JOHN WAIHEE
GOVERNOR

EDWARD Y. HIRATA
DIRECTOR

DEPUTY DIRECTORS
DAN T. KOCHI (PRIMARY)
RONALD N. HIRANO
JEANNE K. SCHULTZ
CALVIN M. TSUDA

IN REPLY REFER TO:

HWY-CM
2.2741

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

RECEIVED
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JUL 16 1990

MEMORANDUM

TO: Mr. Abdul Salau
Office of Environmental Quality Control

FROM: Director of Transportation

SUBJECT: NEGATIVE DECLARATION - 138 KV OVERHEAD TRANSMISSION LINE, KAMEHAMEHA HIGHWAY, RADFORD DRIVE, BOUGAINVILLE DRIVE, LAWEHANA STREET AND MALAAI STREET, TMK: 9-8-03:01, 02, 03, 04; 9-8-21; 9-8-07; 9-8-09; 9-8-14; 9-8-15; 9-8-19; 9-8-71; 9-9-04; 9-9-12; 9-9-03; 9-9-01; and 9-9-02

We are enclosing the negative declaration for your review and publication in the OEQC.

Thank you for your cooperation.

Should you have any question, please call Morris Arakaki at 523-2702.

Edward Y. Hirata

1990-07-23-OA-FEA

FILE COPY

FINAL

ENVIRONMENTAL ASSESSMENT AND ROUTING REPORT

WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE PROJECT

Prepared for
HAWAIIAN ELECTRIC COMPANY, INC.

CH2M HILL
May 1990

EXECUTIVE SUMMARY

Hawaiian Electric Company, Inc. (HECO) proposes to build a new 138,000 volt (138 kilovolt [kV]) alternating current (AC) transmission line from the Waiau Power Plant to the Makalapa Substation, a distance of approximately 4.5 miles.

PURPOSE AND NEED

The Waiau-Makalapa No. 2 138 kV Transmission Line Project is needed for two reasons:

1. To assure the reliable delivery of power by preventing the overload of the existing Waiau-Makalapa No. 1 line during an emergency condition. An additional path for power flow is required to provide adequate transmission line capacity during outages caused by lightning, fires, vehicular accidents, or high winds, and during periods when other lines are out of service for routine maintenance.

2. To provide additional transmission capacity to meet growing demands for power in the Pearl Harbor, Foster Village, and Aiea areas, as well as throughout the island.

PROPOSED ACTION

The Waiau-Makalapa No. 2 138 kV Transmission Line Project includes the following facilities and activities.

- Construction of approximately 4.5 miles of 138 kV, single-circuit, three-phase, AC transmission line between Waiau Power Plant and Makalapa Substation

- Realignment of the existing Makalapa No. 1 138 kV Transmission Line from the makai to the mauka side of Kamehameha Highway (Kam Highway) between the Aiea interchange and the intersection of Kam Highway and Salt Lake Boulevard

- Placement of existing 12 kV distribution lines and service connections underground from Waiau Power Plant to McGrew Point along the makai side of Kam Highway (subject to PUC approval)

- Upgrade of the Waiau and Makalapa Substations to accommodate new electrical equipment

The proposed Waiau-Makalapa No. 2 138 kV Transmission Line will consist of a single-circuit 138 kV transmission line with a single 46 kV circuit underbuild on tubular steel poles 80 to 135 feet tall. Foundations will be either conventional drilled pier foundations, or (in areas where soil conditions require them) deep pole foundations. The 138 kV circuit will consist of three sets of two aluminum conductors, arrayed vertically. The 46 kV circuit will consist of three sets of single aluminum conductors.

The new poles will generally be placed along existing rights-of-way and will replace the existing 46 kV poles. Along the makai side of Kam Highway between Waiau Power Plant and McGrew Point, existing 12 kV distribution lines and service connections are proposed (subject to PUC approval) to be placed underground.

SCHEDULE AND COST

The construction of foundations for the steel poles in order to realign Waiau-Makalapa No. 1 138 kV transmission line is scheduled to start in April 1991. The construction of the Waiau-Makalapa No. 2 138 kV overhead line is scheduled to begin in September 1991 and be completed by August 1992. Underground placement of the 12 kV line is scheduled to occur between mid-1992 and mid-1994.

The estimated capital cost for the project is $25.2 million (in current year dollars for the project). This amount includes $18.5 million for the overhead 138 kV line and substation upgrade and $6.5 million for the underground placement of existing overhead 12 kV lines and service connections along portions of Kam Highway.

PREFERRED ALIGNMENT LOCATION

The preferred alignment of the Waiau-Makalapa No. 2 138 kV Transmission Line begins at the Waiau Power Plant and follows the alignment of an existing 46 kV transmission line along the makai side of Kam Highway (within the highway right-of-way) as far as McGrew Point. At that location, the existing 46 kV line angles makai of Kam Highway across the area proposed for the Aiea Bay State Recreation Area. Instead of following the existing 46 kV line, the new transmission line will continue to follow the makai side of Kam Highway as the highway turns south near Aloha Stadium. In order to provide adequate separation between the new line and the existing Waiau-Makalapa No. 1 138 kV line near Aloha Stadium, the existing line will be relocated from the makai to the mauka side of Kam Highway from the Aiea interchange to the intersection of Kam Highway and Salt Lake Boulevard. This will require placing one transmission pole in the retaining wall of the Aloha Stadium parking lot (the retaining wall will be rebuilt around the pole).

South of Aloha Stadium the new line will follow the makai side of Kam Highway to approximately 1,500 feet north of Radford Drive, where it will cross to the mauka side of the highway. The alignment will follow the north side of Radford Drive and then turn north for approximately 1,250 feet along the makai side of Bougainville Drive (the mauka side of the H-1 freeway). It will turn south to cross Bougainville Drive and follow the south side of Lawehana Street and Malaai Street to the Makalapa Substation. In order to provide adequate separation between the new line and existing lines, one pole of the existing Makalapa-Iwilei 138 kV line will be relocated from the east to the west side of Bougainville Drive.

ALTERNATIVES TO THE PROPOSED ACTION

Both alternative transmission technologies and alternative alignments were evaluated before the preferred overhead transmission line alignment was selected. Chapter 2 of the Routing Report documents the environmental and engineering criteria used to evaluate the following transmission alternatives.

- Overhead transmission line over land
- Overhead transmission line across Pearl Harbor
- Underground transmission line
- Submarine transmission line

As documented in Chapters 4 through 8 of the Routing Report, alternative corridors, and within them, alternative alignments, were identified and evaluated to select a preferred alignment.

THE ROUTE SELECTION PROCESS

The Routing Report documents the sequential process that considered environmental, engineering, and public concerns in completing the following tasks.

- Definition of a study area

- Identification of alternative corridors within the study area

- Evaluation of corridors and selection of a preferred corridor

- Identification of alternative alignments within the preferred corridor
- Evaluation of alternative alignments and selection of a preferred alternative

PUBLIC AND AGENCY CONSULTATION

Public and agency consultation was an essential component of the route selection process (as documented in Chapter 8 of the Routing Report and Appendix G). A project fact sheet and two newsletters were mailed to key public groups and individuals. Public meetings were held in November 1988 to review alternative alignments, and six presentations were made to neighborhood boards in Pearl City, Aiea, and Aliamanu/Salt Lake/Foster Village. Two Consolidated Application Process meetings were held with interested federal, state, and county agencies. In addition to the formal consultation activities, numerous other contacts with representatives of agencies, landowners, and the public took place.

ENVIRONMENTAL ASSESSMENT AND ROUTING REPORT
WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE PROJECT

The environmental assessment and the routing report for the Waiau-Makalapa No. 2 138 kV Transmission Line Project are presented in this three-ring binder. Material that is relevant to both documents (i.e., References, List of Preparers, and Glossary and Acronyms) are grouped together under one tab divider; the appendices are presented in the same format. The following list shows the order in which the material is presented.

Environmental Assessment

WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE PROJECT

ENVIRONMENTAL ASSESSMENT

Prepared for
HAWAIIAN ELECTRIC COMPANY, INC.

Prepared by
CH2M HILL

May 1990

ENVIRONMENTAL ASSESSMENT

Applicant	Hawaiian Electric Company, Inc.
Applicant Contact	Mary Ellen Nordyke-Grace Telephone: 808/543-7876
Approving Agency	State of Hawaii Department of Transportation Highways Division
Prepared by	CH2M HILL 1585 Kapiolani Boulevard, Suite 1312 Honolulu, Hawaii 96814 Telephone: 808/943-1133

WAIAU-MAKALAPA NO. 2
138 kV TRANSMISSION LINE PROJECT

ENVIRONMENTAL ASSESSMENT CONTENTS

TABLES

CONTENTS
(continued)

FIGURES

CONTENTS
(continued)

AGENCIES AND ORGANIZATIONS CONSULTED

The following were consulted with during the preparation of the environmental assessment or the routing report.

Agency or Organization	Person Contacted	Date	Subject
Federal			
Department of the Interior, Fish and Wildlife Service	Thomas Harvey	2/5/88	CAP Meeting No. 1
	Andy Yuen	2/5/88	CAP meeting No. 1
	Ernest Kosuku	2/22/88	Siting guidelines
Department of the Interior, National Park Service	Brian Harry	2/5/88	CAP Meeting No. 1
		7/18/88	U.S.S. Arizona Memorial
Federal Aviation Administration	David Wellhouse	2/5/88	CAP Meeting No. 2
U.S. Army Corps of Engineers	Stan Arakaki	11/29/88	CAP Meeting No. 2
	Warren Kanai	9/23/89	Section 10/Section 404 Permit
		9/29/89	Stream Crossing Permit
U.S. Navy	R. Hommon	2/88	Pearl Harbor Cultural Resources
	J.L. Busekrus	4/15/88	Pearl Harbor Master Plan
	Bill Liu	6/20/88	Alternative Alignment Review
	J. Michael Killian	7/14/88	Request for Right of Entry and Easement
	Jim Cammon	7/14/88	
	Alan Higuchi	7/14/88	
	Bob Minamoto	7/14/88	
	Kenneth Umemoto	7/14/88	
	Rodney Bow	7/14/88	
	Wayne Yamashita	7/14/88	
	Curtis Noborikawa	7/14/88	
	Ben Ramelb	7/14/88	
	Bill Liu	7/14/88	
	Eugene Chock	9/8/88	Navy concerns about alignment alternatives
State			
Aloha Stadium Authority	Calvin Nekonishi	7/19/89	Easement across Aloha Stadium
	Ken Kiyabu	8/8/89	
Coastal Zone Management (CZM) Program	John Nakagawa	2/5/88	CAP Meeting No. 1
	Doug Tom	2/5/88	CAP Meeting No. 1
		11/29/88	CAP meeting No. 2
Department of Business and Economic Development, Energy Division	Jerry Lesperance	2/5/88	CAP Meeting No. 1
		11/29/88	CAP Meeting No. 2
	Maurice Kaya	11/29/88	CAP Meeting No. 2

Agency or Organization	Person Contacted	Date	Subject
Department of Health	David Borgeson	2/5/88	CAP Meeting No. 1
	Bruce Anderson	4/19/88	Siting guidelines
	Bernard Shiratori	7/18/88	Noise regulations
	Kevin Sumida	11/29/88	CAP Meeting No. 2
Department of Land and Natural Resources, Division of State Parks, Outdoor Recreation, and Historic Sites	Dan Quinn	2/1/88 5/3/88 7/7/88 9/26/88	Aiea Bay State Recreation Area
	Joyce Bath	2/88	Oahu historic sites and cultural resources
		11/29/88	CAP Meeting No. 2
	Dr. D. Hibbard	2/29/89	Pearl Harbor National Register District
Department of Land and Natural Resources, Division of Water and Land Development	S. Samuels	4/88	Stream channel permit
	Roger Evans	11/29/88	CAP Meeting No. 2
	George Matsumoto	11/29/88	CAP Meeting No. 2
Department of Land and Natural Resources, Office of Conservation and Environmental Affairs	Dean Uchida	2/5/88	CAP Meeting No. 1
		11/29/88	CAP Meeting No. 2
		9/15/89	Environmental review for easement on Aloha Stadium property
Department of Transportation, Harbors Division	Napoleon Agroan	2/5/88	CAP Meeting No. 1
	Derrick Lining	11/29/88	CAP Meeting No. 2
	Emil Barroga, Jr.	11/29/88	CAP Meeting No. 2
	Thomas Fujikawa	11/29/88	CAP Meeting No. 2
	Fred Shinsato	11/29/88	CAP Meeting No. 2
Department of Transportation, Highways Division	Ron Tsuzuki	2/2/88	Highway system map and improvements
	Ian Tanaka	2/5/88	CAP Meeting No. 1
	Morris Arakaki	2/5/88	CAP Meeting No. 1
	Fred Shinsato	11/29/88	CAP Meeting No. 2
	T. Harano	12/8/88	H-1 freeway crossing
	Morris Arakaki	12/8/88	H-1 freeway crossing
		1/5/89	138 kV line--freeway crossing of H-1
		9/19/89	Environmental review for Permit to Construct on a State Highway
		10/4/89	Permit requirement for construction within State Highway ROW
House of Representatives	Clarice Hashimoto	7/28/88	Project update
	David Ige	7/28/88	Project update
	Roland Kotuni	7/28/88	Project update
	Jim Shon	8/22/89	Request for information on EMF
Land Use Commission	Esther Ueda	2/5/88	CAP Meeting No. 1
	Ray Young	11/29/88	CAP Meeting No. 2
Office of Environmental Quality Control (OEQC)	Faith Miyamato	2/5/88	CAP Meeting No. 1
	Bruce Swartz	11/29/88	CAP Meeting No. 2
Office of State Planning	Harold Matsumoto	10/19/88	Request for CAP meeting

Agency or Organization	Person Contacted	Date	Subject
Senate	Norman Mizuguchi	7/28/88	Project update
	Eloise Tungpalan	7/28/88	Project update
City and County of Honolulu			
Aiea Neighborhood Board	Board Members	4/11/89	Project presentation--Q&A on alternative corridor
		9/11/89	Project presentation--Q&A on preferred alignment
Aliamanu/Salt Lake/Foster Village Neighborhood Board	Board Members	5/12/88	Project presentation--Q&A on alternative corridor
		9/14/89	Project presentation--Q&A on preferred alignment
Board of Water Supply	Susan Uyesugi	2/88	Proposed projects
City Council	Arnold Morgado	7/28/89	Project update
Department of General Planning	Eugene Connell	3/14/88	Public facilities map and transmission lines
	Harold Sato	9/15/89	Salt Lake Boulevard widening plans
Department of Land Utilization	Steve Salis	2/1/88	Proposed projects
	D. Tameta	2/1/88	Pearlridge Community Park improvements
	Calvin Ching	2/5/88	CAP Meeting No. 1
	Bennett Mark	12/8/88	SMA Permit Process
	Robin Foster	9/21/89	SMA Permit and Conditional Use Permit
	Nadine Nakamura	9/22/89	Conditional Use Permit
Department of Public Works	R. Lum W. Watani	9/29/89	Construction within a County Road Right-of-Way
		11/13/89	Construction within a County Road Right-of-Way
Department of Transportation Services, Rapid Transit System Project	Marvin Char	7/29/88	Rapid Transit System plans
	Jim Ball Ray McDonald Jim Egan	11/10/88	Rapid Transit System plans
	Marvin Char M. Choy B. Sumitomo	7/17/89	CAP Meeting No. 2
Pearl City Neighborhood Board	Board Members	11/17/88	Project presentation--Q&A on alternative corridor
		8/31/89	Project presentation--Q&A on preferred alignment

Agency or Organization	Person Contacted	Date	Subject
Other Aiea/Foster Village/Aliamanu Public Meeting	Alice Fujikawa/Office of City Council-woman Donna Kim Mike Miura/Chairman Aiea Neighborhood Board	11/17/88	Alignment public meeting
Chevron USA	Marshall McCormick	3/88 6/88	Pipeline locations
Halawa Associates	Kevin Corney	6/11/88 6/13/88	Halawa Associates Shopping Center Castle Park Site Plan
Hawaiian Independent Refinery	Jason Lembeck	4/88 5/88	Pipeline locations
Pearl City Community Association	Mark Yasuda	7/28/89	Project update
Pearl City Public Meeting	Rita Ebisu/Pearl City Community Church Mary Yasuda/Pearl City Community Church Thomas Kam/Pearl City Neighborhood Board Bob Loew/KDEO Radio	11/16/88	Alignment public meeting

Note: CAP = Consolidated Application Process.

