sugar cane and rice cultivation, as well as taro cultivation, appear to have been more widespread at 110 - 130 cm (186) than previously in this area. The low quantities of rice and sugar cane pollen observed in the lower portions of this trench may represent either cultivation of these crops in the immediate vicinity, or wind or water transport of this pollen from other nearby areas. They may also be the result of working "green manure" into the soil to prepare the ground for taro cultivation, thus introducing the pollen into lower levels. The recovery of kukui and hau pollen in Area 4

Trench 9 suggests that these branches may have been used as "green manure" to enrich the soil. In addition, hau pollen was recovered in Area 1 Trench 6, again suggesting either the presence of hau at the field boundaries or use of hau branches as "green manure."

The pollen record suggests that rice-size pollen recovered from most locations (which did not exceed c. eight percent) is wind transported grass pollen. The only rice-size pollen to exceed eight percent was recovered from Layer V of Trenches 6 and 12 in Area 1--an area in which rice may have been cultivated. None of the other areas trenched display large frequencies of rice-size grass pollen. Identification of a "threshold" frequency for rice-size grass pollen that would serve to indicate probable rice cultivation is necessary to further work in this area. This would be best accomplished by sampling modern cultivated fields as controls for interpreting the historic and prehistoric field sediments. This type of control is particularly important in the interpretation of evidence for rice cultivation.

Sweet potato pollen was recovered from two locations: Area 1 Trench 14 and Area 2 Trench 7. The presence of sweet potato pollen is a strong indication of cultivation of this crop, since the plant is insect pollinated and the pollen does not travel unless carried by man or insect, or possibly water. Due to the relatively wet nature of most of the study area, sweet potato cultivation is expected to be confined to only a few areas.

The recovery of corn pollen was unexpected in this area. Its presence raises questions concerning the abundance of this crop and locations of fields in which it was grown. Cruciferae pollen that most closely resembles radish was abundant in one location (Area 2 Trench 7). Additional pollen representing garden vegetables may be recovered during future sampling.

The successful recovery of pollen from a variety of plants in these 24 samples examined from four survey areas indicate that palynology is a valuable tool in describing and defining historic and prehistoric cultivated areas. Based on analysis of the material, additional study and analysis of these fields is strongly recommended. Definition of agricultural fields is possible through the identification of pollen representing cultivated plants. Analysis of additional samples within these areas would provide better definition of agricultural fields used by the historic and prehistoric occupants of this area. It would assist in defining areas that had been used for the cultivation of sweet potatoes as opposed to rice or taro. The growth of corn in this area would also be further identified. A mosaic of pollen samples across all areas that may have been cultivated would assist in a definition of areas used in the cultivation of corn, as well as other crops.

Additional sampling should be structured to sample identified stratigraphic layers in each survey area, as well as provide a representative horizontal distribution of samples across each area.

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APPENDIX D:

DETAILED SUMMARY OF SHALLOW SUBSURFACE TESTING RESULTS - SHOVEL TEST UNITS IN SURVEY AREA 5

HOAKAE POINT - (SU-1 thru SU-74)

Shovel Unit 1

0-30 cmbs	Compact, brown clay loam containing large amounts of marine and brackish-water shell. No cultural material present.
30-50 cmbs	Very durable, compact, brown sandy clay loam. No cultural material present.

Shovel Unit 2

0-10 cmbs	Compact, brown clay loam with basalt gravel fill. No cultural material present.
10-30 cmbs	Very hard, durable, brown clay loam. No cultural material present.

Shovel Unit 3

0-30 cmbs	Very loose dark brown loam with decomposing organic materials; probably an O/A-horizon. Large amounts of *Pinctada* spp. shell present. No cultural material present.
30 cmbs	Coral-shell reef.

Shovel Unit 4

0-65 cmbs	Brown clay loam with sparse amounts of shell.
65 cmbs	Coral-shell reef.

Shovel Unit 5

0-50 cmbs	Brown clay loam matrix containing large amounts of marine and brackish-water shell and one volcanic glass fragment.
50-65 cmbs	Compact brown clay loam with no cultural material.

Shovel Unit 6

0-38 cmbs	Brown sandy clay loam with sparse amounts of shell.
38-50 cmbs	Compact brown clay loam with no cultural material.

Shovel Unit 7

0-5 cmbs	Brown sandy clay loam with one piece each of ceramic and bottle glass, not retained.
5-50 cmbs	Brown sandy clay loam with no cultural material.

Shovel Unit 8

0-40 cmbs	Soft brown sandy loam which contained about 12 pieces of shell, and modern trash and glass.
40-60 cmbs	Hard compact clay.

Shovel Unit 9

0-45 cmbs	Very loose dark brown loam with decomposing organic material and large amounts of marine and brackish-water shell; probably an O/A-horizon. One to two pieces of charcoal and fish bone were present between 0-30 cmbs.
45 cmbs	Coral-shell reef.

Shovel Unit 10

0-10 cmbs	Light brown alluvial sand containing a few pieces of shell.
10 cmbs	Coral-shell reef.

Shovel Unit 11

0-35 cmbs	Brown sandy loam with shell and charcoal.
35cmbs	Coral-shell reef.

Shovel Unit 12

0-40 cmbs	Compact brown sandy clay loam.
40-55 cmbs	Sterile very compact brown clay loam.

Shovel Unit 13

0-35 cmbs	Compact brown sandy clay loam with one *Cypraea* sp. and one fire-cracked basalt fragment.
35-50 cmbs	Sterile very compact brown clay loam.

Shovel Unit 14

0-35	Brown sandy clay loam with no cultural material.
35-55 cmbs	Sterile compact brown clay loam.

Shovel Unit 15

0-30 cmbs	Dark brown sandy clay loam containing large amounts of marine and brackish-water mollusc shell, one flake of volcanic glass, and two machine-made nails.
30-50 cmbs	Very compact, reddish-brown clay loam. No cultural material present.

Shovel Unit 16

0-30 cmbs	Dark brown sandy loam containing large amounts of marine and brackish-water mollusc shell, and scattered charcoal.
30-50 cmbs	Compact, reddish-brown clay loam. No cultural material present.

<u>Shovel Unit 17</u>

0-40 cmbs	Soft brown sandy loam containing large amounts of marine and brackish-water mollusc shell and one flake of volcanic glass.
40-60 cmbs	Very compact, brown clay loam. No cultural material present.

<u>Shovel Unit 18</u>

0-60 cmbs	Disturbed brown sandy clay loam with shell material, basalt fill, charcoal, and automobile glass and metal.
60 cmbs	PVC pipe. Unit discontinued.

<u>Shovel Unit 19</u>

0-50 cmbs	Same as SU-18. Unit discontinued.

<u>Shovel Unit 20</u>

0-50 cmbs	Road fill. Unit discontinued.

<u>Shovel Unit 21</u>

0-30 cmbs	Dark brown clay loam containing small amounts of marine mollusc shell, basalt rocks, and one bird bone.
30-35 cmbs	Compact brown clay with no cultural materials.

<u>Shovel Unit 22</u>

0-10 cmbs	Brown sandy clay loam with marine and brackish-water mollusc shell.
10-35 cmbs	Brown clay loam with no cultural material.
35 cmbs	Coral-shell reef.

<u>Shovel Unit 23</u>

0-20 cmbs	Dark brown, compact clay loam containing minor amounts of shell, one fragment of green bottle glass, and miscellaneous recent garbage.
20-50 cmbs	Very compact, brown clay loam. No cultural material present.

<u>Shovel Unit 24</u>

0-10 cmbs	Dark grayish-brown clay loam containing only three fragments of marine shell.
10-50 cmbs	Very compact, brown clay loam. No cultural material present.

<u>Shovel Unit 25</u>

0-35 cmbs	Reddish-brown sandy loam containing small scattered amounts of shell, recent historic garbage, and brick fragments. Local informant indicates that this is recently placed land fill.
35-55 cmbs	Very dark brown silt containing small scattered amounts of shell. According to local informant this area was a mud flat prior to land filling. This lower deposit is probably comprised of the former mudflat.

<u>Shovel Unit 26</u>

0-30 cmbs	Compact, dark brown clay loam containing large amounts of <u>Brachidontes</u>, other shellfish remains, and scattered charcoal.
30-46 cmbs	Very compact brown clay loam. No cultural material present.

<u>Shovel Unit 27</u>

0-10 cmbs	Dark brown clay loam containing small, scattered amounts of marine and brackish-water shell.
10-25 cmbs	Light gray decomposing coral.
25-50 cmbs	Very dark gray water-saturated silt loam scattered with a small amount of shell.

<u>Shovel Unit 28</u>

0-15 cmbs	Dark brown clay loam containing recent miscellaneous garbage and a single flake of volcanic glass. Also present were small amounts of scattered marine shell.
15-21 cmbs	Decomposing coral bedrock.

Shovel Unit 29

0-12 cmbs	Compact dark brown clay loam, containing small amounts of scattered marine and brackish-water shell.
12-55 cmbs	Loosely compacted, light brown to brown sandy loam, containing moderate amounts of shell and waterworn basalt and coral.