Chapter 1
Description of the Proposed Action

Chapter 1
DESCRIPTION OF THE PROPOSED ACTION

1.1 PROJECT PURPOSE AND NEED

Background

The Waiau-Makalapa No. 2 138 kV Transmission Line Project is proposed as a single-circuit, 138 kV alternating current (AC) transmission line from the Waiau Power Plant to the Makalapa Substation, a distance of approximately 4.5 miles (Figure 1.1-1)

Purpose and Need

The Waiau-Makalapa No. 2 138 kV Transmission Line is needed for two reasons:

1. To assure the reliable delivery of power by preventing an overload of the existing Waiau-Makalapa No. 1 line during an emergency condition. An additional path for power flow is required to provide adequate transmission line capacity during outages caused by lightning, fires, vehicular accidents, or high winds, and during periods when other lines are out of service for routine maintenance.

2. To provide additional transmission capacity to meet growing demands for power in the Pearl Harbor, Foster Village, and Aiea areas, as well as throughout the island.

The reasons for the project--system reliability and load growth--are discussed in more detail below.

System Reliability

Hawaiian Electric Company, Inc.'s (HECO's) transmission system is designed to meet stringent construction and maintenance standards: Hawaii Public Utilities Commission (PUC) General Order No. 6 (State of Hawaii, 1969), the National Electrical Safety Code (NESC) (American National Standards Institute, 1987), U.S. Department of Labor Occupational Safety and Health Standards (USDL OSHA), and HECO's own requirements to provide maximum safety and protection for landowners and property. Meeting these standards ensures reliable service in the event of unlikely but plausible transmission system emergencies caused by lightning, high winds, fires, or vehicular accidents. During emergency conditions, transmission service could be interrupted and other lines could be overloaded because, in an integrated transmission system such as HECO's 138 kV system, power flow in any line can be affected by conditions and events that occur anywhere on the system. When a line is disconnected, power flow in other lines increases.

HECO's transmission system studies show that as loads grow to levels projected for the 1990s, the existing Waiau-Makalapa No. 1 line could overload during emergency conditions. By 1992, emergency conditions could result in an overload and subsequent loss of the Waiau-Makalapa No. 1 line. The combined effect of an emergency condition and the loss of the Waiau-Makalapa No. 1 line could result in widespread outages.

The emergency conditions that could trigger widespread outages are not implausible occurrences: the 1983 islandwide outage occurred when two 138 kV lines were being repaired after Hurricane Iwa and a canefield fire triggered the failure of another double-circuit 138 kV line. On September 10, 1988, much of Oahu experienced a blackout when a conductor on one 138 kV line failed while two other 138 kV circuits were out of service for scheduled work. Adding more transmission capacity to improve system reliability was one of many recommendations made by Stone and Webster (1984), an engineering consulting firm hired by HECO to evaluate its system following the 1983 blackout.

By constructing the proposed Waiau-Makalapa No. 2 138 kV Transmission Line, a new path for power flow will be created. This will reduce power flow in other lines (especially the Waiau-Makalapa No. 1 line), thereby preventing damage or loss of this line and reducing the risk of a widespread power outage.

Load Growth

If the line failures described above were to occur today, the existing Waiau-Makalapa No. 1 line would probably not be in danger of overload. However, demand for electricity continues to grow at a steady pace on Oahu (see Routing Report, Chapter 1, for discussion of projected loads). As loads grow, additional generation must be added to meet demands for power in the Pearl Harbor, Foster Village, and Aiea areas, as well as throughout the island. Currently, HECO plans to serve growing loads by purchasing power from independent power producers to augment the power generated by HECO's units. By the early 1990s, load growth will

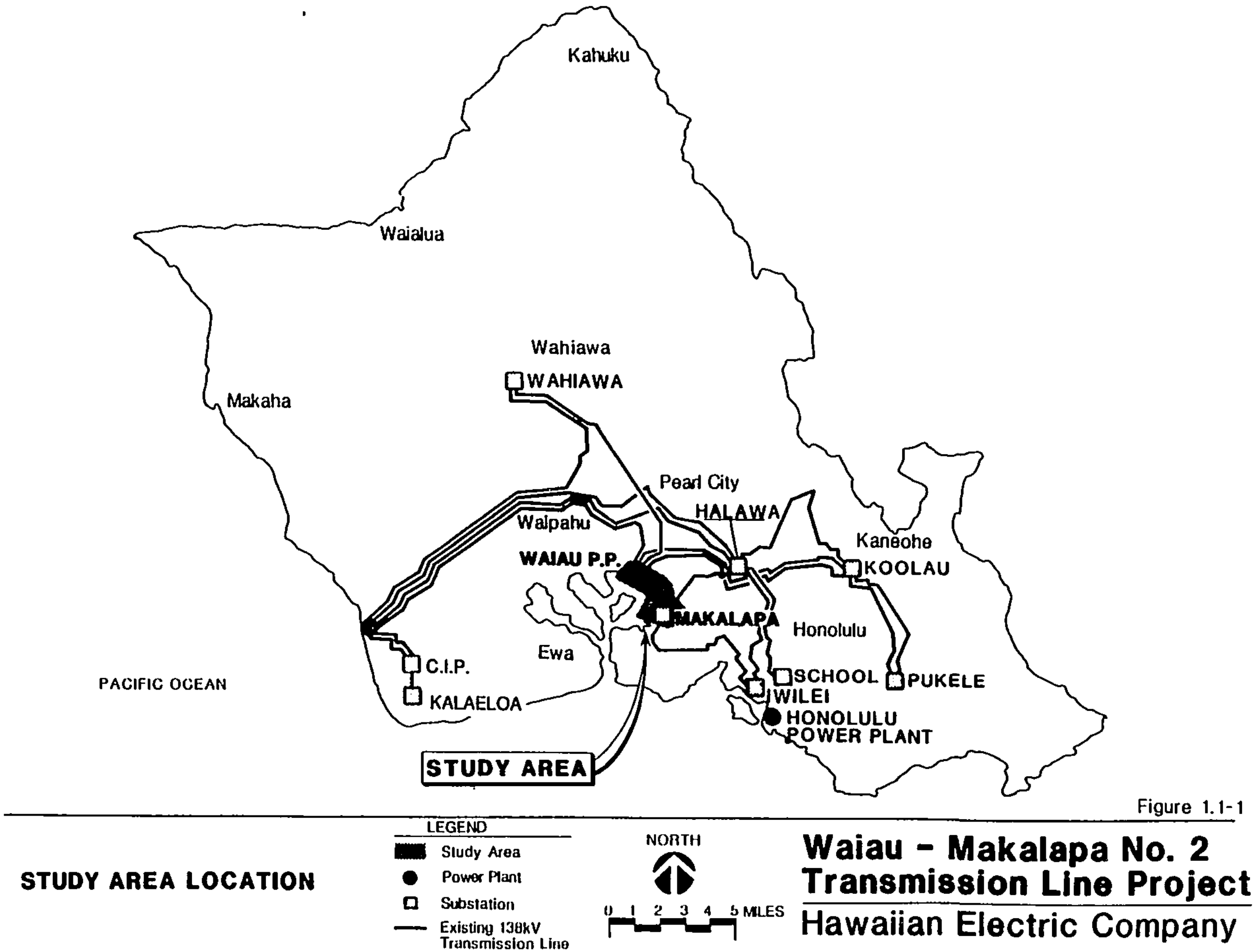


Figure 1.1-1

STUDY AREA LOCATION

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

impair the reliable functioning of the existing Waiau-Makalapa No. 1 line unless the Waiau-Makalapa No. 2 138 kV Transmission Line is added to the system.

1.2 PREFERRED ALIGNMENT LOCATION

The preferred alignment of the Waiau-Makalapa No. 2 138 kV Transmission Line begins at the Waiau Power Plant and follows the alignment of an existing 46 kV electric line along the makai side of Kamehameha (Kam) Highway as far as McGrew Point (Figure 1.2-1). At that point, the existing 46 kV line angles makai of Kam Highway across the area proposed for the Aiea Bay State Recreation Area. Instead of following the existing 46 kV line, the new transmission line will continue to follow the makai side of Kam Highway as the highway turns south near Aloha Stadium. In order to provide adequate separation between the new line and the existing Waiau-Makalapa No. 1 138 kV Transmission Line near Aloha Stadium, the existing line will be relocated from the makai to the mauka side of Kam Highway from the Aiea interchange to the intersection of Kam Highway and Salt Lake Boulevard. This will require placing one transmission pole in the retaining wall of the Aloha Stadium parking lot (the retaining wall will be rebuilt around the pole).

South of Aloha Stadium the new line will use the alignment of an existing 46 kV line along the makai side of Kam Highway to approximately 1,500 feet north of Radford Drive, where it will cross to the mauka side of the highway. The alignment will follow the north side of Radford Drive and then turn north for approximately 1,250 feet along the makai side of Bougainville Drive (the mauka side of the H-1 freeway). It will turn south to cross Bougainville Drive and follow the south side of Lawehana Street and Malaai Street to the Makalapa Substation. In order to provide adequate separation, one pole of the existing Makalapa-Iwilei 138 kV line will be relocated from the east to the west side of Bougainville Drive at Lawehana Street.

1.3 TECHNICAL CHARACTERISTICS

The Waiau-Makalapa No. 2 138 kV Transmission Line Project includes the following facilities and activities:

- Construction of approximately 4.5 miles of 138 kV, single-circuit, alternating current (AC) transmission line between Waiau Power Plant and Makalapa Substation

- Realignment of the existing Makalapa No. 1 138 kV Transmission Line from the makai to the mauka side of Kam Highway between the Aiea interchange and the intersection of Kam Highway and Salt Lake Boulevard

- Upgrade of the Waiau and Makalapa Substations to accommodate new electrical equipment

- Placement of existing 12 kV distribution lines and service connections underground from Waiau Power Plant to McGrew Point along the makai side of Kam Highway (subject to PUC approval)

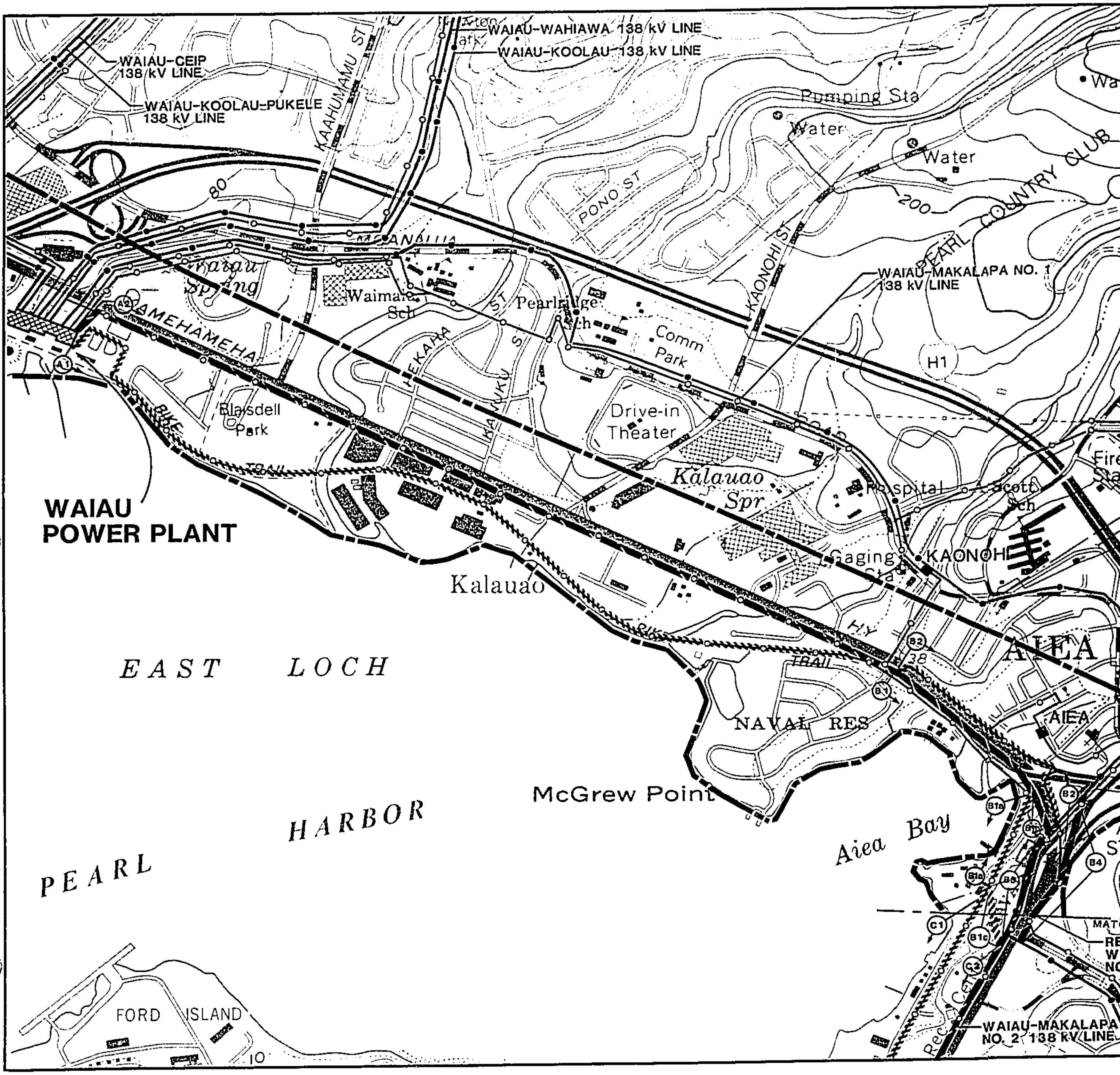
The Waiau-Makalapa No. 2 138 kV Transmission Line is scheduled to be operational by September 1992.

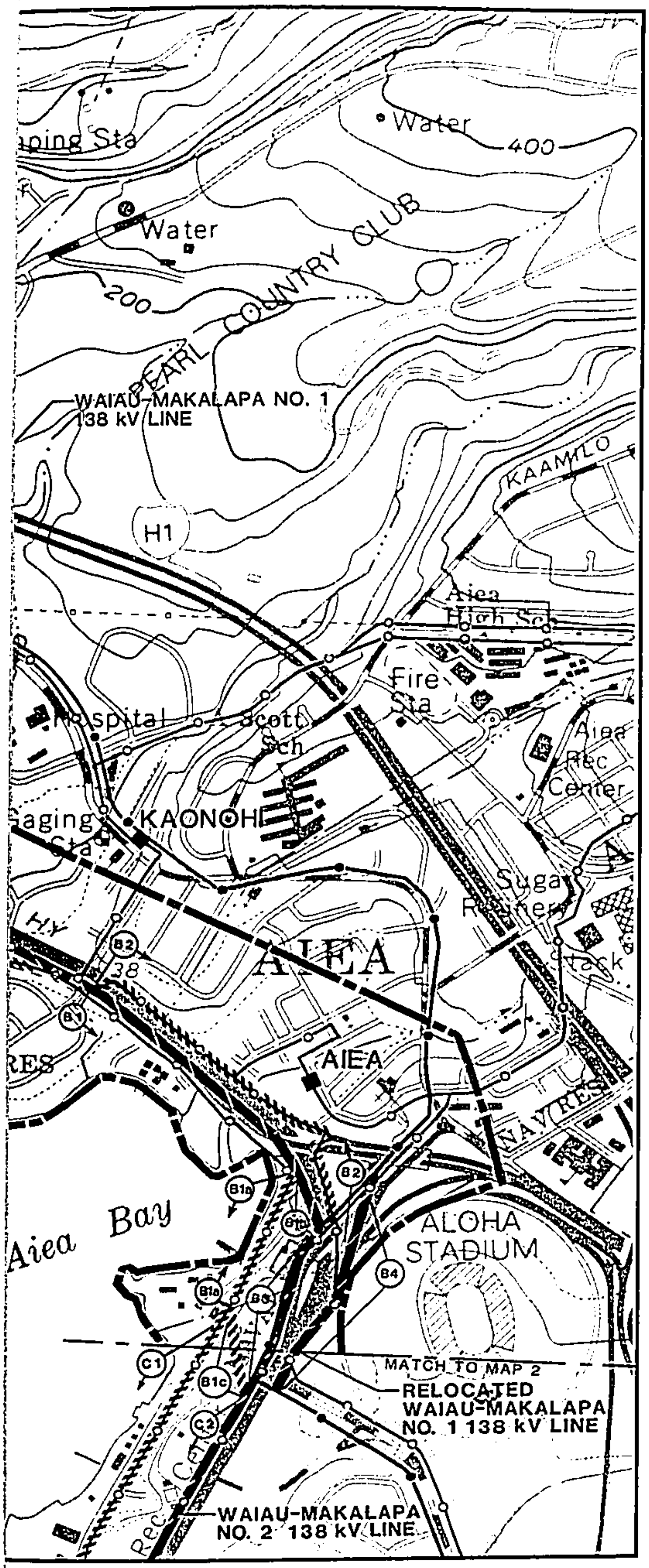
General Configuration

The proposed Waiau-Makalapa No. 2 138 kV Transmission Line will consist of a single-circuit 138 kV transmission line with a single-circuit 46 kV underbuild on tubular steel poles. Figure 1.3-1 illustrates the typical single-circuit pole, conductor, and insulator configuration. Table 1.3-1 summarizes the design characteristics of the project; engineering details are available in the Routing Report (Chapter 3). The new poles will generally be placed along existing public rights-of-way and will replace the existing 46 kV poles. Along the makai side of Kam Highway between Waiau Power Plant and McGrew Point, existing 12 kV lines will be placed underground, if approved by PUC.

Pole heights, locations, and span lengths vary and are determined by the following factors: natural terrain and topography, structural limitations, costs, visual considerations, existing and proposed land uses, crossings of man-made features such as roads and telephone lines, and other criteria that may be unique to the project. The distances between poles will vary according to the terrain (e.g., the need to span streams or roads), the number of curves and angles in the route, and opportunities to minimize visual impacts by careful pole location. There will be 9 to 18 poles per mile.

In many cases in urban areas, 12 kV distribution lines are located along the same alignment as 46 kV lines. Generally, 12 kV wooden poles are 45 to 55 feet high and are spaced 150 to 300 feet apart, while 46 kV lines are 55 to 65 feet high and are spaced 300 to 600 feet apart. Where existing 46 kV lines will be strung on the new 138 kV poles, pole heights


WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
KAAHUMANU ST
Pumping Sta
Water
Water
PEARL COUNTRY CLUB
PONO ST
KAONOHI ST
WAIAU-MAKALAPA NO. 1 138 kV LINE
Waimalu Sch
Pearlridge Sch
Comm Park
H1
KAMEHAMEHA
Blaisdell Park
Drive-in Theater
Kalauao Spr
Hospital
Scott Sch
Gaging Sta
KAONOHI
WAIAU POWER PLANT
Kalauao
EAST LOCH
AIEA
NAVAL RES
McGrew Point
HARBOR
Aiea Bay
PEARL
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE

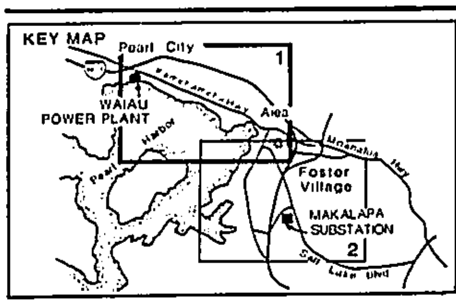


ALIGNMENT DATA MAP

PREFERRED ALIGNMENT

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

(A1) Alignment Segment Identifier



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 1.2-1

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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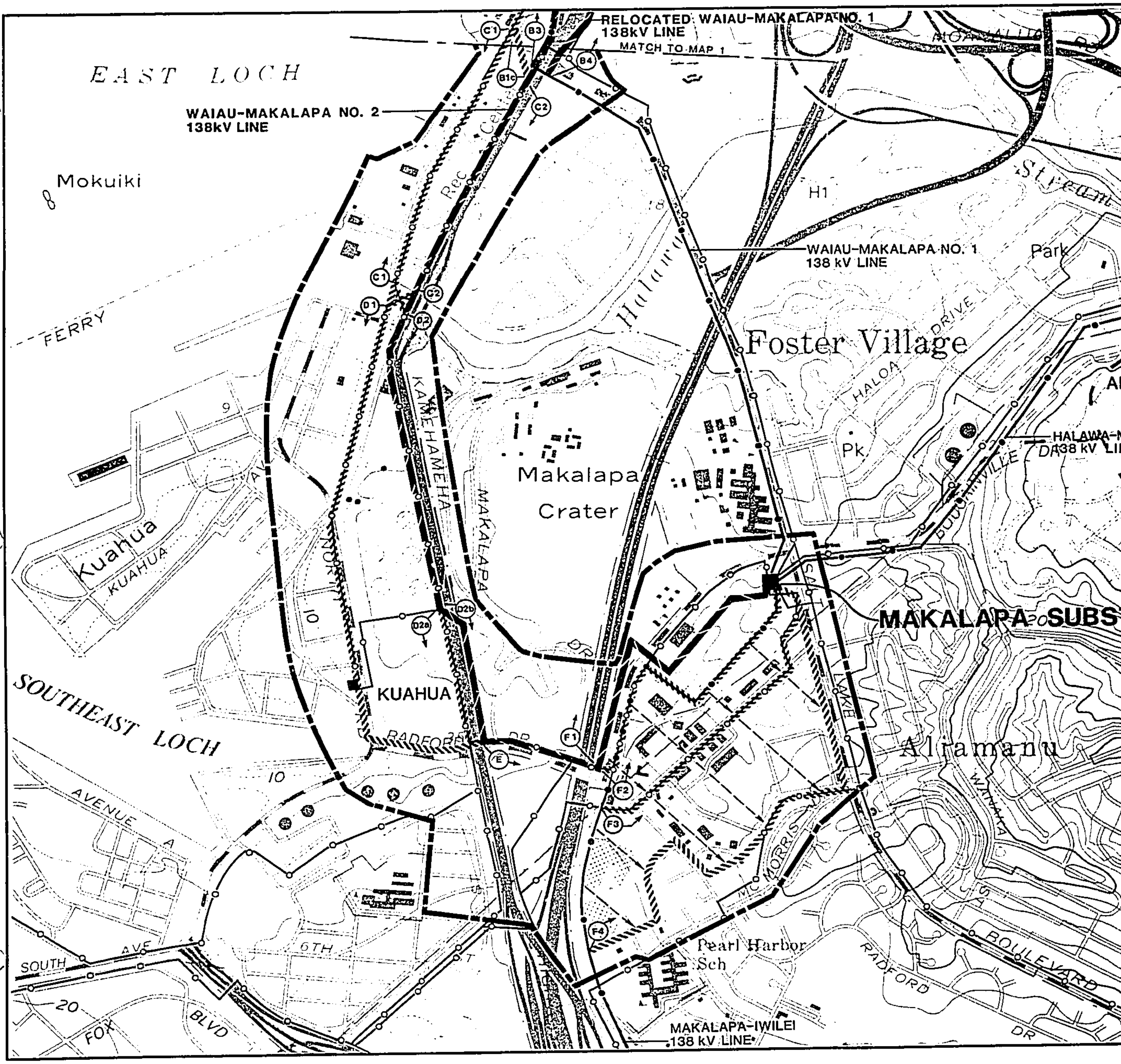
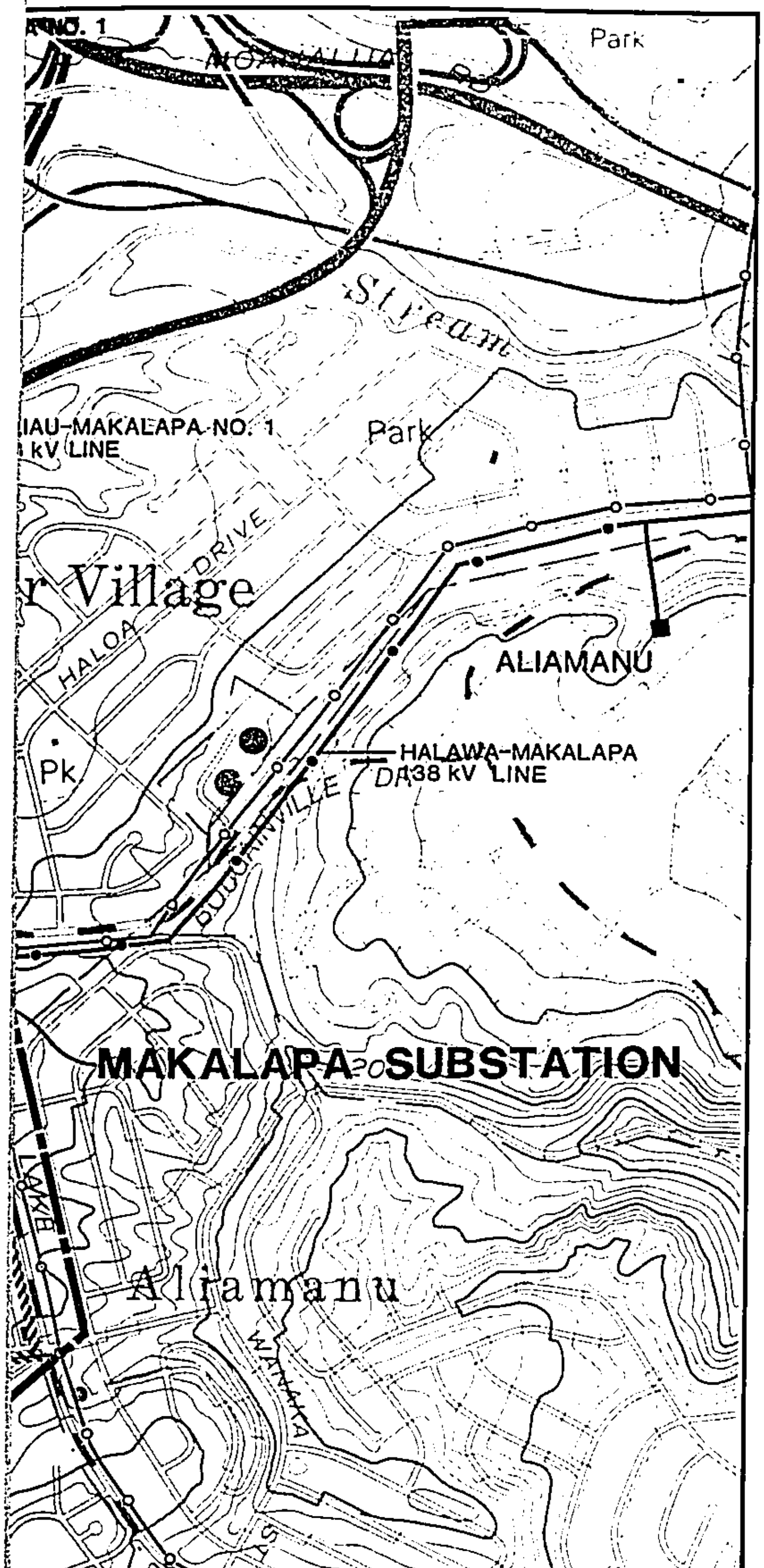
10/89



RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
H1
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
FERRY
Foster Village
HALOA
DRIVE
Pk
Makalapa
Crater
KAMEHAMEHA
MAKALAPA
Kuahua
KUAHUA
NORTH
MAKALAPA SUBS
SOUTHEAST LOCH
KUAHUA
RADFORD
DR
SALT LAKE
Alamanu
AVENUE
A
MC MORRIS
6TH
SOUTH
AVE
Pearl Harbor
Sch
RADFORD
BOULEVARD
FOX
BLVD
MAKALAPA-IWILEI
138 kV LINE
DR

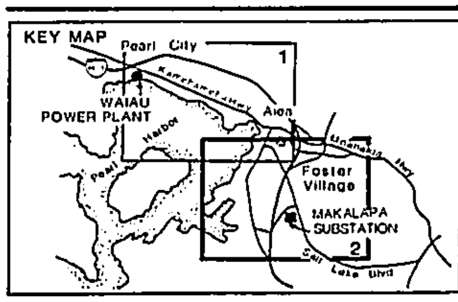


ALIGNMENT DATA MAP

PREFERRED ALIGNMENT

Corridor Boundary
Alternative Alignment
Preferred Alignment
Existing 46 kV Line
Existing 138 kV Line
Substation