Shovel Unit 30

0-30 cmbs	Loosely compacted light brown clay loam, containing moderate amounts of shell, charcoal, and modern garbage.
30-50 cmbs	Loosely compacted light brown clay loam containing a small number of waterworn basalt cobbles and pebbles.

Shovel Test 31

0-22 cmbs	Brown sandy clay with no cultural materials.
22-47 cmbs	Waterworn basalt pebbles and cobbles; either alluvial or river/beach bed. No cultural material present.

Shovel Unit 32

0-20 cmbs	Brown silty clay loam, mostly basalt fill, with no cultural material present.
20 cmbs	Extremely compact sandy clay with decomposing shell and coral reef.

Shovel Unit 33

0-10 cmbs	Sterile sandy clay loam.
10 cmbs	Coral-shell reef.

Shovel Unit 34

0-15 cmbs	Dark brown silty clay loam with shell, charcoal, crustacea, kukui, and fire-cracked waterworn basalt.
15-35 cmbs	Very dark brown silty clay loam with charcoal and fire-cracked basalt.
35-40 cmbs	Very compact sandy clay with decomposing shell and coral rock. No cultural material present.

Shovel Unit 35

0-30 cmbs	Dark brown sandy clay loam with marine and brackish-water mollusc shell. No cultural material present.
30-50 cmbs	Brown sandy clay loam with no shell and no cultural material.

Shovel Unit 36

0-10 cmbs	Brown sandy loam, loose with moderate amounts of shell and recent trash.
10-35 cmbs	Brown sandy loam with shell, charcoal fragments, and no trash.
35-50 cmbs	Very compact clay loam with a decrease in shell material. No cultural material present.

Shovel Unit 37

0-7 cmbs	Brown clay loam, compact, with rusty metal fragments.
7-35 cmbs	Brown clay loam, compact, with moderate shell and no metal.
35-40 cmbs	Very compact brown clay with a decrease in shell material. Unit discontinued.

Shovel Unit 38

0-30 cmbs	Dark brown loam with organic material and some marine and brackish-water mollusc shell (including Nerita picea).
30-50 cmbs	Slightly compact brown clay loam. No cultural material present.

Shovel Unit 39

0-25 cmbs	Compact yellowish-brown clay loam with 20 pig vertebrae.
25-40 cmbs	Basalt rock in a clay loam matrix. No cultural material present.

<u>Shovel Unit 40</u>

0-20 cmbs	Dark brown loam with modern trash.
20-50 cmbs	Compact dark brown loam with moderate amounts of marine and brackish-water shell, sparse fish bone, and charcoal.
50 cmbs	Brown, very hard stony loam with shell material decreasing. Unit discontinued.

<u>Shovel Unit 41</u>

0-22 cmbs	Brown sandy clay loam with moderate amounts of marine and brackish-water shell, and sparse charcoal.
22-26 cmbs	Yellowish-brown silt loam with no cultural material.
26-35 cmbs	Brown stony sandy loam with no cultural material. Unit discontinued.

<u>Shovel Unit 42</u>

0-15 cmbs	Brown sandy clay loam with modern glass.
15-25 cmbs	Very hard clay loam with no modern glass.
25-35 cmbs	Sterile compact brown clay loam.

<u>Shovel Unit 43</u>

0-10 cmbs	Brown loam with decomposing organic material. No cultural material present.
10-25 cmbs	Compact brown clay loam with some marine and brackish-water shell.
25-40 cmbs	Very hard sterile clay loam.

<u>Shovel Unit 44</u>

0-20 cmbs	Very hard brown clay loam with modern trash and sparse amounts of shell.
20-45 cmbs	Extremely hard clay loam.

<u>Shovel Unit 45</u>

0-50 cmbs	Dark brown sandy clay loam with alluvial waterworn basalt. Shovel unit bisects most likely post-1950 terrace with retaining wall. No cultural material present. Unit discontinued.

<u>Shovel Unit 46</u>

0-45 cmbs	Dark brown clay loam with no cultural material present.
45 cmbs	Coral-shell reef.

<u>Shovel Unit 47</u>

0-45 cmbs	Disturbed brown clay loam with sparse shell and PVC water pipes. Unit discontinued.

<u>Shovel Unit 48</u>

0-20 cmbs	Brown silty clay with marine and brackish-water mollusc shell. No cultural material present.
20-50 cmbs	Compact silty clay with less shell material. No cultural material present.

<u>Shovel Unit 49</u>

0-60 cmbs	Brown sandy clay loam with marine and brackish-water mollusc shell and one pig tooth.
60-85 cmbs	Brown sandy clay loam with sparse mollusc shell. Unit discontinued.

<u>Shovel Unit 50</u>

0-20 cmbs	Slightly compact sandy clay loam with no cultural material present.
20-35 cmbs	Very hard brown clay loam with no cultural material present.

<u>Shovel Unit 51</u>

0-30 cmbs	Soft brown sandy clay loam with sparse marine and brackish-water mollusc shell. No cultural material present.
30-50 cmbs	Compact brown clay loam with a decrease in shell. No cultural material present.

<u>Shovel Unit 52</u>

0-37 cmbs	Brown sandy clay with no cultural material present.
37 cmbs	Coral-shell reef.

<u>Shovel Unit 53</u>

0-35 cmbs	Brown silty clay loam with large amounts of marine and brackish-water mollusc shell, sparse charcoal, <u>kukui</u>, and one piece of fire-cracked waterworn basalt.
35-50 cmbs	Very hard sterile brown clay.

<u>Shovel Unit 54</u>

0-32 cmbs	Brown sandy clay loam containing metal fragments, burnt shell, and worked bottle glass.
32-40 cmbs	Compact sterile clay.

<u>Shovel Unit 55</u>

0-47 cmbs	Dark brown sandy to gravelly clay loam with bottle glass, and ceramic sherd. Tar uncovered at 35 cmbs.
47-60 cmbs	Dark brown gravelly clay loam with no cultural material present. Unit discontinued.

<u>Shovel Unit 56</u>

0-60 cmbs	Brown sandy clay loam with no cultural material present.
60 cmbs	Coral-shell reef.

<u>Shovel Unit 57</u>

0-25 cmbs	Brown clay loam containing a small amount of, scattered shell. No cultural material present.
25-50 cmbs	Compact reddish-brown clay loam. No cultural material present.

<u>Shovel Unit 58</u>

0-10 cmbs	Grayish-brown sandy loam with modern trash.
10 cmbs	Coral-shell reef.

<u>Shovel Unit 59</u>

0-40 cmbs	Dark grayish-brown silt loam containing large amounts of <u>Brachidontes</u> sp. shell, as well as minor quantities of other shell types. Scattered charcoal, ash, and waterworn basalt pebbles also present. A single basalt adze fragment was recovered 0 and 12 cmbs.
40-50 cmbs	Very compact brown clay loam. No cultural material present.

<u>Shovel Unit 60</u>

0-35 cmbs	Semi-compact grayish-brown sandy silt loam containing large amounts of marine and brackish-water shell, predominantly <u>Brachidontes</u> sp. Scattered ash and charcoal and several small waterworn basalt cobbles and pebbles also present. A small amount of recent-historic rusted metal fragments were present within the upper portion of this layer.
35 cmbs	Light gray decomposing coral-shell reef.

<u>Shovel Unit 61</u>

0-30 cmbs	Loosely compact, reddish-brown silty clay loam containing large amounts of marine and brackish-water shell fish remains.
30-40 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 62</u>

0-31 cmbs	Loosely compact grayish-brown silty sand containing large amounts of fragmented shell, a few pieces of burned shell, two unburnt fish bones, ash, charcoal, and fire-cracked rock.
31-37 cmbs	Concentrated layer of ash and charcoal; probably the remains of a buried hearth.
37-40 cmbs	Very hard brown clay. No cultural material present.

<u>Shovel Unit 63</u>

0-30 cmbs	Dark brown silty clay loam containing small amounts of marine and brackish-water shellfish remains.
30-40 cmbs	Very compact, brown clay loam. No cultural remains present.

<u>Shovel Unit 64</u>

0-25 cmbs	Grayish-brown silty loam containing large amounts of shell fragments, sparsely scattered charcoal, and waterworn basalt cobbles and pebbles.
25-40 cmbs	Very compact yellow-brown clay loam. No cultural remains present.

<u>Shovel Unit 65</u>

0-45 cmbs	Moderately compact, grayish-brown sandy silt loam containing large amounts of shell, coral, and basalt cobbles and pebbles.
45-50 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 66</u>

0-50 cmbs	Loosely compact, light brown sandy silt loam containing large amounts of fragmented shell, vesicular and waterworn basalt cobbles and pebbles, and recent historic tar paper, plastic, and charcoal.
50-60 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 67</u>

0-35 cmbs	Loosely compact grayish-brown sandy silt loam containing recent garbage, charcoal, and ash.
35-50 cmbs	Very compact yellow-brown clay loam. No cultural material present.