Alignment Segment Identifier



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

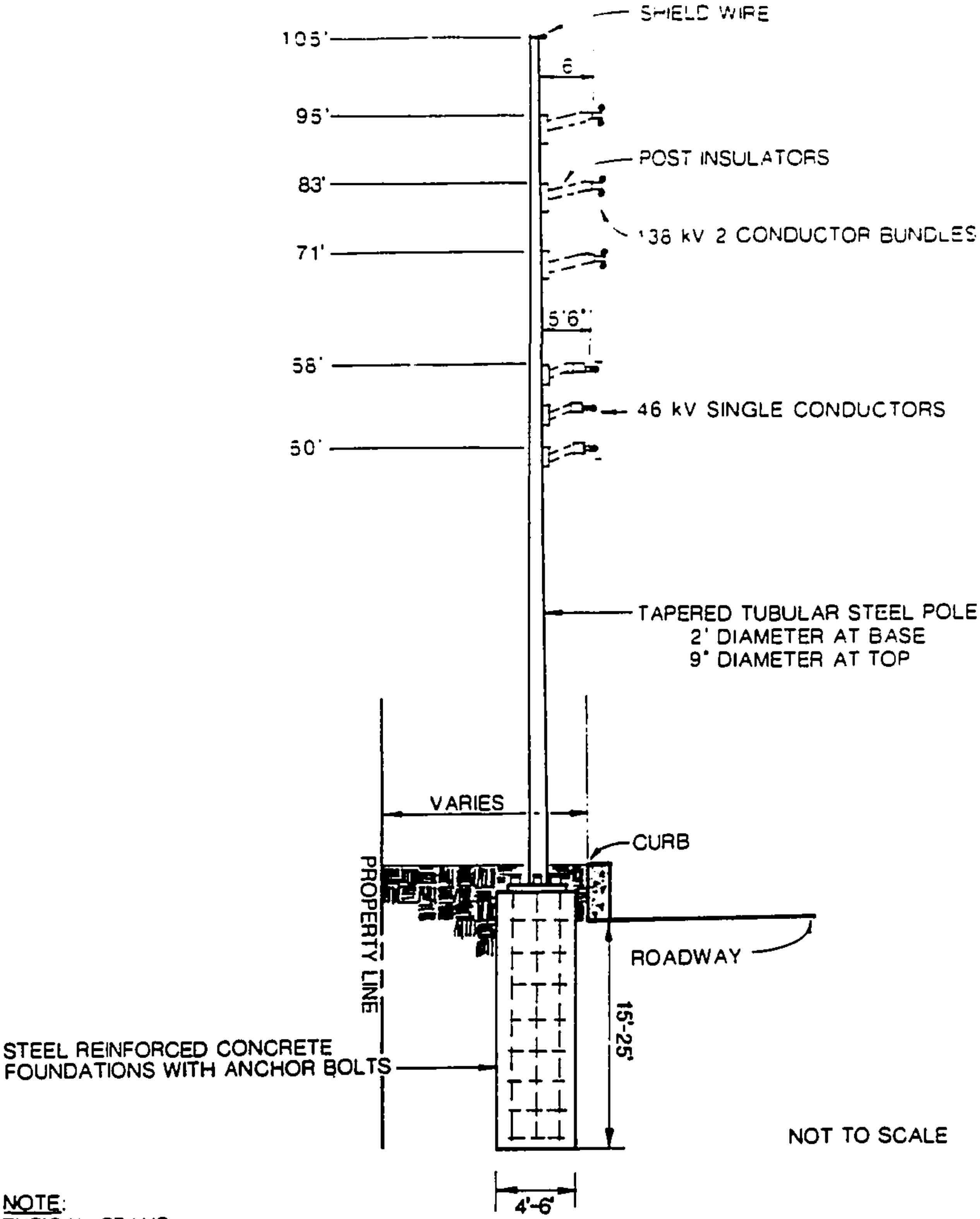
NORTH

FIGURE 1.2-1

Waiau – Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

CH2M HILL

10/89



NOTE:
TYPICAL SPANS
300-600 FEET

STRUCTURE SHOWN USED ADJACENT TO ROADWAY

FIGURE 1.3-1

TYPICAL 138 kV SINGLE CIRCUIT STRUCTURE

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

Table 1.3-1
WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE
DESIGN CHARACTERISTICS

	Units
Line length	4.5 miles (approximate)
Type of structure	Tubular steel, single-pole
Structure height	80 to 135 feet
Structure weight	6,000 to 24,000 pounds
Structure foundation type	Augered/reinforced concrete, piers or piles
Structure foundation dimensions	Piers: 15 to 25 feet deep; 4 to 6 feet in diameter
	Piles: 50 to 150 feet deep
Average span length	300 to 600 feet (longer if needed because of terrain)
Number of structures per mile	9 to 18
Right-of-way width	25 to 100 feet
Land temporarily disturbed	
• Foundation	40 ft by 40 ft, or 1,600 ft^2 (approximately)
• Conductor pulling site	50 ft by 100 ft, or 5,000 ft^2 (approximately)
138 kV conductor configuration	
• Bundle description	Two conductors per phase (three phases per circuit); 12-inch vertical spacing
• Conductor size and type	795 kcmil[1]; AAC "ARBUTUS"[2]
• Conductor ground clearance	30 ft minimum at 212°F, final sag
• Shield wire	Optical ground wire (OPGW)
Normal operating voltage	138,000 volts AC (138 kV) ±5%
138 kV subconductor thermal limit	215 MVA normal (900 amps) 247 MVA emergency (1,035 amps)
138 kV conductor bundle capacity	430 MVA normal (1,800 amps) 480 MVA emergency (2,000 amps)

[1]Cross-sectional measure of the conductor area in thousands of circular mils.
[2]Aluminum industry standard code for the conductor and size of strands.

may be up to 135 feet. In this case, the 138 kV poles will replace the 46 kV poles, but 12 kV poles will remain between the taller poles. The exception will be along the makai side of Kam Highway between Waiau Power Plant and McGrew Point, where HECO proposes (subject to PUC approval) to place existing 12 kV lines underground.

Foundations

Soils along the preferred alignment between the Waiau Power Plant and Aloha Stadium makai of Kam Highway consist primarily of recent alluvium. These soils are generally poorly suited for foundation loads. It is anticipated that a deep pile foundation system will be required to support the transmission line poles in portions of these areas.

Soil types along the preferred alignment between Aloha Stadium and Radford Drive, including the area surrounding Makalapa Substation, consist of volcanic tuff. This formation can more easily support heavy foundation loads. It is anticipated that conventional pier foundations will be used to support the proposed transmission line poles in these areas.

The types of foundations to be used at each pole location will be determined following further geotechnical investigations (including borings and field and laboratory testing) prior to the final design stage of the project. Foundation installation is described in more detail in Chapter 3 of the Routing Report, Subsection 3.3.5.

Underground Installation of Distribution Lines and Service Connections

In conjunction with the Waiau-Makalapa No. 2 138 kV Transmission Line Project, HECO proposes (subject to PUC approval) underground placement of the existing overhead 12 kV distribution lines and service connections on the makai side of Kam Highway between Waiau Power Plant and McGrew Point.

The 12 kV underground lines will be installed in ductlines buried approximately 3 feet beneath the roadway along Kam Highway. The main cable will be a solid dielectric polyethylene insulated cable approximately 2 inches in diameter. Manholes will be installed every 200 to 300 feet to facilitate cable splicing, service connections, and inspections. Four to five switch vaults (pad-mounted metal-clad structures each 4 feet high and 6 by 6 feet square) will be installed along the 2-mile route. HECO will work with customers to identify appropriate locations for the switch vaults on customer property. Each switch vault will service a number of pad-mounted transformers with 12 kV fused/switched feeders.

The existing overhead pole-mounted transformers will be replaced with pad-mounted transformers ranging in sizes from 3 by 3 feet by 2-1/2 feet high to 5 by 5 feet by 6 feet high (depending on the size of the customer's load). Most commercial and apartment buildings will each require a transformer; in some locations (depending on the size of the load and the distances involved), a single transformer can serve several single-family houses. HECO will work with each customer to identify an appropriate location for the pad-mounted transformer within each customer's property. Transformers may also be installed underground beneath sidewalks; however, because of high initial construction costs and high recurring maintenance costs, this is not usually a viable alternative.

Each customer will be connected to a transformer by an underground secondary line (service connection). Service ductlines and cables will be buried approximately 2 feet deep.

HECO has informed the City and County of Honolulu, GTE Hawaiian Tel, and Oceanic Cable Vision about HECO's plan to underground the distribution line along Kam Highway. If these entities agree to participate, street light feeders, telephone lines, and television cables may also be placed underground. If they decide not to participate, poles that carry cables for these services will remain on the makai side of Kam Highway; however, many of the wooden poles will be shortened after the electric distribution lines are removed.

1.4 CONSTRUCTION PRACTICES

During the construction of a typical HECO transmission line, most or all of the following phases of work must be accomplished: surveying, traffic management practices, establishing construction facilities or base yards, installing foundations, erecting poles, installing conductors, and cleaning up and removing construction equipment. In the case of the Waiau-Makalapa No. 2 138 kV Transmission Line, an additional step is proposed (subject to PUC approval): the placement underground of existing 12 kV distribution lines and service connections between Waiau Power Plant and McGrew Point along the makai side of Kam Highway.

Surveying Phase

Surveying for construction of a transmission line includes surveys of property, rights-of-way, soils, ground profiles, access roads, and construction sites. A typical survey crew includes three people. Additionally, geotechnical investigations at selected locations will determine the types of foundations required at each pole site. This activity may require coning off a lane of traffic for a few hours at each test location.

Clearing Requirements

Right-of-way clearing is done when required to prepare for efficient installation of poles and conductors and to provide for required electrical clearances. Because the study area is urban with little high-growing vegetation, and because most construction will occur adjacent to existing roadways, very little, if any, right-of-way clearing will be required.

Traffic Management Practices

When poles are installed adjacent to roads, part of the road must sometimes be occupied by equipment used in installing foundations, poles, and conductors. Work on public roads must follow traffic control procedures prescribed by the Federal Highway Administration, the State Department of Transportation Highways Division, and the City and County of Honolulu Department of Transportation Services. Work adjacent to a state road or highway requires a Permit to Perform Work on State Highways, which must incorporate a Traffic Control Plan approved by the Highways Division. The City and County of Honolulu requires observation of state and federal traffic control regulations for any work on county roads.

HECO and its construction contractors follow state guidelines for the types of signs, lights, markers, position of traffic cones, areas coned off, and the use of flaggers and/or police officers (State of Hawaii Department of Transportation; U.S. Federal Highway Administration, 1978).

Coning off a lane of traffic is usually required during foundation, pole, and conductor installation phases of line construction, and coning off is also required when existing 12 kV lines are placed underground. At any one point along the new route, traffic might have to be interrupted for several relatively brief periods over the course of a few months. The time required to complete each phase of construction is described in Chapter 3 of the Routing Report, Section 3.3.

Construction Support Facilities

A construction yard headquarters will be identified in a location near the new line's route. The construction yard headquarters is the base station where employees report at the start and end of each day's activities. These facilities are used for other activities, including field office; pole and davit arm laydown areas; storage of materials, equipment, and vehicles; and security.

One material storage yard or staging area will probably be used during construction of the Waiau-Makalapa No. 2 138 kV Transmission Line; it will probably be located on HECO property at or adjacent to the Waiau Power Plant.

Foundation Installation

The next phase in the construction of the transmission line is foundation installation. For pier-type foundations, this consists of excavation, drilling, forming, and pouring of concrete. Typically, two to three foundations at a time are excavated, formed, and poured, requiring 2 to 3 weeks to complete. For pile-type foundations, 6 to 12 concrete piles are driven into the soil by a diesel, steam, or compressed-air pile-driver. The piles are linked into a reinforced concrete pile cap. If the poles are located adjacent to a roadway, foundation installation may require coning off a single lane of traffic for approximately 1,000 to 1,500 feet. This coned area is moved forward as the foundations are completed. Details of the installation for both pier- and pile-type foundations are in Chapter 3 of the Routing Report, Section 3.3.

Pole Assembly and Installation

After the foundation concrete is cured, the poles are transported to the pole locations and are assembled and erected. In congested areas, the poles are partially or completely assembled, then transported to the pole locations and erected. A mobile crane is used to lift each assembled pole or section into place.

The base section of each steel pole is fitted with a baseplate with an array of anchor bolt holes that match the anchor bolt pattern installed in the foundation. Anchor bolt leveling nuts are tightened in accordance with the manufacturer's recommendations before the pole is erected.

Insulator hardware is assembled and installed on each pole after it is erected.

Approximately two to four poles per day can be erected by four to seven workers.

Conductor Installation

Before conductor installation begins, temporary clearance structures may be installed at road crossings and at locations where the conductors might inadvertently contact existing electrical or communication facilities and vehicular traffic during installation.

The conductors, the tensioner, the puller, and other related equipment and material are assembled at sites located along the route at 1- to 2-mile intervals. "Tension-stringing" is used to install the conductors. This method prevents the conductors from touching the ground or other objects by maintaining a certain tension and sag during the stringing operation.

In pole locations adjacent to roadways, one lane would be closed to traffic during pulling and sagging operations. Approximately 1 month is required to complete 1 mile of conductor installation.

Underground Installation of Distribution Lines and Service Connectors

Underground installation of distribution lines and service connections will be completed after the transmission line has been constructed and energized.

First, HECO will work with each customer to establish the customer's demand (load) and the location of pad-mounted transformers required to serve the customer's load. Easements for concrete pads (either 5 by 5 feet or 10 by 10 feet, depending on the customer's load) will be acquired and transformers ordered.

Next, the primary 12 kV distribution ductline and manholes will be constructed underground within the roadway. Pavement saws, jackhammers, and backhoes will be used to cut through the asphalt of Kam Highway and dig a trench approximately 2 to 4 feet wide and 5 to 10 feet deep. Manholes or hand holes of various sizes will be established every 200 to 300 feet, as needed. Concrete pads for switch vaults and transformer vaults will be constructed as needed within the sidewalk area for customers whose properties do not have space for pad-mounted transformers. The main distribution cables will then be pulled into the ductline, spliced in the manholes (or hand holes), and connected to the pad-mounted switch vaults. After the main cables have been installed, 12 kV fused and switched feeders will be installed from the switch vaults to customers' transformers and connected.

Next, the underground distribution lines will be tested and energized and work will begin on converting service connections from overhead to underground. Service connections (between the transformer and the customer) typically require trenches about 2 feet deep and 6 inches to 1 foot wide, depending on the number of ducts required to serve the customer's load. A backhoe will be used to dig the trench. When the new service ductline has been installed, the soil will be replaced and any asphalt or concrete surfaces will be patched. Converting from overhead to underground service connections requires a brief outage for each customer (1 to 3 hours). HECO will work with each customer to schedule the cable installation and conversion at a time that is mutually acceptable to the customer and the construction crews.

After distribution lines and service connections are installed and energized, the old overhead line and any superfluous poles will be removed. In those places where the overhead line shared poles with overhead telephone, television cable, or streetlight feeder lines, these poles will be "topped" (shortened) above the remaining lines.

The entire underground installation of 12 kV distribution lines and feeders is predicted to take 6 to 8 months.

Quality Control, Cleanup, and Removal of Construction Materials

As sections of the transmission line are completed, HECO will thoroughly inspect the work to verify that it is built according to specifications and standards. Anything that does not comply will be corrected.

Cleanup work generally includes:

- Removing all temporary crossing and clearance structures and backfilling any remaining holes used for temporary poles

- Disposing of packing crates, reels, shipping material, and debris

- Dressing roads, work sites, and pole sites to remove ruts, and leveling and preparing areas for seeding, if required

- Repairing gates and fences to their original condition or better

- Grounding fences and trellises, as needed

- Repairing any damage that occurred during construction

Substation Improvements

To accommodate the Waiau-Makalapa No. 2 138 kV Transmission Line, new equipment must be installed at the substations that terminate the line. At the Waiau Power Plant, three 138 kV circuit breakers and associated steel and concrete support and foundation structures will be installed, along with line protection and control equipment. At the Makalapa Substation, two 138 kV circuit breakers and associated line protection and control equipment, and steel and concrete support and foundation structures will be installed. All substation work will take place within existing HECO property.

1.5 RIGHT-OF-WAY ACQUISITION AND USE

Right-of-way easements are the land rights acquired for the construction, operation, and maintenance of the transmission line within private property. The right-of-way for the transmission line is established only when all easement rights have been documented.

It is currently proposed that the Waiau-Makalapa No. 2 138 kV Transmission Line route follow, completely or in large part, existing 46 kV subtransmission lines between the Waiau Power Plant and the Makalapa Substation. Assuming that the 138 kV transmission line is an overbuild of the existing 46 kV line, few new right-of-way easements need be acquired.

HECO's franchise (granted by the state) allows it to place utilities within the rights-of-way of state and county roads. Where the line would be located parallel and adjacent to a state highway in an urban area, the pole must be set back at least 2 feet from the curb. Where curbs do not exist, the pole must be located at least 20 feet from the edge of the traveled roadway, except where protective barriers are installed.

If new easements on private property or widening of existing easements are required, they will be negotiated with the landowners. The landowner grants HECO an easement for its facilities, but retains title to the land and full use of the easement area, subject only to safety limitations and vegetation clearance requirements.

Land use activities within and adjacent to the transmission line right-of-way would be permitted within the terms of the easement. Incompatible activities within the right-of-way include constructing buildings, drilling wells, growing trees that may interfere with line operation, or other activities that may compromise safety. If necessary, appropriate techniques would be used within the right-of-way to control vegetation that might interfere with reliable service. HECO's standard vegetation control practice is to trim or remove all vegetation within 10 feet of the extreme position (defined as the lowest position at rest or the farthest position of the conductor in high winds) of 138 kV conductors and within 8 feet of the extreme position of 46 kV conductors. Low-growing vegetation may be left in the right-of-way. Because the new line will make use of existing 46 kV line alignments, there should be little vegetation trimming.

1.6 PROJECT SCHEDULE, COST, AND WORK FORCE

Figure 1.6-1 illustrates the project schedule, showing the relationship of the regulatory process, engineering and design, land acquisition, and construction. Construction of the transmission line will take about 16 months, from May 1991 to September 1992. Operation of the line is scheduled for 1992. Placing existing 12 kV lines along portions of Kam Highway underground would take place after the line has been energized (late 1992 to 1993).

The preliminary capital cost estimate for the Waiau-Makalapa No. 2 138 kV Transmission Line Project is $27.7 million (in 1991 dollars). This amount includes $21 million for the overhead 138 kV line and substation improvements and $6.7 million to place existing overhead 12 kV lines along portions of Kam Highway underground.

The construction work force for the Waiau-Makalapa No. 2 138 kV Transmission Line Project will be made up of 30 to 40 workers. There will be two separate work forces, one for substation improvements and another for transmission line construction.

Foundation construction will probably be performed by contractors. HECO construction crews will erect the poles and string the conductors with a work force of approximately 20 workers. HECO construction crews will also make necessary substation improvements. The substation work force will be smaller--approximately 10 to 20 workers.

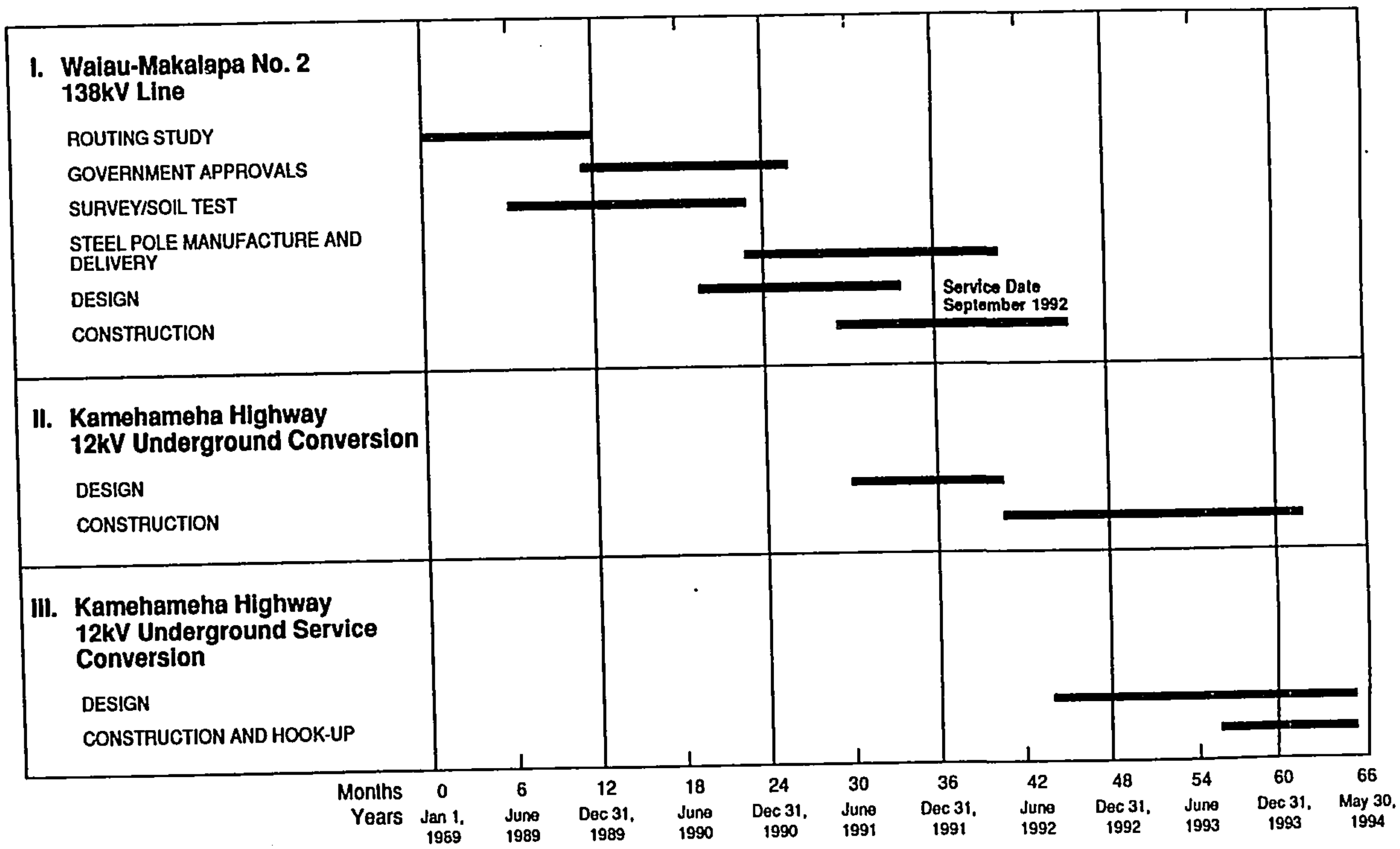


FIGURE 1.6-1

PROJECT SCHEDULE

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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Chapter 2
Alternatives Considered

Chapter 2
ALTERNATIVES CONSIDERED

2.1 TRANSMISSION ALTERNATIVES

Four transmission alternatives were evaluated for a 138 kV transmission line between Waiau Power Plant and Makalapa Substation:

- Overhead transmission line over land
- Overhead transmission line across Pearl Harbor
- Underground transmission cable
- Submarine transmission cable

The basic elements of these four alternative transmission technologies are described below and the environmental and economic considerations of construction and maintenance for each alternative are compared. Table 2.1-1 compares these characteristics for each alternative.

2.1.1 Overhead Transmission Line Over Land

Basic System Components

Basic components of a typical HECO 138 kV transmission line in an urban area include tubular steel poles and aluminum conductors that are electrically insulated from the poles with porcelain or polymer/fiberglass insulators. Figure 1.3-1 shows the typical configuration of overhead structures. Poles would be 80 to 135 feet high and spaced approximately 300 to 600 feet apart.

Cost

Engineering and construction for the Waiau-Makalapa No. 2 overhead line and related substation improvements are projected to cost approximately $18.5 million, excluding the costs of acquiring right-of-way easements and conversion of 12 kV overhead lines along portions of Kam Highway to underground lines.

Geophysical Considerations

Construction of an overhead line for the Waiau-Makalapa No. 2 138 kV Transmission Line would have minimal impact on topography and soils because only soils in and around the pole locations would be disturbed. Soils would be temporarily disturbed at each pole site for augured excavations or for pile-driving and backfilling. The land between the

Table 2.1-1
TRANSMISSION SYSTEM ALTERNATIVES
SUMMARY OF CHARACTERISTICS AND ENVIRONMENTAL EFFECTS

Transmission Alternative	Basic System Components	Approx. Line Length (Mile)	Construction Cost ($M/Mile)	Construction and Operation Effects: Geological, Biological, and Cultural Resources	Construction and Operation Effects: Socioeconomics, EMF, and Visual Resources	Traffic Considerations	Maintenance Considerations
Conventional Overhead Across Land	Augered concrete pier foundations Pile foundations in wet soils; 6 to 12 piles per pole Tubular steel poles; 80 to 135 ft. high Three aluminum conductor bundles and one shield wire Some sections underbuilt with 46 kV lines	4.5	4.1	Clearing of surface vegetation at pole sites Excavation for pile foundations 14 ft. x 18 ft. x 4 ft. Trees near ROW trimmed within 10 ft. of conductor position in high wind Excavation required for all foundations; 70 to 100 poles Subsurface archaeological features may be disturbed in excavations; requires field archaeologist to survey pole sites	Assumes single circuit line with 46 kV underbuild Electric field at center of ROW approx. 0.5 kV/m or less Magnetic field at center of ROW approx. 21 mG or less Poles and conductors visible throughout	Construction: ROW near roadway--one lane of traffic obstructed for 4 to 6 weeks per mile during off-peak traffic periods Maintenance: Potential traffic disruption or delays depending on type of repair/maintenance practices	Locating and accessing faults relatively easy Repair time: hours "Live line" maintenance possible
Overhead Across Pearl Harbor	Pile foundations; 6 to 12 piles each pole across water and in wet soils Tubular steel poles; 100 to 120 ft. high Three aluminum conductor bundles and one shield wire Some sections underbuilt with 46 kV lines	4.5 (2.0 across water; 2.5 over land)	3.8	Temporary disruption of benthic ecosystems; loss of habitat as a result of pile foundation installation Potential conflict with known historic resources in Pearl Harbor; extensive mitigation may be required Effects for overland portion would be the same as those for conventional overhead	Field strengths similar to overhead line on land Poles and conductors visually intrusive from recreation areas, shorelines, and the Pearl Harbor National Landmark Recreational boaters and Navy ships may require safety markers on poles and lines Effects for overland portion would be the same as those for conventional overhead	Potential ship traffic disruption during construction, operation, and maintenance Effects for overland portion would be the same as those for conventional overhead	Difficult access for maintenance and repair Repair time: days Poles and foundations will require extensive maintenance due to harsh marine environment Effects for overland portion would be the same as those for conventional overhead

Table 2.1-1
(continued)

Transmission Alternative	Basic System Components	Approx. Line Length (Mile)	Construction Cost ($M/Mile)	Construction and Operation Effects: Geological, Biological, and Cultural Resources	Construction and Operation Effects: Socioeconomics, EMF, and Visual Resources	Construction and Operation Effects: Traffic Considerations	Maintenance Considerations
Underground (HPFF)	High-pressure fluid-filled pipe containing cable, plus smaller fluid return pipe Fluid handling stations at each terminal Splice vaults (manholes) every 2,000 to 4,000 feet Cooling stations, filtering, and recirculation equipment may be required	3.5	13	Construction: Trench excavation; 5 ft. wide by 6 ft. deep Temporary loss of surface vegetation along entire route Potential to disrupt subsurface cultural resources within ROW Operation: Potential need to excavate pipe for repair of line Potential for leaks resulting from line rupture	No electric field Magnetic field 1 to 44 mG at soil surface directly above pipe No visual impact from underground cable Fluid handling equipment would require screening unless placed in industrial area	Construction: Longer period of traffic disruption for trenching and laying pipe than for conventional overhead Potential traffic disruptions during maintenance	Potential for heavy traffic disruption during maintenance or repairs Difficult to locate faults: could take hours to days Repair time: weeks Daily maintenance of fluid-handling equipment necessary
Submarine Cable	Six fluid-filled cables with conductors laid in trench (three cables per circuit) Transition stations with fluid pumping equipment at shoreline Overland portion consists of high-pressure, fluid-filled underground cable	3.6 (2.0 submarine; 1.6 underground)	13	Temporary disruption of benthic habitat Submarine trench 0 to 12 ft. deep Potential for fluid leaks because of rupture by ship traffic Potential disruption of submarine historic artifacts within Pearl Harbor Effects for overland portion would be the same as those for underground cable	Field strengths low to negligible at surface, depending on depth of cable No visual impact under water Transition stations and other equipment visible on shoreline Effects for overland portion would be the same as those for underground cable	Construction: Potential ship traffic disruption during construction Maintenance: Frequent dive inspections that may affect ship traffic Effects for overland portion would be the same as those for underground cable	Periodic dive inspection required Difficult to locate faults: could take days or weeks Repair time: weeks Potential for heat buildup in cable Effects for overland portion would be the same as those for underground cable

poles would remain largely undisturbed, with the exception of areas where equipment for conductor pulling and splicing would be required. Surface soils may be compacted from movement of this equipment. There is the possibility of some soil loss through erosion until vegetation is reestablished.

Biological Considerations

Biological resources are few within the overhead route of Waiau to Makalapa. Selective clearing or trimming of street trees and woody plants may be necessary if a line is constructed through dense shrubland or along roadways in order to provide room for construction equipment and proper conductor clearances.

Cultural Resources

An overhead transmission line route is selected to minimize impacts on cultural resources; careful pole siting can eliminate impacts to any resources that are identified within the alignment.

Electric and Magnetic Fields

Current research on electric and magnetic fields (EMF) and estimated field strengths along the preferred alignment are discussed in Section 3.9 of this Environmental Assessment and in Appendix C. For the overhead transmission line over land, field strengths are highest almost directly under the conductors at that point where the conductors sag closest to the ground. There, the electric field underneath a 138 kV transmission line with standard phasing and a 46 kV underbuild (i.e., a 46 kV line strung on the same poles) is about 0.5 kV per meter (kV/m), or less. The corresponding magnetic field would be about 21 milliGauss (mG) under normal line loadings (HECO, May 1988). Forty-six kV lines tend to cancel out some of the electric and magnetic fields; therefore, in locations where the 138 kV line does not share poles with a 46 kV line, electric and magnetic field strengths directly under the 138 kV conductors would be somewhat higher--up to 1.8 kV/m and 48 mG, respectively. Field strengths drop steadily to the right and left of the conductors, as described in Section 3.9 of this Environmental Assessment and in Appendix C.

Visual Quality

Poles and conductors would be visible throughout the route of this alternative. Poles can be painted to blend with the environment and screening can be provided by trees.

Traffic Disruption During Construction and Maintenance

For an overhead line, the major traffic disruption would occur during construction. HECO construction crews will need to close a lane of traffic on multilane roads during off-peak traffic periods while preparing foundations, setting poles, and stringing conductors. At any one place along the 4.5-mile line, construction would occur in stages, separated by days or weeks.