<u>Shovel Unit 68</u>

0-23 cmbs	Dark grayish-brown sandy silt loam containing small, scattered amounts of charcoal, and rusted fragments of metal.
23-45 cmbs	Very compact brown sandy clay loam. A small amount of shell present.

<u>Shovel Unit 69</u>

0-15 cmbs	Loosely compacted brown clay loam. No cultural material present.
15-50 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 70</u>

0-20 cmbs	Dark brown clay loam containing a small, scattered amount of shell.
20-50 cmbs	Very compact reddish-brown clay. Small amount of shell present near the upper boundary of this otherwise culturally sterile deposit.

<u>Shovel Unit 71</u>

0-40 cmbs	Compact brown clay loam. No cultural material present.
40-50 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 72</u>

0-15 cmbs	Very compact brown clay loam. No cultural material present.
15-50 cmbs	Very compact reddish-brown clay. No cultural material present.

<u>Shovel Unit 73</u>

0-30 cmbs	Very compact brown clay loam containing a small number of scattered marine and brackish-water shells.
30-50 cmbs	Very compact reddish-brown clay. No cultural material present.

Shovel Unit 74

0-20 cmbs	Dark brown sandy loam with historic glass and metal.
20 cmbs	Coral-shell reef.

SITE 3319 AND IMMEDIATE VICINITY (SU-1 thru SU-24)

Shovel Unit 1

0-5 cmbs	Decomposing forest litter and unconsolidated organic debris plus scattered marine shell fragments.
5-50 cmbs	Compact, dark brown loamy soil containing large amounts of marine invertebrates, and scattered waterworn basalt pebbles and cobbles. A thin ash deposit containing fire-cracked rock (a possible hearth) encountered at c. 30-38 cmbs. A single piece of volcanic glass encountered at 40-50 cmbs.
0-55 cmbs	Hard, compact reddish-brown clay loam. No cultural material present.

Shovel Unit 2

0-30 cmbs	Decomposing forest litter and unconsolidated organic debris. Under the surface litter/debris was an A-horizon which extended to 30 cmbs. Within this horizon was a moderate amount of marine/brackish-water shell, including a single fragment of worked or modified marine shell.
30-50 cmbs	Comprised of a consolidated reddish-brown clay. No cultural material present.

Shovel Unit 3

0-30 cmbs	A-horizon contained a moderate amount of marine/brackish-water shellfish remains, a small number of terrestrial gastropods, and small waterworn basalt pebbles and cobbles.
30 cmbs	Comprised of compact, sterile reddish-brown clay. No cultural materials.

Shovel Unit 4

0-10 cmbs	A thin A-horizon containing small amounts of marine/brackish-water bivalve shells.
10 cmbs	Compact, sterile reddish-brown clay. No cultural remains.

Shovel Unit 5

0-18 cmbs	Contained a small amount of marine and brackish-water shell.
18-28 cmbs	A large coral boulder packed in a tight matrix of waterworn basalt cobbles and pebbles.
28-30 cmbs	Waterworn basalt cobbles and pebbles containing two (probably adult) human teeth, a lower incisor and a premolar fragment. Also present were fragments of possible human bone, including a short mid-section of a long bone.

Shovel Unit 6

0-10 cmbs	A-horizon contained small amounts of unidentified mammal bone and small amounts of brackish-water and marine shell.
10 cmbs	Reddish-brown clay subsoil. No cultural materials.

Shovel Unit 7

0-5 cmbs	Comprised of unconsolidated decomposing humus and forest litter.
5-25 cmbs	Sterile reddish-brown clay. No cultural materials were recovered.

Shovel Unit 8

0-5 cmbs	Comprised of humus, unconsolidated forest litter, and very small amounts of shell and charcoal.
5-35 cmbs	Sterile subsoil; no cultural material.

Shovel Unit 9

0-5 cmbs	Comprised of unconsolidated humus and organic debris.
5-35 cmbs	Sterile subsoil; no cultural remains.

Shovel Unit 10

0-10 cmbs	Thin A-horizon of forest litter and humus which contained a small amount of shell.
10-40 cmbs	Sterile reddish-brown clay. No cultural remains present.

Shovel Unit 11

0-40 cmbs	A-horizon containing large amounts of brackish- and fresh-water shells, a number of terrestrial gastropod shells, and a fish vertebra.
40-55 cmbs	Sterile reddish-brown clay.

Shovel Unit 12

0-30 cmbs	Comprised of water-saturated, reddish-brown clay loam which probably eroded off the top of the ridge nose. No cultural material present in the loam.
30-50 cmbs	Coarse sand; this sand may have once been part of a beach that bordered West Loch. A small amount of marine and brackish-water shell was recovered from the sand.

Shovel Unit 13

0-60 cmbs	Homogenous deposit of reddish-brown loamy clay; this clay probably eroded off the top of the ridge nose. No cultural material was recovered.

Shovel Unit 14

0-50 cmbs	Comprised of loosely compact, water-saturated dark brown clay loam.
50-65 cmbs	Compact reddish-brown clay. No cultural material was recovered.

Shovel Unit 15

0-55 cmbs	Comprised of loosely compacted, dark brown clay loam. This loam became increasingly saturated with water as the depth of the unit increased. Two marine shell fragments were recovered from the loam.

Shovel Unit 16

0-10 cmbs	Comprised of loosely compacted, dark brown clay loam.
10-65 cmbs	Comprised of a thick layer of historic garbage—plastic, glass bottles, aluminum cans, and pull-top rings.

Shovel Unit 17

0-30 cmbs	Loosely consolidated, dark brown loamy clay.
30-33 cmbs	A dark grey lens of clay.
33-35 cmbs	Consolidated reddish-brown loam containing numerous waterworn basalt cobbles and pebbles.
35-50 cmbs	Reddish-brown loam; no cultural remains.

Shovel Unit 18

0-40 cmbs	Comprised solely of loosely compacted, dark brown to reddish-brown loam. Within the loam eight fragments of marine and brackish-water shell were recovered. Excavation terminated on coral bedrock.

Shovel Unit 19

0-35 cmbs	Comprised of loosely consolidated dark brown to dark reddish-brown clay loam. Within this loam were several fragments of marine shell, a modern glass bottle neck, a probable canine mandible fragment, and numercus waterworn basalt and coral cobbles and pebbles.
35-45 cmbs	Compact clay loam.

Shovel Unit 20

0-50 cmbs	Loosely consolidated, dark brown clay loam. Present throughout this loam were basalt stream cobbles and pebbles—which are indicative of alluvial conditions. The sizes and numbers of the cobbles and pebbles increased with the depth of the unit. Three shell fragments were recovered from the unit.

Shovel Unit 21

0-25 cmbs	Loosely consolidated, dark brown clay loam and scattered basalt gravel.
25-50 cmbs	The quantity and size of the gravel increased in this layer and severely impaired the excavation. The material was obviously alluvial, and yielded no cultural remains.

Shovel Unit 22

0-25 cmbs	Dense alluvial gravel; no cultural remains.

Shovel Unit 23

0-30 cmbs	Piled basalt boulders; a single unidentified bone fragment was recovered at 20 cmbs.
30-75 cmbs	Dark brown, somewhat compact clay loam. Within this loam were large amounts of *Brnchidontes* sp. shell and charcoal.
75-95 cmbs	Sterile brown to reddish-brown compact clay loam.

Shovel Unit 24

0-30 cmbs	A loosely constructed basalt cobble and boulder cairn raised 30 cm above ground surface.
30-50 cmbs	Dark brown silty loam which contained large amounts of marine and brackish-water shellfish remains and small amounts of charcoal and ash.
50 cmbs	Sterile brown to dark brown compact clay subsoil.

APPENDIX E:

DETAILED SUMMARY OF DEEP SUBSURFACE BACKHOE TRENCH TESTING RESULTS - SURVEY AREAS 1, 2, 3, AND 4

SURVEY AREA 1

Backhoe Trench 1-1

LAYER	DESCRIPTION
I	0-80 cmbs; Ap-horizon. Plow zone of 5YR-3/3 dark reddish-brown clay loam probably derived from recent historic alluvial and colluvial overburden (Soil Unit Eh).
II	80-110 cmbs; C-horizon. 5YR-3/1 very dark grey clay.
III	110-180 cmbs; Agb-horizon. Gleyed pondfield deposit of 5b-4/1 dark blue-gray very fine clay loam (Soil Unit Gs).

Backhoe Trench 1-2

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. Plow zone of 5YR-3/3 dark reddish-brown clay loam probably derived from recent historic alluvial and colluvial overburden (Soil Unit Eh).
II	70-100 cmbs; B/C-horizon. 2.5YR-3/4 dark reddish-brown clay overburden of recently deposited historic period alluvium and colluvium (Soil Unit Eh).
III	100-120 cmbs; IIAgb1-horizon. Gleyed pondfield deposit predominantly comprised of 5G-4/1 dark greenish-gray fine clay loam (Soil Unit Gs).
IV	120-160 cmbs; IIAgb2-horizon. Gleyed pondfield deposit of N-4/0 dark gray fine clay loam (Soil Unit Gs). Water table encountered at approximately 160 cmbs.

Backhoe Trench 1-3

Stratigraphic soil profile of this trench was not described in detail due to imminent danger of side-wall collapse.

LAYER	DESCRIPTION
I	Ap-horizon. Historic plow zone.
II	B/C-horizon. Recently deposited overburden of historic period colluvium and alluvium (Soil Unit Eh).
III	110+ cmbs; IIAgb-horizon. Gleyed deposit of fine clay possibly associated with buried pondfield agricultural system (Soil Unit Ga).

Backhoe Trench 1-4

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Historic plow zone of 5YR-3/3 to 5YR-3/4 dark reddish-brown clay loam.
II	60-105 cmbs; Apb2-horizon. Buried historic period plow zone of 5YR-3/2 dark reddish-brown clay. Contains numerous cane burn lenses and fragments of carbonized cane.
III	105-160 cmbs; B-horizon. 10YR-4/2 dark grayish-brown clay.
IV	160-190 cmbs; C-horizon. 10YR-4/1 dark gray fine clay.

Backhoe Trench 1-5

LAYER	DESCRIPTION
I	0-65 cmbs; Ap-horizon. Historic period plow zone. 5 YR-3/4 dark reddish-brown clay loam.
II	65-115 cmbs; B-horizon. 5YR-3/2 dark reddish-brown clay (Soil Unit Eh).
III	115-145 cmbs; Agnb/C-horizon. Gleyed deposits of N-4/0 dark gray fine clay loam possibly associated with buried pondfield agricultural system (Soil Unit Ga). Water table encountered at 145 cmbs.

Backhoe Trench 1-6

LAYER	DESCRIPTION
I	0-3 cmbs; C-horizon. Recent sheet wash deposit of silty alluvium and evaporated salts.
II	3-25 cmbs; IIApb1-horizon. Historic period plow zone, 7.5YR-3/2 dark brown silt clay loam (incorporates Soil Unit Eh).
III	25-115 cmbs; IIAanb 2-horizon. Recent historic land fill and garbage dump (probably post-World War II).
IV	115-130 cmbs; III Ab?-horizon. Probably represents original land surface prior to land filling. Predominantly 10YR-4/2 dark grayish-brown silt clay loam. Contains scattered historic artifacts, probably of early 20th-century origin.
V	130-190 cmbs; IIIAgb-horizon. Gleyed deposit of 5Y-4/1 dark gray and 5B-4/1 dark bluish-gray fine clay loam. This deposit is probably associated with the buried pondfield agricultural complex (Soil Unit Ga).
VI	190-215 cmbs; IIIB/C-horizon. 10YR-4/4 dark yellowish-brown clay with numerous oxidized root cast mottling of 7.5YR-4/4 brown to dark brown.
VII	215-235 cmbs; IIIC-horizon. Fine sticky clay, 2.5Y-4/4 to 7.5Y-4/2 dark grayish-brown to olive brown. Water table encountered at 235 cmbs (Soil lens + Gn).

Backhoe Trench 1-7

LAYER	DESCRIPTION
I	0-30 cmbs; Ap-horizon. Historic period plow zone, 7.5 YR-4/2 brown to dark brown clay with mottling of 5 YR-4/4 reddish-brown. Contains fragments of carbonized cane and <u>Brachidontes</u> shells (incorporates Soil Unit Eh).
II	30-220 cmbs; B/C-horizon. 10YR-4/3 brown to dark brown, and 10YR-4/4 dark yellowish-brown clay with clay skins of 10YR-4/6 dark gray. Deposit represents eroded edge of upland terrace (Soil Unit Eh parent material).

Backhoe Trench 1-8

LAYER	DESCRIPTION
I	0-25 cmbs; Ap-horizon. Historic period plow zone of 10 YR-3/2 very dark grayish-brown clay loam.
II	25-30 cmbs; IIAanb1-horizon. Recent historic period land fill and rubbish (post-World War II).
III	30-35 cmbs; IIAanb2-horizon. Recent historic period land fill and rubbish (post-World War II).
IV	35-45 cmbs; IIB/C-horizon. 10YR-4/3 brown to dark brown clay.
V	45-85 cmbs; IIC1-horizon. 10YR-4/2 dark grayish-brown clay.
VI	85-155 cmbs; IIC2-horizon. 10YR-4/4 dark yellowish-brown clay.
VI	155-170 cmbs; IIC3-horizon. Coarse-grained alluvial sands and gravels; lightly gleyed. Water table encountered at 170 cmbs.

Backhoe Trench 1-9

LAYER	DESCRIPTION
I	0-25 cmbs; Ap-horizon. Recent historic plow zone, 10 YR-3/2 very dark grayish-brown clay.
II	25-60 cmbs; Aanb-horizon. Recent historic land fill and rubbish (post-World War II).
III	60-110 cmbs; IIApb-horizon. Probably represents original ground surface prior to burial by land filling. 10YR-4/2 dark grayish-brown clay loam with scattered fragments of carbonized organic materials.
IV	110-170 cmbs; II B/C-horizon. 2.5Y-4/2 to 2.5Y-4/4 dark grayish-brown to olive-brown clay.
V	170-230 cmbs; IIC1-horizon. 2.5Y-5/2 very dark grayish-brown with 2.5Y-N3/0 very dark gray sandy clay alluvium and scattered fragments of <u>Brachidontes</u> shell.
VI	230-240 cmbs; IIC2-horizon. 2.5Y-N3/0 very dark gray sandy clay alluvium with scattered fragments of <u>Brachidontes</u> shell.

LAYER	DESCRIPTION
VII	240-255+ cmbs; IIC3-horizon. 5Y-4/1 dark gray sandy clay alluvium containing scattered fragments of <u>Brachidontes</u> shell.

Backhoe Trench 1-10

LAYER	DESCRIPTION
I	0-50 cmbs; Ap-horizon. Recent historic period plow zone of 5YR-3/2 dark reddish-brown clay loam (incorporates upper boundary of Soil Unit Eh).
II	50-66 cmbs; B-horizon. 10YR-4/6 dark yellowish-brown silty clay.
III	66-96 cmbs; C1-horizon. 10YR-3/3 dark brown silty clay.
IV	96-126 cmbs; C2-horizon. 10YR-4/2 dark grayish-brown clay with scattered fragments of shell and charcoal.
V	126-176 cmbs; C3-horizon. 10YR-4/3 brown to dark brown coarse alluvial sands with numerous fragments of <u>Brachidontes</u> shell.

Backhoe Trench 1-11

LAYER	DESCRIPTION
I	0-25 cmbs; Ap-horizon. Recent historic period plow zone of 7.5YR-3/4 dark brown silt clay loam.
II	25-55 cmbs; C-horizon. Thin deposit of cross-bedded angular shell and sand. Appears to be a localized alluvial deposit.
III	55-75 cmbs; IIAb?-horizon. Deposit of silt clay loam containing angular fragments of <u>Brachidontes</u> shell and charcoal. Matrix is 10YR-3/3 dark brown.
IV	75-90 cmbs; B-horizon. 10YR-3/6 dark yellowish-brown clay.
V	90-110 cmbs; C1-horizon. 10YR-3/3 to 10YR-3/4 dark brown to very dark brown coarse alluvial sand containing pulverized shell and charcoal.
VI	110-200 cmbs; C2-horizon. 10YR-3/6 dark yellowish-brown very compact clay.

Backhoe Trench 1-12

LAYER	DESCRIPTION
I	0-25 cmbs; Ap-horizon. Recent historic plow zone of 10 YR-3/6 dark yellowish-brown clay loam.
II	25-60 cmbs; Aan-horizon. Recent historic land fill and rubbish (post-World War II).
III	60-90 cmbs; B/C-horizon. 10YR-3/4 dark yellowish-brown clay with fragments of marine shell and charcoal.
IV	90-110 cmbs; C1-horizon. 10YR-5/1 gray mottled clay with 10YR-4/6 dark yellowish-brown clay.
V	110-130 cmbs; IIAgb1-horizon. Gleyed deposit of N-4/0 dark gray and 5b-4/1 dark bluish-gray fine clay loam, possibly associated with buried pondfield agricultural system (Soil Unit Ga).
VI	130-160 cmbs; IIAgb2-horizon. Gleyed deposit of 5b-4/1 dark bluish-gray to 5bg-4/1 dark greenish-gray fine clay loam, possibly associated with buried pondfield agricultural system (Soil Unit Ga).
VII	160-165 cmbs; R-horizon. Weathered bedrock of decomposing coral. Water table encountered at approximately 165 cmbs.