Maintenance and Repair Considerations

New "live line" maintenance techniques are being implemented by HECO to increase the efficiency and economy of routine maintenance and repair. Operation and maintenance for overhead lines are routine and relatively inexpensive. Although overhead lines are vulnerable to vandalism (such as gunshot damage to insulators) and other kinds of damage (such as vehicular collisions), most routine repairs can be accomplished within hours.

2.1.2 Overhead Transmission Line Across Pearl Harbor

During initial public meetings, HECO was asked about the feasibility of routing segments of the new line across Pearl Harbor on poles located within the waters of the harbor. An advantage of this alternative would be that the route would avoid some residential, commercial, and park areas along Kam Highway.

Basic System Components

Routing the transmission line across Pearl Harbor would probably involve the use of tubular steel poles mounted on concrete piles, as shown in Figure 2.1-1. The concrete pile structure would be made up of several concrete piles set into the floor of Pearl Harbor and the pile cap mounted on top of the piles would be set several feet above the high-tide water level. There would be an overland segment between the shore of Pearl Harbor and Makalapa Substation.

Cost

The costs of this alternative would be roughly comparable with those for a conventional overland line.

Geological Considerations

The pole platforms for the over-water portions of this alternative would be created by driving several concrete piles for each tower into the soils underlying Pearl Harbor. Disturbance would be limited to the areas surrounding each of the piles. The overland portions of the line would be the same as the conventional overhead transmission line.

Biological Considerations

Benthic ecosystems would be temporarily disrupted by the driving of piles for the pole platforms. The biological effects for the overland portion of the line would be comparable to those of conventional overhead lines.

Cultural Resources

There is some potential that historical artifacts from the 1941 attack on Pearl Harbor within the Pearl Harbor National Register District/National Historic Landmark could be disrupted because of driving piles. Underwater investigations at each potential pole location would reveal any potential impact to historical artifacts.

Electric and Magnetic Fields

Current research on EMF and field strengths along the preferred alignment is discussed in Section 3.9 of this Environmental Assessment and in Appendix C. The field strengths of the sections of line sited across Pearl Harbor, as measured from the land, would probably be very low to negligible; however, the transmission line sited across water would have the same electric and magnetic fields as conventional overhead lines.

Visual Quality

The poles located in Pearl Harbor would be visible from several public vantage points along Pearl Harbor and could be considered to be highly intrusive into existing shoreline views. A transmission line sited just offshore would obstruct horizon views from both Pearl Harbor (Blaisdell) Park and a planned park (Aiea Bay State Recreation Area). It would also be visible from McGrew Point, some locations

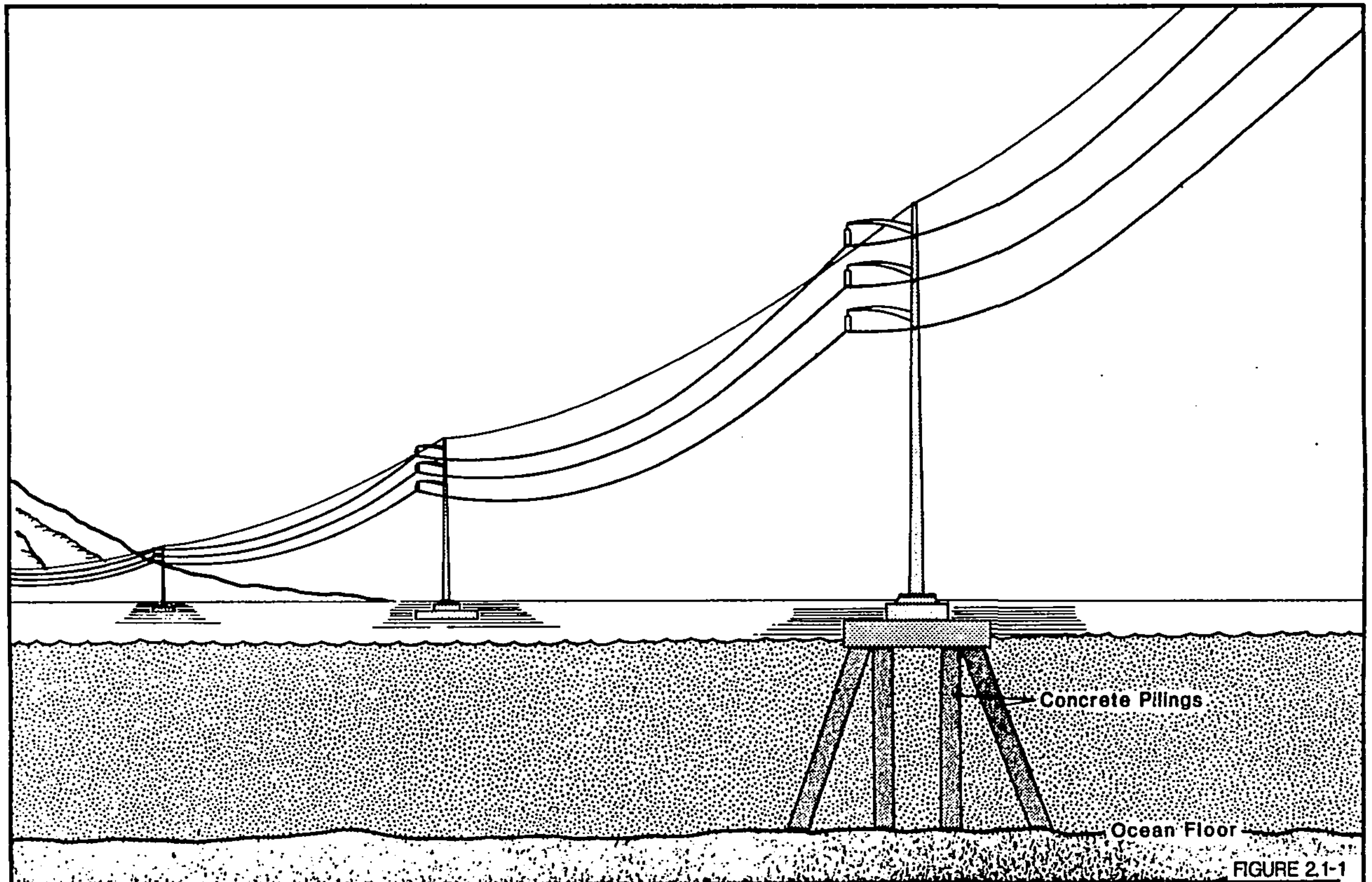

FIGURE 2.1-1

POSSIBLE CONFIGURATION
138kV TRANSMISSION LINE
SITED OVER WATER

(Not to scale)

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

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along Kam Highway, Richardson Recreation Center, and the U.S.S. Arizona Memorial site and ferry.

Traffic Disruption During Construction and Maintenance

The use of barges and specialized pile-driving equipment could substantially interfere with ship navigation and submarine operations.

Maintenance and Repair Considerations

Maintenance repair of the over-water portions of the line would require the use of barges with special bucket equipment to reach the lines. This would increase the cost and time involved in maintenance and repairs.

2.1.3 Underground Transmission Cable

Basic System Components

An underground transmission system would use a high-pressure, fluid-filled pipe (HPFF) technology, considered to be the most reliable underground transmission line system available today. An HPFF 138 kV underground line would consist of three paper-insulated cables installed in a fluid-filled pipe for each circuit. The pipe would contain a pressurized low-viscosity dielectric fluid. A typical configuration of HPFF cable construction is shown in Figure 2.1-2. The pipe system would be buried in a special backfill material with specified thermal characteristics if the native soil has poor thermal properties. A smaller, fluid-filled return pipe is often installed adjacent to the cable pipe. Cooling stations with pumping, cooling, filtering, and recirculating components at the line terminals would be installed if forced cooling is required. If forced cooling is not required, only fluid pressurization stations need to be installed at the terminals. Splice vaults (manholes) are spaced approximately 2,000 to 4,000 feet apart.

Cost

The current HECO estimate for the underground option is approximately $45 million, excluding the cost of easements.

Geological Considerations

The area of excavation required for the installation of a 138 kV HPFF system depends on the number and sizes of pipes to be installed. The Waiau-Makalapa No. 2 138 kV Transmission Line would require two 8-inch-diameter pipes and excavation 6 feet deep and 5 feet wide. Cable trenching and backfill may cause soil compaction and mixing of soil layers which may, in turn, affect soil particle sizes and chemical characteristics. Approximately ten splice vault excavations would be required for the estimated 3.5-mile line length, based on the topography and number of bends in the projected route. Because the cable is filled with dielectric fluid for insulation and cooling, a rupture in the pipe system could result in fluid leakage. The pipe system would be designed to reduce potential damage caused by seismic activity and subsequent soil movement.

Biological Considerations

Existing vegetation (both natural communities and landscaping), wetlands, and wildlife habitat can be adversely affected by trench excavation. All surface vegetation along the route would have to be removed during construction; however, revegetation would take place naturally or could be expedited by planting a ground cover.

Cultural Resources

The potential for disrupting cultural resources is higher with an underground cable than for an overhead line because of the greater amount of earthwork involved in laying the cable in trenches.

Electric and Magnetic Fields

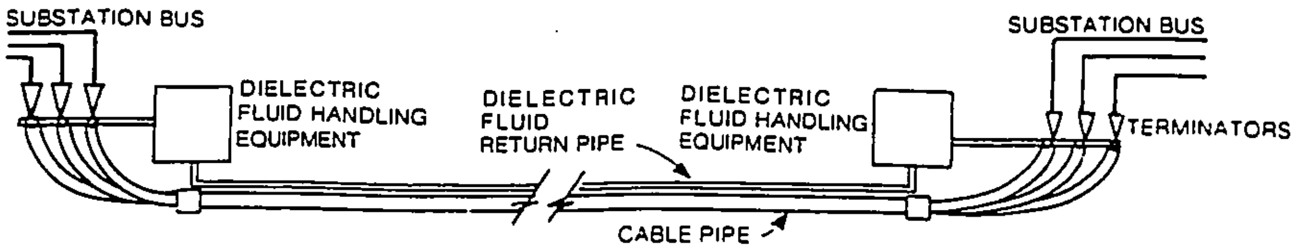
Current research on EMF and field strengths along the preferred alignment is discussed in Section 3.9 of this Environmental Assessment and in Appendix C. The pipe that encases the conductor in typical HPFF underground cable systems effectively eliminates any measurable electric field outside the pipe. Magnetic fields would not be eliminated, but could measure from 1 to 44 mG at the surface of the soil directly above the pipe (Power Technologies, Inc., 1989).

Visual Quality

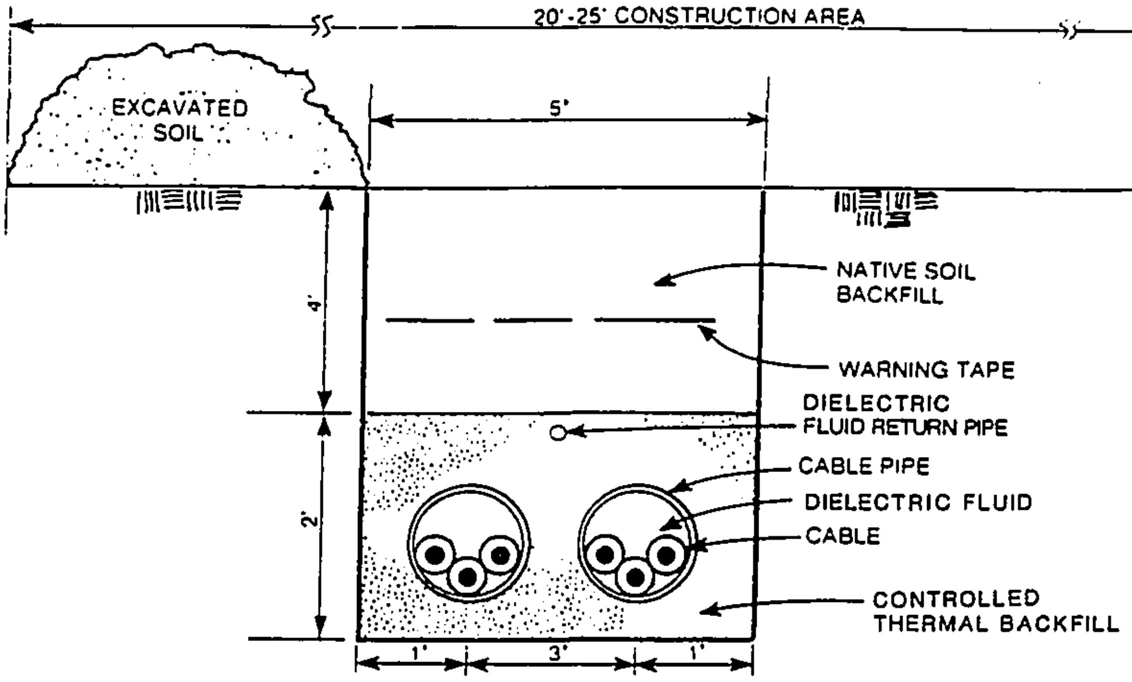
After installation of an underground cable, there is no visual impact from the line itself. Transition stations at the substation would be small and would be fenced or screened.

Traffic Disruption During Construction and Maintenance

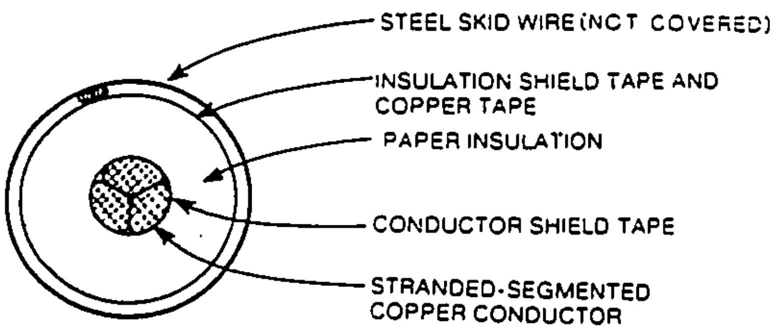
Because trenching would be required along the entire route of an underground line, traffic disruption would be more



TYPICAL HIGH-PRESSURE FLUID-FILLED PIPE-TYPE CABLE SYSTEM



TYPICAL HPFF PIPE-TYPE CABLE TRENCH SECTION



TYPICAL HPFF CABLE CONSTRUCTION

FIGURE 2.1-2

TYPICAL 138kV UNDERGROUND SYSTEM

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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extensive and would take place over longer periods than it would be during construction of overhead lines. Electrical faults on underground lines could take up to several weeks to locate and repair. Traffic disruption during repair would be prolonged because excavation and backfilling would be required.

Maintenance and Repair Considerations

The fluid-handling equipment of an HPFF system requires periodic onsite attention. In addition, continual remote monitoring must be performed. System repair requires skilled workers who are experienced in cable splicing. Certain types of failure may require time-consuming and expensive trenching to locate the failure.

2.1.4 Submarine Transmission Cable

Basic System Components

A submarine cable system would comprise six fluid-filled cables with conductors (Figure 2.1-3) laid in a trench and transition stations with fluid-pumping equipment at the shoreline. The submarine portion of the system would run for 2 miles. The 1.6-mile overland portion would consist of high-pressure, fluid-filled underground cable.