Backhoe Trench 1-13

LAYER	DESCRIPTION
I	0-30 cmbs; B/C-horizon. 10YR-4/4 dark yellow to 10 YR-4/3 dark brown silty clay. Deposit comprised of recent alluvium derived from adjacent upland slope wash.
II	30-70 cmbs; C/IIB-horizon. 5Y-4/1 dark gray clay with numerous oxidized root cast and mottling of 2.5YR-3/6 dark red.
III	70-130 cmbs; C-horizon. 10Y-4/8 dark gray to 10YR-3/3 dark brown clay.
IV	130-210 cmbs; IIAgb-horizon. Gleyed soil deposit of N-4/0 dark gray fine clay, possibly associated with buried pondfield system (Soil Unit Ga).

Backhoe Trench 1-14

LAYER	DESCRIPTION
I	0-35 cmbs; C-horizon. Deposit comprised of recent alluvium and colluvium from adjacent upland slopes. 10 YR-4/6 dark yellowish-brown silty clay.
II	35-55 cmbs; B-horizon. 5Y-4/1 dark gray clay with numerous root cast of 2.5Y-4/4 olive-brown.
III	55-80 cmbs; C-horizon. 5Y-3/1 very dark gray fine sticky clay.
IV	80-95 cmbs; IIC-horizon. 5Y-4/2 to 5/2 olive-gray sand.
V	95-115 cmbs; IIIC-horizon. 5Y-4/2 olive-gray fine clay.
VI	115-160 cmbs; IVAgb-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga).

Backhoe Trench 1-15

This backhoe trench collapsed immediately after excavation. Gleyed soil deposits were observed in the spoil pile suggesting the presence of buried pond fields. No detailed description of the soil profile in this trench was made.

Backhoe Trench 1-16

LAYER	DESCRIPTION
I	0-90 cmbs; C-horizon. Deposit comprised of colluvial and alluvial slope wash derived from the adjacent uplands. 7.5YR-4/2 brown to dark brown silt clay mottled with 10YR-5/3 brown silt clay.
II	90-105 cmbs; IIAb-horizon. Probably represents recently buried ground surface. 2.5YR-4/2 dark grayish-brown silt clay loam containing scattered fragments of carbonized sugar cane.
III	105-145 cmbs; IIAb2-horizon. Appears to be a second buried surface. 10YR-3/1 very dark gray silt clay loam containing scattered fragments of charcoal and small lumps of burnt clay.
VI	160+ cmbs; IIB-horizon. Weathered clay 10YR-4/3 brown to dark brown.

Backhoe Trench 1-17

LAYER	DESCRIPTION
I	0-90 cmbs; C-horizon. 2.5YR-4/2 dark grayish-brown clay mottled with 2.5Y-4/4 olive-brown. Contains small quantities of terrestrial gastropods. This deposit is probably the result of colluvial slope washing of the adjacent upland slopes.
II	90-105 cmbs; C/Ab-horizon. 5Y-4/1 dark gray clay loam.
III	105-120 cmbs; IIAgb1-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). 5Y-4/1 dark gray to 5GY-4/1 dark bluish-gray fine clay loam.
IV	120-145 cmbs; IIAgb2-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). 5Y-5/1 gray clay loam.
V	145-175 cmbs; IIAgb3-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). N 4/0 dark gray clay loam containing numerous small terrestrial gastropods.

Backhoe Trench 1-18

LAYER	DESCRIPTION
I	0-80 cmbs; C-horizon. Recent deposit of alluvium and colluvium derived from the adjacent upland slopes. 10 YR-4/1 dark gray to 10YR-4/4 dark yellowish-gray clay.
II	80-105 cmbs; B-horizon. 10YR-4/1 dark gray clay.
III	105-135 cmbs; C-horizon. 10YR-3/2 very dark grayish-brown clay.
IV	135-155 cmbs; IIAgb1-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). N-4/0 dark gray clay containing numerous terrestrial gastropod shells.
V	155-180 cmbs; IIAgb2-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). 5G-4/1 dark greenish-gray fine clay containing numerous terrestrial gastropod shells.

Backhoe Trench 1-19

The stratigraphic soil profile of this trench was not described in detail because the side walls collapsed immediately after excavation. An inspection of the spoil pile, however, revealed that gleyed soils were present and that these contained numerous shell fragments, some of which appeared to be terrestrial gastropods and others that were marine or brackish-water species. It is possible that these gleyed soils were associated with buried fishpond/pondfield agricultural systems.

Backhoe Trench 1-20

LAYER	DESCRIPTION
I	0-25 cmbs; Ap-horizon. Recent historic period plow zone of 10YR-5/4 yellowish-brown clay loam.
II	25-60 cmbs; B/C-horizon. 10YR-4/2 dark grayish-brown clay.
III	60-130 cmbs; C-horizon. 10YR-3/3 dark brown to 2.5Y-4/2 dark grayish-brown clay.
IV	130-150 cmbs; IIAgb1-horizon. This is a gleyed soil deposit possibly associated with buried pondfield agricultural systems (Soil Unit Ga). 5 G-4/1 dark greenish-gray clay.
Layer V	150-175 cmbs; IIAgb2-horizon. This is a gleyed soil deposit possibly associated with buried pondfield agricultural systems (Soil Unit Ga). N-4/0 dark gray clay. Water table encountered at approximately 175 cmbs.

Backhoe Trench 1-21

A detailed description of the stratigraphic soil profile in this trench was not made because the side walls collapsed immediately after excavation. An inspection of the spoil pile revealed that no gleyed soil deposits were present.

Backhoe Trench 1-22

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Recent historic period plow zone, 7.5YR-4/4 dark brown clay loam
II	60-125 cmbs; B/C-horizon. 7.5YR-4/2 brown to dark brown mottled with 7.5YR-5/6 strong brown clay.

LAYER	DESCRIPTION
III	125-155 cmbs; C-horizon. 10YR-4/1 dark gray clay.
IV	155-185 cmbs; IIAgb-horizon. Gleyed soil deposit possibly associated with buried pondfield agricultural system (Soil Unit Ga). 5 B-4/1 dark greenish-gray clay. Water table encountered at approximately 185 cmbs.

Backhoe Trench 1-23

No detailed description of the stratigraphic soil profile of this trench was made because the side walls collapsed immediately following excavation. An inspection of the spoil pile indicated that gleyed soil deposits, possibly indicative of buried pondfield agricultural systems, were present.

SURVEY AREA 2

Backhoe Trench 2-1

LAYER	DESCRIPTION
I	0-58 cmbs; Ap-horizon. Recent historic period plow zone of coarse alluvial clay mixed with basalt boulders, cobbles, and pebbles. 7.5YR-4/2 brown to dark brown.
II	58-72 cmbs; B-horizon. 7.5YR-4/2 brown to dark brown hard compact clay (Soil Unit Eh).
III	72-127 cmbs; B/C-horizon. 7.5YR-3/2 to 3/4 dark brown sandy clay which grades vertically into cross-bedded and vertically sorted alluvial stream deposits of sands and rounded to angular basalt pebbles.

Backhoe Trench 2-2

LAYER	DESCRIPTION
I	0-53 cmbs; Ap-horizon. 7.5YR-4/2 brown to dark brown coarse alluvial clay with small rounded to angular pebbles and cobbles of basalt. This deposit is a recently formed plow zone.
II	53-78 cmbs; B1-horizon. 10YR-4/3 brown to dark brown hard compacted clay containing small oxidized (weathered) concretions.

LAYER	DESCRIPTION
III	78-86 cmbs; B2-horizon. 10YR-3/3 dark brown hard, compact sandy clay.
IV	86-146 cmbs; C-horizon. 7.5YR-4/2 brown to dark brown coarse angular sand and pebbles.
V	146-200 cmbs; IIB/C-horizon. 10YR-3/3 dark brown silt clay .

Backhoe Trench 2-3

LAYER	DESCRIPTION
I	0-33 cmbs; Ap-horizon. Recent historic period plow zone of 10YR-3/1 very dark gray clay.
II	33-58 cmbs; B1-horizon. 5YR-3/2 dark reddish-brown silt clay loam.
III	58-78 cmbs; B2-horizon. 5YR-3/2 dark reddish-brown sandy clay.
IV	78-110 cmbs; B3-horizon. 10YR-4/3 brown to dark brown silt clay.
V	110-120 cmbs; B4-horizon. 10YR-3/3 dark brown sandy clay.
VI	120-130 cmbs; B4-horizon. 10YR-4/4 dark yellowish-brown silt clay.
VII	130-143 cmbs; B5-horizon. 10YR-3/3 and 10YR-4/2 dark brown and dark grayish-brown sandy clay.

Backhoe Trench 2-4

LAYER	DESCRIPTION
I	0-48 cmbs; Ap-horizon. Recently formed historic period plow zone. 5YR-3/2 dark reddish-brown clay loam.
II	48-60 cmbs; B1-horizon. 5YR-3/3 dark reddish-brown hard compact clay (Soil Unit Eh).
III	60-79 cmbs; IIApb-horizon. Possible buried surface beneath recent deposits of colluvium and alluvium. 5YR-3/2 dark reddish-brown clay loam with scattered charcoal and unconsolidated organic staining.

LAYER	DESCRIPTION
IV	79-101 cmbs; IIB-horizon. 5YR-3/2 dark reddish-brown silt clay.
V	101-108 cmbs; IIC-horizon. 10YR-3/3 dark brown sandy clay lens of alluvium.
VI	108-230 cmbs; II/IIIB-horizon. 10YR-4/3 brown to dark brown silt clay.

Backhoe Trench 2-5

LAYER	DESCRIPTION
I	0-40 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam. Represents recently formed historic period plow zone.
II	40-120 cmbs; B-horizon. Massive clay bed of 7.5YR-4/2 dark brown to brown clay (Soil Unit Eh).
III	120-150 cmbs; K?-horizon. 10YR-5/2 grayish-brown compact silt calcium carbonate layer (Soil Unit K). Possible bleached or dried out and oxidized gleyed soil possibly associated with buried pondfield deposits.
IV	150-195 cmbs; IIB-horizon. 10YR-5/3 brown compact clay.

Backhoe Trench 2-6

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Recently formed historic plow zone; 7.5YR-3/2 dark brown clay loam.
II	60-100 cmbs; B-horizon. 7.5YR-4/2 dark brown to brown clay (Soil Unit Eh).
III	100-130 cmbs; IIApb-horizon. Probably a recently buried plow zone containing large amounts of carbonized cane fragments and unconsolidated organic matter. 10YR-4/1 dark gray clay loam.
IV	130-190 cmbs; IIB-horizon. 7.5YR-4/6 yellowish-brown clay.
V	190-260 cmbs; IIC-horizon. Unconsolidated coarse-grained stream deposits of cross-bedded sands and silts, basalt boulders, cobbles, and pebbles.

Backhoe Trench 2-7

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Recently developed historic plow zone, 7.5YR-4/2 brown to dark brown clay loam.
II	55-130 cmbs; B-horizon.7.5YR-4/6 strong brown, hard, compact clay (Soil Unit Eh).
III	130-190 cmbs; K?-horizon. Possilby bleached or dried out calcium carbonate layer of gleyed silty clay. 10YR-4/2 dark brown to brown clay (Soil Unit K).
IV	190-240 cmbs; IIB-horizon. 10YR-5/3 yellowish-brown clay.
V	240-280 cmbs; IIC-horizon. Unconsolidated, massive bed of alluvial stream deposits of large basalt boulders, cobbles, and rounded pebbles intermixed with cross-bedded sands and silts.

Backhoe Trench 2-8

Refer to Backhoe Trench 2-7 for a detailed description of soil stratigraphy characteristic of Backhoe Trench 2-8.

Backhoe Trench 2-9

Refer to Backhoe Trench 2-7 for a detailed description of soil stratigraphy characteristic of Backhoe Trench 2-9.

Backhoe Trench 2-10

LAYER	DESCRIPTION
I	0-35 cmbs; Ap-horizon. Plow zone of 10YR-3/1 very dark brown clay loam.
II	35-70 cmbs; C-horizon. 5Y-3/1 very dark gray clay.
III	70-90 cmbs; IIAgb1-horizon. Gleyed soil deposit of 5G-6/2 to 5G-4/2 pale green to grayish-green sandy clay. Water table encountered at approximately 70 cmbs (Soil Unit Ga).
IV	90-110 cmbs; IIAgb2-horizon. Gleyed soil deposit of 5BG-4/1 dark greenish-gray sandy clay (Soil Unit Ga).
V	110-145 cmbs; IIAgb3-horizon. Gleyed soil deposit of 5GY-5/1 greenish-gray clay (Soil Unit Ga).

Backhoe Trench 2-11

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Plow zone of 7.5YR-4/0 dark gray clay mottled with 7.5YR-3/2 dark brown.
II	60-115 cmbs; B/C-horizon. 5Y-4/1 dark gray clay.
III	115-155 cmbs; Cg-horizon. Gleyed deposit of 5Y-5/1 gray fine sandy clay. Water table encountered at 115 cmbs (Soil Unit Ga?).

Backhoe Trench 2-12

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. 2.5YR-3/4 dark gray brown clay loam
II	70-85 cmbs; Apb-horizon. Buried plow zone of 10YR-3/1 very dark gray silt clay loam containing large amounts of cane charcoal and ash. May represent a filled-in drainage ditch.
III	85-115 cmbs; C1-horizon. Vertically sorted alluvial bed of basalt cobbles and pebbles.
IV	115-140 cmbs; Cg2-horizon. Gleyed deposit of N4/0 dark gray sandy clay. Water table encountered at approximately 115 cmbs (Soil Unit Ga).
V	140-185 cmbs; IIAgb-horizon. Gleyed deposit of 5Y-6/1 gray clay.

Backhoe Trench 2-13

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. Plow zone of 7.5YR-4/2 brown to dark brown coarse silt clay.
II	70-100 cmbs; B1-horizon. 7.5YR-3/4 dark brown silt clay.
III	100-140 cmbs; B2-horizon. 10YR-4/2 dark grayish-brown mottled with 10YR-3/6 dark yellowish-brown and 10YR-3/2 very dark grayish brown fine sandy clay loam.

LAYER	DESCRIPTION
IV	140-197 cmbs; C-horizon. 5Y-4/1 dark gray mottled with 5Y-5/6 olive sandy clay.
V	197-250 cmbs; IIAgb-horizon. Gleyed soil deposit of 5 Y-4/1 dark gray clay (Soil Unit Ga).

Backhoe Trench 2-14

LAYER	DESCRIPTION
I	0-80 cmbs; Ap-horizon. Plow zone of 10YR-4/2 dark grayish-brown silt clay loam.
II	80-108 cmbs; B1-horizon. 10YR-4/3 brown to dark brown silt clay.
III	108-153 cmbs; B2-horizon. 10YR-4/2 to 10YR-5/2 dark grayish-brown to dark brown fine sandy clay.
IV	153-203 cmbs; IIAgb-horizon. Gleyed soil deposit of 5Y-5/1 gray fine sticky clay with oxidized root cast and mottled peds of 10YR-6/6 brownish-yellow.

Backhoe Trench 2-15

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Plow zone of 10YR-4/1 dark gray clay.
II	60-90 cmbs; B-horizon. 10YR-5/4 yellowish-brown mottled with 10YR-5/2 grayish brown clay.
III	90-140 cmbs; B/C-horizon 10YR-5/2 grayish-brown coarse clay.
IV	140-170 cmbs; IIAgb-horizon. Gleyed soil deposit of 5 Y-5/1 gray clay (Soil Unit Ga).
V	170-195 cmbs; IIC-horizon. 5YR-4/1 dark gray silty clay.

Backhoe Trench 2-16

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. Plow zone of 7.5YR-3/2 dark brown clay.
II	70-110 cmbs; B-horizon. 10YR-4/2 dark grayish-brown mottled with 7.5YR-5/8 strong brown silty clay.
III	110-130 cmbs; C1-horizon (Soil Unit K?). 10YR-5/2 grayish-brown silty clay.
IV	130-143 cmbs; C2-horizon. Predominantly 7.5YR-5/2 brown coarse-grained alluvial sand.
V	143-200 cmbs; C3-horizon. Vertically sorted alluvial deposit of basalt pebbles, cobbles and boulders.

Backhoe Trench 2-17

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Plow zone of 7.5YR-3/2 dark brown clay.
II	55-85 cmbs; B1-horizon. 7.5YR-4/2 brown to dark brown clay.
III	85-155 cmbs; B2-horizon. 10YR-5/8 to 10YR-5/4 yellowish-brown silt clay.
IV	155-200 cmbs; C-horizon. Vertically sorted alluvial stream deposit of basalt pebbles, cobbles, and boulders.

Backhoe Trench 2-18

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Plow zone of 5YR-3/2 dark reddish-brown clay loam.
II	60-90 cmbs; B1-horizon. 5YR-3/3 dark reddish-brown mottled with 7.5YR-6/8 reddish-yellow clay.
III	90-120 cmbs; B2-horizon. 10YR-5/2 grayish-brown clay (Soil Unit K?).
IV	120-170 cmbs; B3-horizon. 10YR-5/3 brown mottled with 10YR-5/8 yellowish-brown coarse silty clay.

Backhoe Trench 2-19

LAYER	DESCRIPTION
I	0-30 cmbs; Ap-horizon. Plow zone of 10YR-4/3 brown to dark brown clay loam.
II	30-110 cmbs; B-horizon. 10YR-6/4 light yellowish-brown silt clay.
III	110-260 cmbs; C-horizon. Vertically sorted deposit of alluvial sands gravels, cobbles and boulders.

Backhoe Trench 2-20

LAYER	DESCRIPTION
I	0-50 cmbs; Ap-horizon. Plow zone of 7.5YR-4/2 brown to dark brown clay loam.
II	50-90 cmbs; B-horizon. 10YR-5/4 yellowish-brown silty clay.
III	90-210 cmbs; vertically sorted deposit of alluvial sands, gravels, cobbles, and boulders.