Cost

HECO currently estimates the submarine option to cost approximately $46 million, including the underground portions and the transition station.

Geological Considerations

Dredging or trenching in the floor of Pearl Harbor could be necessary. Geological concerns include potential heat buildup in the cable were it to be buried in the ocean bottom muds because the muds would provide insulation. Additionally, there is a concern about potential damage to the shoreline and terminal facilities during storms.

Biological Considerations

During the exploration and laying of the submarine cable, benthic ecosystems would temporarily be disrupted. Shoreline habitat would be affected during the lifetime of the project by the placement of the terminal facilities and the increased activity near these plants. In the event of cable failure, fluid could leak from one or more cables. The quantity of fluid released could be significant before repairs are completed because fluid pressure must be maintained to minimize contamination of the cable insulation by sea water.

Cultural Resources

Laying cable through land and water areas of Pearl Harbor would potentially disrupt the underwater and on-land historical artifacts of the 1941 attack on Pearl Harbor within the Pearl Harbor National Register District/National Historic Landmark.

Electric and Magnetic Fields

Current research on EMF and field strengths along the preferred alignment is discussed in Section 3.9 of this Environmental Assessment and in Appendix C. The electric and magnetic fields at the surface of the water above a submarine transmission cable would vary according to the depth of the cable, but generally would be negligible.

Visual Quality

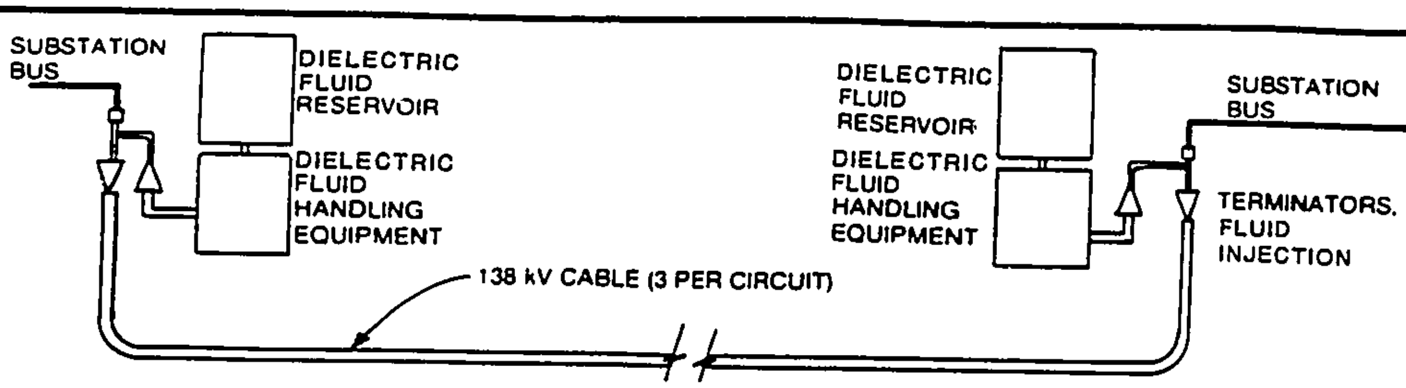
Although the underwater portions of a submarine cable system would not be visible, a transition station that includes fluid-pumping equipment would be required at the shoreline. Because of the visual sensitivity of many shoreline areas, the transition station could be viewed as objectionable, depending on its location and treatment.

Traffic Disruption During Construction and Maintenance

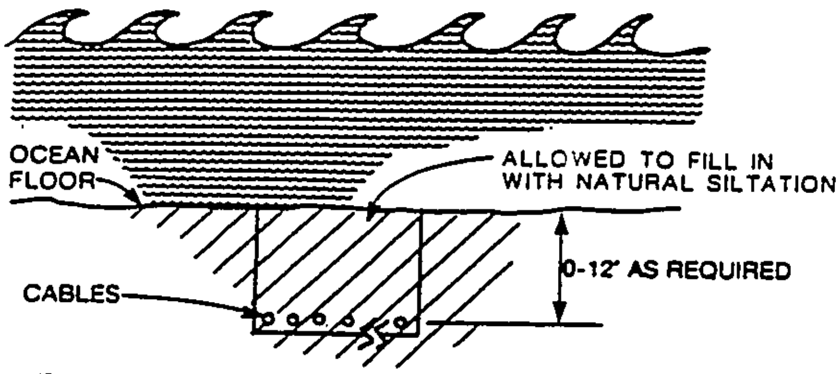
The submarine portion of a Waiau-Makalapa No. 2 submarine transmission system would run through Pearl Harbor. There could be substantial interference with ship operations while each cable is being laid or while maintenance is performed. The underground portions would have the impacts described above for underground cables.

Maintenance and Repair Considerations

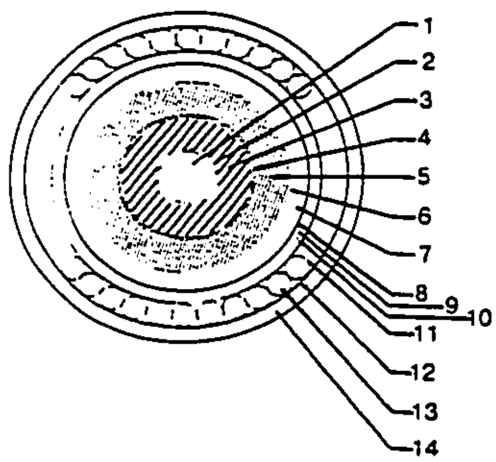
Submarine cables require fluid handling equipment and frequent monitoring and maintenance. Other considerations include potential heat buildup in the cable if it is buried in ocean bottom muds that act as insulation, and potential damage to cables and shoreline facilities by storms or ships' anchors. Repair to a damaged or failed marine cable requires locating the fault, uncovering the faulted section of cable, raising it to a barge, and splicing in a length of



TYPICAL SUBMARINE CABLE SYSTEM



TYPICAL SUBMARINE CABLE TRENCH SECTION



1. DIELECTRIC FLUID CHANNEL
2. GALVANIZED STEEL SPIRAL
3. STRANDED COPPER CONDUCTOR
4. CARBON BLACK CONDUCTOR SHIELD TAPE
5. PAPER INSULATION
6. CARBON BLACK INSULATION SHIELD TAPE
7. LEAD ALLOY SHEATH
8. RUBBER COATED FABRIC TAPE
9. STAINLESS STEEL TAPE
10. RUBBER COATED FABRIC TAPE
11. EXTRUDED POLYETHLENE
12. RUBBER COATED FABRIC TAPE
13. GALVANIZED STEEL ARMOR WIRE
14. COMPOUNDED JUTE

TYPICAL CABLE CONSTRUCTION

FIGURE 2.1-3

TYPICAL 138kV SUBMARINE CABLE SYSTEM

Waiau – Makalapa No. 2 Transmission Line Project
Hawaiian Electric Company
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new cable. The repair technique is even more demanding for submarine cables than repairs on underground pipe cables because the lead sheath and steel armor must be replaced. The time required to complete repairs could be lengthy and could affect service to customers. The on-land portions of this alternative would be subject to the same maintenance and repair considerations described for underground cable systems.

2.1.5 Conclusion

After reviewing the alternatives to an overhead transmission line, HECO has selected the conventional overhead line technology as the preferred alternative for the Waiau-Makalapa No. 2 138 kV Transmission Line.

The overhead line sited across Pearl Harbor is not a viable alternative for several reasons. This alternative would probably be the most visually intrusive of all the alternatives because it would be prominently visible from park sites and residences. The construction of over-water sections could disrupt ship traffic in the harbor and might damage marine biological resources. Maintenance costs would be higher because specialized barges would have to be used as work platforms.

Several considerations make the submarine cable alternative unattractive. The marine technology is fairly rare in the United States and has never been used by HECO; therefore, the potential for costly delays and unnecessary construction costs is higher than for the other alternatives. Additionally, the location and repair of faults in the underwater cable, although likely to be rarely necessary, would be costly and time-consuming. The construction costs of a submarine cable would be comparable with the costs of the underground alternative, or close to $46 million.

The underground cable alternative has both advantages and also has significant drawbacks. The principal advantage is the low level of visual impact. The drawbacks include significantly higher construction and maintenance costs and much longer time required for construction and repair than for a conventional overhead line. In addition, the extensive excavation required for construction of an underground cable would pose a greater risk to biological and cultural resources. Locating and repairing faults would be costly and time-consuming, with greater disruption to traffic. The costs of an underground cable would be higher (around $45 million) with greater potential to increase electricity rates than the conventional overhead alternative.

For the reasons explained above, HECO believes that the overhead transmission line technology is the only viable alternative for the Waiau-Makalapa No. 2 138 kV Transmission Line Project.

2.2 CORRIDOR AND ALIGNMENT ALTERNATIVES

The Routing Report documents the sequential process that was used to accomplish the following:

- Define a study area
- Identify alternative corridors within the study area
- Evaluate corridors and select a preferred corridor
- Identify alternative alignments within the preferred corridor
- Evaluate alternative alignments and select a preferred alignment

2.2.1 The Study Area

The following guidelines were used to define the study area:

- Include sufficient area to allow flexibility in locating a new 138 kV transmission line right-of-way
- Include all shoreline areas, but minimize the open water areas
- Minimize the inclusion of major residential communities
- Include existing major linear facilities, such as transportation rights-of-way and utility corridors
- Minimize the length of the route connecting the power plant and the substation

2.2.2 Alternative Corridors

The study area was evaluated for constraints that could be avoided and opportunities for siting the line (see Routing Report Chapter 5). The following principal guidelines were used to identify alternative corridors--bands of land one-quarter to one-half mile wide that can accommodate two or more alternative alignments:

- Avoidance of Conservation District land
- Avoidance of major residential areas and schools
- Avoidance of Aloha Stadium
- Avoidance of shoreline military operations (e.g., submarine docks and maintenance areas)
- Avoidance of the interstate freeway (because of regulatory restrictions on siting within freeway rights-of-way)
- Maximum use of existing electric line rights-of-way and transportation corridors
- Avoidance of crossing existing 138 kV transmission lines and maintain adequate separation from existing 138 kV lines for maximum reliability

Two corridor alternatives and a shared corridor segment were identified using these selection criteria (Figure 2.2-1). Between Waiau Power Plant and Aloha Stadium only a single shared corridor could be identified--the strip of land centered on Kam Highway. Between Aloha Stadium and Makalapa Substation, the Kam/shoreline, or "KS" alternative, runs along Kam Highway from Aloha Stadium to North Road, and then follows Bougainville Drive to Makalapa Substation. The Salt Lake Boulevard, or "SL" alternative, follows Salt Lake Boulevard from Aloha Stadium to the substation.

2.2.3 The Preferred Corridor

The two corridor alternatives were compared against the following criteria (see Routing Report Chapter 6):

- Avoiding major residential areas
- Maximizing separation from existing 138 kV lines for improved reliability
- Minimizing conflict with proposed projects

The evaluation of the alternative corridors against these criteria led to the selection of the KS corridor as the preferred corridor (Figure 2.2-2), based on the following considerations:

- Siting along Salt Lake Boulevard would require adding a 138 kV line immediately adjacent to residential areas. Within the KS corridor segment, the line could be sited on the opposite side of Kam Highway from most residential areas.

- Siting the new line along Salt Lake Boulevard would not meet the objective of maintaining adequate separation between 138 kV lines. For over a mile, the new line would be separated from the existing line only by the width of Salt Lake Boulevard. In addition, two existing 138 kV lines and three 46 kV lines exit the north side of Makalapa Substation and routing a new 138 kV line into the north side of the substation would be very difficult electrically; this would compromise separation criteria. If the KS corridor is used, the new line would enter Makalapa Substation on the south side, where only one 138 kV line and two 46 kV lines now enter.

- There are fewer proposed projects in the KS corridor than in the SL corridor. A new shopping center, a new water line, a series of road improvements, and one alternative alignment for the Rapid Transit System are proposed within the SL corridor.

2.2.4 Alternative Alignment

The following environmental, land use, and engineering criteria guided the identification and evaluation of alternative alignments (each approximately 100 feet wide) within the preferred corridor (see Routing Report Chapter 7):

- Avoiding residential areas, schools, recreations areas, and other high-public-use areas

- Minimizing conflict with proposed projects

- Avoiding certain classes of publicly owned land (such as U.S. Navy, county school or park land, the Special Management Area, or the state-owned rights-of-way of freeways)