Backhoe Trench 2-21

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon Plow zone of 7.5YR-3/2 dark brown clay loam.
II	60-200 cmbs; B/C-horizon. 7.5YR-5/6 strong brown to 5 Y-5/6 olive silty clay.

Backhoe Trench 2-22

LAYER	DESCRIPTION
I	0-80 cmbs; Ap-horizon. Recently formed historic period plow zone. 7.5YR-4/4 dark brown to brown, mottled with 7.5YR-3/2 dark brown sandy clay loam.
II	80-150 cmbs; B/C-horizon. 7.5YR-4/2 brown to dark brown, mottled with 7.5YR-5/6 strong brown clay.

LAYER	DESCRIPTION
III	150-190 cmbs; C-horizon. 10YR-4/1 dark gray mottled with 5YR-5/8 yellowish-red clay.
IV	190-240 cmbs; IIC-horizon. Massive alluvial stream deposit of vertically and horizontally sorted boulders, cobbles, gravels, sands, and silts.

Backhoe Trench 2-23

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Recently formed historic period plow zone, 7.5YR-3/2 dark brown clay loam.
II	60-75 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown to 10YR-4/3 dark brown hard, compact clay (Soil Unit Eh).
III	75-90 cmbs; IIAan-horizon. Cultural midden deposit, 10 YR-4/3 dark brown to brown and 10YR-3/3 brown loamy clay.
IV	90-130 cmbs; IIB-horizon. 5YR-3/2 dark reddish-brown to 10YR-4/2 dark reddish-gray compact silt clay.
V	30-150 cmbs; K-horizon. Bleached or dried-out homogenous silt, 10YR-6/3 pale brown to 10YR-7/1 light gray (Soil Unit K).
VI	150-195 cmbs; IIIB-horizon. 10YR-5/3 brown silt clay.

Backhoe Trench 2-24

LAYER	DESCRIPTION
I	0-50 cmbs; Ap-horizon. Recently formed historic period plow zone (incorporates Soil Unit Eh). 7.5YR-3/2 dark brown clay loam.
II	50-75 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown compact clay (Soil Unit Eh).
III	75-90 cmbs; IIAan-horizon. 10YR-4/3 dark brown to brown clay loam cultural midden deposit.
IV	90-130 cmbs; IIB-horizon. 5YR-3/2 dark reddish-brown and 10YR-4/4 dark yellowish-brown silt clay.

LAYER	DESCRIPTION
V	130-160 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
VI	160-205 cmbs; IIIB-horizon. 10YR-5/3 brown silt clay.

Backhoe Trench 2-25

LAYER	DESCRIPTION
I	0-65 cmbs; Ap-horizon. Recently formed historic plow zone (incorporates Soil Unit Eh). 7.5YR-3/2 dark brown clay loam containing small, scattered amounts of artifactual material (historic) and midden.
II	65-80 cmbs; IIAan-horizon. Cultural midden deposit, the upper boundary of which has been truncated by the plow zone throughout most of the extent of Backhoe Trench 2-25. Layer II is a loamy clay, 10YR-4/3 dark brown to brown and 10YR-3/3 brown. Contains scattered charcoal (wood?), marine and brackish-water shell, volcanic glass, mammal bone and historic period glass (early 19th century ?).
III	80-110 cmbs; IIB-horizon. 5YR-3/2 dark reddish-brown to 10YR-4/2 dark reddish-gray very compact silty clay. Contains minor quantities of midden and artifacts that are probably the result of intrusion from overlying Layer II, or erosional transport (Soil Unit Eh).
IV	110-130 cmbs; IIIAn-horizon. Cultural midden deposit and buried landscape. 10YR-6/3 pale brown to 5YR-4/4 reddish-brown silty clay loam.Contains small amounts of worn basalt gravel and cobbles as well as scattered marine and brackish-water shells, charcoal (wood?), and mammal bone (including a single human interment). Subsurface pits and postholes were observed originating in the midden deposit and intruding into the underlying sterile matrix of Layer V.
V	130-160 cmbs;K-horizon. Bleached or dried-out layer of homogenous silt. 10YR-7/1 light gray silt loam (Soil Unit K).
VI	160-200 cmbs; IIIB-horizon. 10YR-5/3 brown silt clay.

Backhoe Trench 2-26

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-27

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Recently formed historic plow zone (incorporates Soil Unit Eh). 7.5YR-3/2 dark brown clay loam.
II	55-75 cmbs; IIAb1-horizon. Cultural midden deposit, discontinuous and truncated by the overlying plow zone. 10YR-4/3 brown to dark brown clay loam.
III	75-95 cmbs; IIB-horizon. 5YR-3/2 dark reddish-brown to 10YR-4/2 dark reddish-gray compact silt clay (Soil Unit Eh)
IV	95-110 cmbs; IIAb2-horizon. Discontinuous cultural midden deposit. 10YR- 4/3 dark brown to brown clay loam.
V	110-135 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
VI	135-250 cmbs; IIIB-horizon. 10YR-5/4 to 10YR-4/4 yellowish-brown to dark yellowish-brown silt clay.

Backhoe Trench 2-28

Refer to Backhoe Trench 2-27 for a detailed description of soil stratigraphy characteristic of Backhoe Trench 2-28.

Backhoe Trench 2-29

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-30

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-31

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-32

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-33

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-34

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-35

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-36

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-37

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt, 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-38

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt. 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-39

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt. 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trench 2-40

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam.
II	60-125 cmbs; B-horizon. 10YR-3/2 very dark grayish-brown and 7.5YR-3/2 dark brown compact clay (Soil Unit Eh).
III	125-150 cmbs; K-horizon. Bleached or dried-out layer of homogenous silt. 10YR-7/1 light gray (Soil Unit K).
IV	150-200 cmbs; IIB-horizon. 10YR-4/6 dark yellowish-brown silt clay.

Backhoe Trenches 2-41 and 2-42

Below water table—collapsed.

SURVEY AREA 3

Backhoe Trench 3-1

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. Recently formed historic period plow zone (incorporates Soil Unit Eh). 5YR-4/1 dark gray clay loam with mottling of 2.5YR-4/4 reddish-brown. Fragmented cane charcoal scattered throughout this layer.
II	70-140 cmbs; C-horizon. 5YR-4/1 dark gray fine sticky clay (Soil Unit Gn).
III	140-200 cmbs; IIAgb-horizon. Gleyed soil deposit of fine, sticky clay, 5Y-4/1 dark gray. Water table encountered at approximately 200 cmbs (Soil Unit Ga).

Backhoe Trench 3-2

LAYER	DESCRIPTION
I	0-65 cmbs; Ap-horizon. Recently formed historic period plow zone (incorporates Soil Unit Eh). 5YR-4/1 dark gray mottled with 2.5YR-4/4 reddish-brown. Fragmented cane charcoal and small waterworn pebbles of basalt are scattered throughout this layer.
II	65-160 cmbs; IIAgb-horizon. Gleyed soil deposit of fine clay, grading vertically into coarser grained materials. Possibly vertically stratified pondfield and alluvial stream deposits 5 BG-5/1 greenish-gray to 5G-4/1 greenish-gray. Water table encountered at approximately 60 cmbs (Soil Unit Ga).

Backhoe Trench 3-3

LAYER	DESCRIPTION
I	0-50 cmbs; Ap-horizon. 7.5YR-3/2 dark brown clay loam; historic plow zone (incorporates Soil Unit Eh).
II	50-130 cmbs; B/C-horizon. 10YR-4/1 dark gray clay lightly mottled with 10YR-5/8 yellowish-brown.

LAYER	DESCRIPTION
III	130-170 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay, N-5/0 gray. Water table encountered at approximately 120 cmbs (Soil Unit Ga).

Backhoe Trench 3-4

LAYER	DESCRIPTION
I	0-60 cmbs; Ap-horizon. Recently formed historic plow zone of 7.5YR-3/2 dark brown clay (incorporates Soil Unit Eh).
II	60-120 cmbs; B/C-horizon. 10YR-4/1 dark gray clay with mottling of 2.5YR-4/4 olive-brown.
III	120-150 cmbs; IIAgb1-horizon. 5Y-4/1 dark gray coarse sandy clay gleyed soil deposit. Water table encountered at approximately 120 cmbs (Soil Unit Ga).
IV	150-170 cmbs; IIAgb2-horizon. 5Y-5/1 gray fine clay gleyed soil deposit (Soil Unit Gn?).

Backhoe Trench 3-5

LAYER	DESCRIPTION
I	0-80 cmbs; Ap-horizon. Recently formed historic plow zone, 7.5YR-4/2 dark brown clay (incorporates Soil Unit Eh).
II	80-100 cmbs; B-horizon. 10YR-4/2 dark grayish-brown clay with mottling of 7.5YR-4/4 dark brown.
III	100-116 cmbs; Cg-horizon. Gleyed alluvial deposit of coarse sand, 5G-5/2 grayish-green. Water table encountered at approximately 10 cmbs (Soil Unit Gn?).
IV	116-175 cmbs; IIAgb-horizon. N-4/0 dark gray fine sticky clay gleyed deposit (Soil Unit Ga).

Backhoe Trench 3-6

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Recently formed historic plow zone, 7.5YR-4/4 dark brown clay loam (incorporates Soil Unit Eh).

LAYER	DESCRIPTION
II	55-145 cmbs; C-horizon. 10YR-4/1 dark gray clay.
III	145-185 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay, 5Y-5/1 gray clay. Water table encountered at approximately 145 cmbs (Soil Unit Ga).

Backhoe Trench 3-7

LAYER	DESCRIPTION
I	0-70 cmbs; Ap-horizon. Recently formed historic plow zone, 7.5YR-3/2 dark brown clay loam (incorporates Soil Unit Eh).
II	70-100 cmbs; B-horizon. 7.5YR-4/2 dark brown clay mottled with 7.5YR-4/6 strong brown (Soil Unit Ga?).
III	100-107cmbs; C1-horizon. 7.5YR-5/2 brown silty clay.
IV	107-147cmbs; C2-horizon. 10YR-4/1 dark gray clay (Soil Unit Gn?).
V	147-185 cmbs; C3g-horizon. Mixed 5BG-4/1 dark greenish-gray clay and 10YR-5/2 grayish-brown sandy clay. Water table encountered at approximately 147 cmbs (Soil Unit Gn).

Backhoe Trench 3-8

LAYER	DESCRIPTION
I	0-40 cmbs; Ap-horizon. Plow zone of 7.5YR-4/2 brown to dark brown clay.
II	40-70 cmbs; C1-horizon. Cross-bedded deposit of coarse alluvial sand and gravel.
III	70-110 cmbs; C2-horizon. 5YR-4/1 dark brown clay.
IV	110-170 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay; 5G-4/1 greenish-gray. Water table encountered at approximately 110 cmbs.

Backhoe Trench 3-9

LAYER	DESCRIPTION
I	0-40 cmbs; Ap-horizon. Plow zone of 7.5YR-4/2 brown to dark brown clay.
II	40-70 cmbs; C1-horizon. Cross-bedded deposit of coarse alluvial sand and gravel.
III	70-110 cmbs; C2-horizon. 5YR-4/1 dark brown clay.
IV	110-170 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay, 5G-4/1 greenish-gray. Water table encountered at approximately 110 cmbs.

Backhoe Trench 3-10 and 11

Below water table; trenches collapsed. Area appears to be former landfill.

SURVEY AREA 4

Backhoe Trench 4-1

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Plow zone of 5YR-3/2 dark reddish-brown clay (incorporates Soil Unit Eh).
II	55-70 cmbs; C1-horizon. Coarse alluvial sand deposit of variable color.
III	70-80 cmbs; C2-horizon. 5YR-3/1 dark gray clay.
IV	80-115 cmbs; C3-horizon. 10YR-3/2 very dark gray sandy clay.
V	115-145 cmbs; IIAgb-horizon. Gleyed soil deposit of 5 G-4/1 dark greenish-gray clay (Soil Unit Ga/Gn).

Backhoe Trench 4-2

LAYER	DESCRIPTION
I	0-50 cmbs; Ap-horizon. 2.5YR-4/8 red clay with 5 YR-3/2 dark reddish-brown clay.
II	50-65 cmbs; Apb-horizon. Buried plow zone of 5YR-3/1 very dark gray clay with scattered fragments of carbonized cane.

LAYER	DESCRIPTION
III	65-80 cmbs; B-horizon. 5YR-3/2 dark reddish-brown clay.
IV	80-120 cmbs; C-horizon. 10YR-3/2 very dark grayish-brown clay (Soil Unit Gn).
V	120-145 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay, N-4/0 dark gray (Soil Unit Ga).

Backhoe Trench 4-3

LAYER	DESCRIPTION
I	0-45 cmbs; Ap-horizon. 7.5YR-4/2 brown to dark brown clay loam plow zone.
II	45-55 cmbs; Apb-horizon. Buried plow zone of 7.5YR-3/2 dark brown clay with scattered fragments of carbonized cane.
III	55-95 cmbs; B-horizon. 5YR-4/2 dark reddish-gray clay with 10YR-4/3 brown to dark brown. Also observed were numerous oxidized root casts (Soil Unit Eh/Ga?).
IV	95-125 cmbs; C-horizon. 10YR-3/2 very dark grayish-brown silty clay.
V	125-150 cmbs; IIAgb-horizon. Gleyed soil deposit of fine sticky clay containing numerous carbonized organics. 5Y-4/1 dark gray (Soil Unit Ga?).

Backhoe Trench 4-4

LAYER	DESCRIPTION
I	0-40 cmbs; Ap-horizon. Plow zone of 5YR-3/4 dark reddish-brown clay loam.
II	40-70 cmbs; B1-horizon. 5YR-3/2 dark reddish-brown to 5YR-3/1 very dark gray clay (Soil Unit Eh?).
III	70-90 cmbs; IIAb-horizon. 10YR-4/1 dark gray clay with mottling of 2.5YR-3/6 dark red. Fragments of charcoal are scattered throughout this layer. Water table encountered at approximately 90 cmbs (Soil Unit Ga?).
IV	90-105 cmbs; IIAgnb1-horizon. Gleyed soil deposit of 5Y-4/1 dark gray to N-4/0 dark gray fine sandy clay (Soil Unit Ga).

LAYER	DESCRIPTION
V	105-115 cmbs; IIAgb2-horizon. Gleyed soil deposit of 5BG-4/1 dark greenish-gray fine sandy clay. Small shell fragments (terrestrial gastropods [?]) and fragments of charcoal are present in this deposit (Soil Unit Ga).
VI	115-122 cmbs; IIAgb3-horizon. Gleyed soil deposit of 5 GY-4/1 dark greenish-gray medium fine sandy clay (Soil Unit Ga/N?).
VII	122-150 cmbs; IIC-horizon. 10YR-3/1 very dark gray fine clay (Soil Unit Gn).

Backhoe Trench 4-5

LAYER	DESCRIPTION
I	0-40 cmbs; Ap-horizon. Plow zone of 5YR-3/2 dark reddish-brown clay.
II	40-80 cmbs; B1-horizon. 5YR-3/4 dark reddish-brown clay (Soil Unit Eh).
III	80-105 cmbs; IIAgb1-horizon. Gleyed soil deposit of 5 BG-4/1 dark greenish-gray clay (Soil Unit Ga).
IV	105-125 cmbs; IIAgnb2-horizon. Gleyed soil deposit of N-4/0 dark gray clay (Soil Unit Ga/Gn?).

Backhoe Trench 4-6

LAYER	DESCRIPTION
I	0-55 cmbs; Ap-horizon. Plow zone of 7.5YR-4/2 dark brown clay mottled with 2.5YR-4/6 red.
II	55-70 cmbs; B1-horizon. 7.5YR-4/2 dark brown silty clay.
III	70-95 cmbs; B2-horizon. 5YR-4/1 dark gray to 5YR-3/1 very dark gray clay mottled with 5YR-4/6 yellowish-red (Soil Unit Eh/Ga).
IV	95-115 cmbs; IIAgb-horizon. Gleyed soil deposit of N-4/0 dark gray fine sticky clay (Soil Unit Ga).

Backhoe Trench 4-7

LAYER	DESCRIPTION
I	0-30 cmbs; Ap-horizon. Plow zone of 5YR-3/2 dark reddish-brown silt clay loam.
II	30-90 cmbs; B-horizon. 10YR-4/1 dark gray mottled with 2.5YR-4/6 red clay (Soil Unit Ga).
III	90-120 cmbs; C-horizon. 5YR-5/1 gray clay.
IV	120-130 cmbs; IIAgb-horizon. Gleyed soil deposit of 5b-4/1 dark blue-gray sandy clay. Water table encountered at approximately 120 cmbs (Soil Unit Gn?).

Backhoe Trench 4-8

LAYER	DESCRIPTION
I	0-17; O/A-horizon. Recently deposited and decaying plant material.
II	17-60 cmbs; B/C-horizon. 2.5YR-2.5/4 to 2.5YR-3/4 very dusky red to dark reddish-brown fine sticky clay (Soil Unit Eh).
III	60-90 cmbs; IIAgb1-horizon. Gleyed soil deposit of 5 Y-4/1 dark gray fine clay loam. Water table encountered at approximately 60 cmbs (Soil Unit Gn?).
IV	90-120+ cmbs; IIAgb2-horizon. 5 B-4/1 dark bluish-gray fine clay with numerous small terrestrial gastropod shells (Soil Unit Ga/Gn?).

Backhoe Trenches 4-9 and 4-10

Refer to Backhoe Trench 4-8 and Site 3322, Discussion. Trenches 4-9 and 4-10 became filled with water and collapsed.