- Maximizing use of alignments of existing 46 kV transmission lines

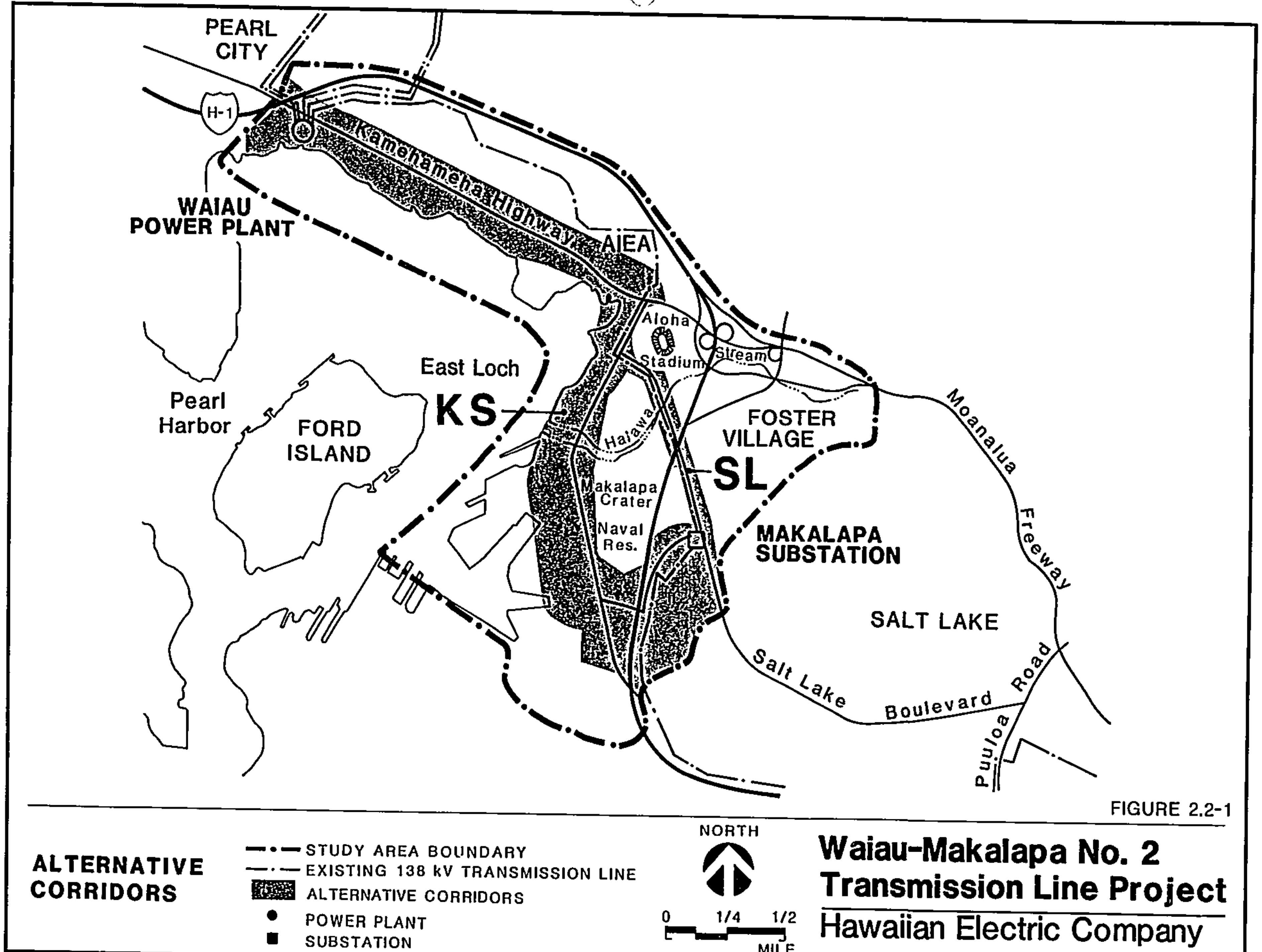

FIGURE 2.2-1

Waiau-Makalapa No. 2 Transmission Line Project

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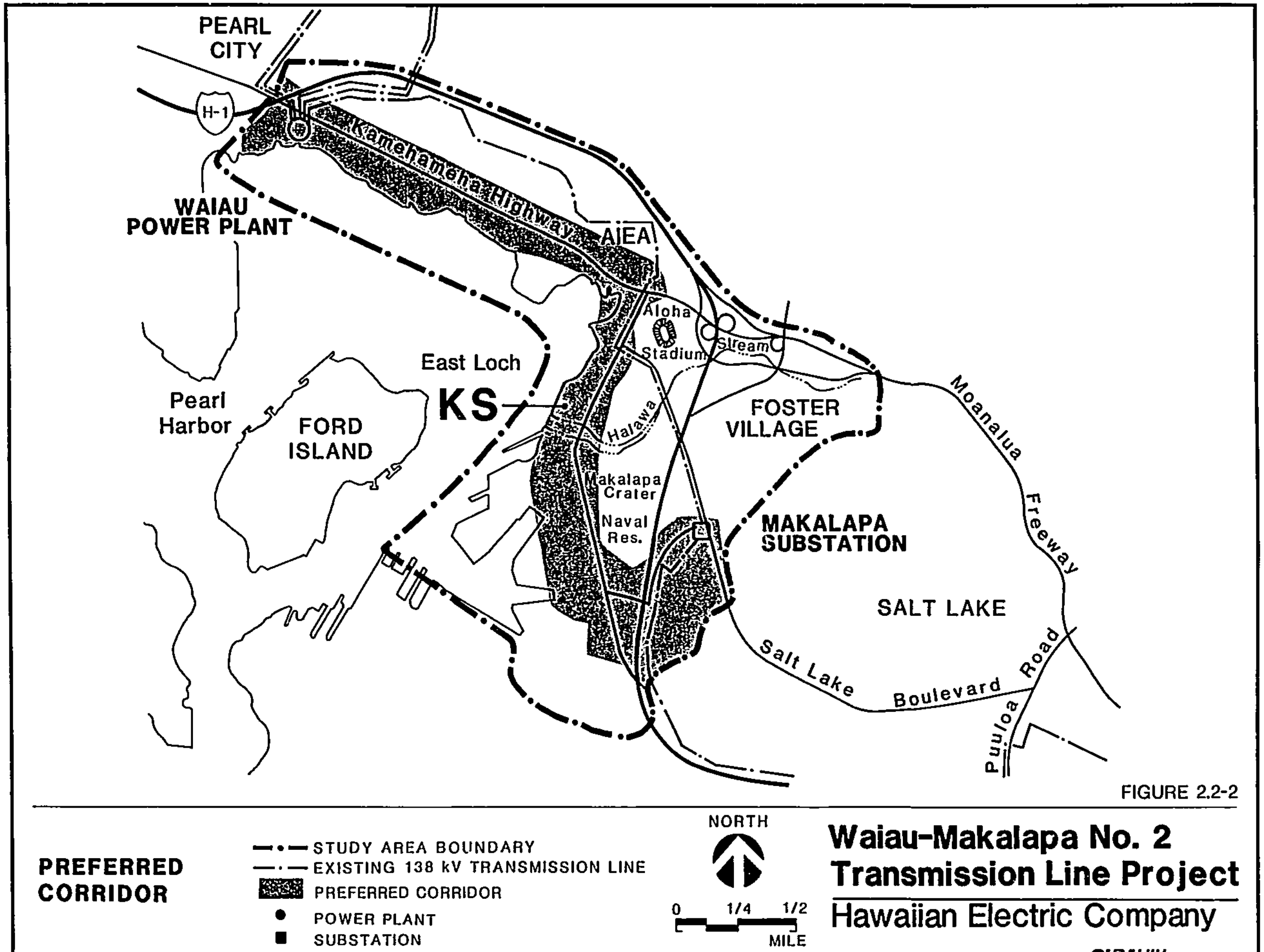

FIGURE 2.2-2

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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- Following roads and highways
- Minimizing alignment length
- Maintaining adequate separation between the proposed line and existing 138 kV lines
- Avoiding areas where complex or costly foundation engineering would be required to give adequate support for transmission poles (i.e., areas with soils classified as recent alluvium or man-made fills)
- Avoiding alignments located adjacent to underground fuel or other pipelines

Based on these guidelines, several alignment alternatives were identified and mapped (Figure 2.2-3). In most sections of the preferred corridor, the alignment alternatives included at least one alternative along Kam Highway, and another closer to the shoreline. Between the Radford Drive/ Bougainville Drive intersection and Makalapa Substation, the alignment alternatives included alternatives crossing Navy property and alternatives requiring the relocation of the existing Makalapa-Iwilei 138 kV transmission line.

2.2.5 The Preferred Alignment

Segment by segment, each alignment alternative was inventoried and evaluated against the criteria used to identify alternative alignments (see Routing Report Chapter 7). The preferred alignment, made up of five segments (see Figure 1.2-1), was selected for the following reasons:

Segment A (Waiau Power Plant to McGrew Point). The A2 segment (following an existing 46 kV transmission line along the makai side of Kam Highway) was selected over the A1 segment (following an existing 46 kV transmission line along the bike path closer to the Pearl Harbor shoreline) for the following reasons:

- It follows a major road (Kam Highway).
- It avoids more residential areas than the alternative.
- It is shorter than the alternative.
- It runs along the mauka edge rather than through Pearl Harbor (Blaisdell) Park.

- It would not involve construction within the Shoreline Setback Area.

- It would not encroach on the Special Management Area, except at the Waiau Power Plant.

- It is located in recent alluvium soils for a slightly shorter distance than the alternative.

- It is not located adjacent to an oil pipeline for most of its length (unlike the alternative).

Segment B (McGrew Point Through the Aloha Stadium Area). This segment includes three alignment alternatives compressed into a narrow area between the Aloha Stadium grounds and the Pearl Harbor shoreline. The preferred alignment (B1/B1b/B3/B4), follows the makai side of Kam Highway and requires relocating a short section of the existing Waiau-Makalapa No. 1 138 kV Transmission Line from the makai to the mauka side of Kam Highway adjacent to Aloha Stadium. The preferred alignment in this area was selected for the following reasons:

- It avoids residential areas on the mauka side of Kam Highway.

- It does not pass through the Navy Richardson Recreation Center or the proposed Aiea Bay State Recreation Area.

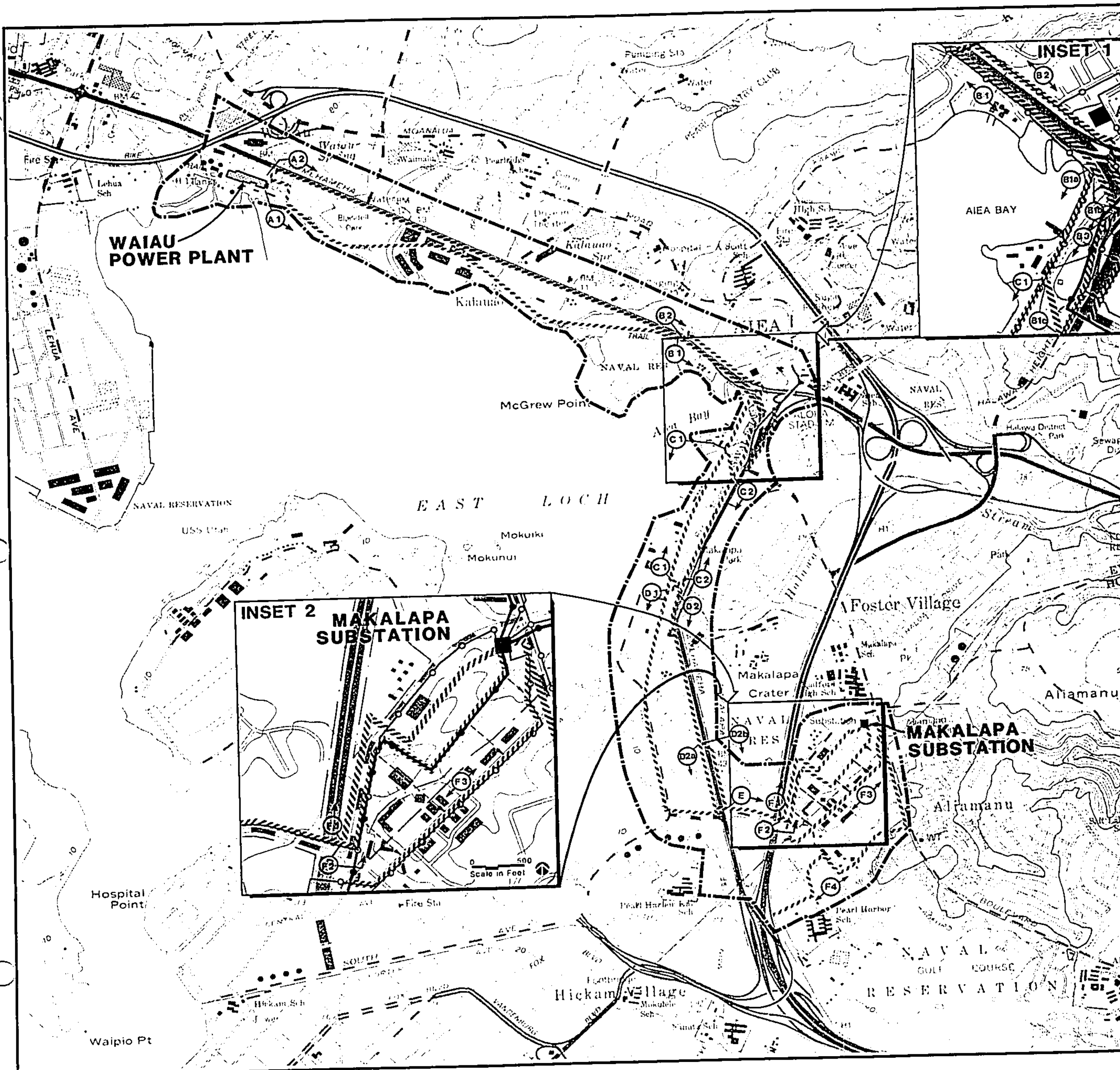
- By relocating a section of the existing Waiau-Makalapa No. 1 138 kV Transmission Line from the mauka to the makai side of Kam Highway, adequate separation can be maintained.

Segment C (Aloha Stadium to Halawa Stream). This segment includes an alignment (C2) following the alignment of an existing 46 kV line along the makai side of Kam Highway and a more makai alternative (C1) following the alignment of an existing 46 kV transmission line within Navy property. The C2 alignment along Kam Highway was selected for the following reasons:

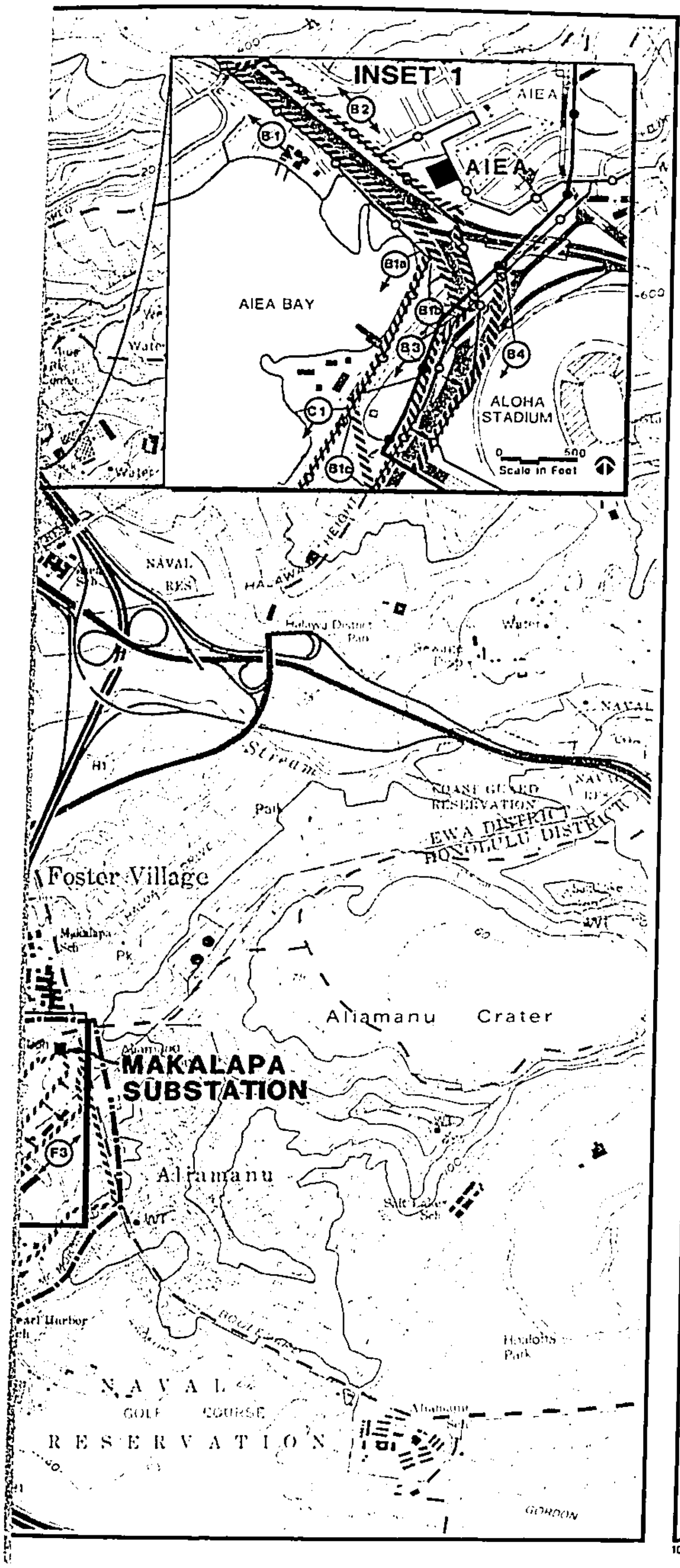
- It follows a major roadway.

- It avoids the Pearl Harbor National Register District and U.S. Navy property.

- It does not cross the parking lot of the U.S.S. Arizona Memorial visitor center.



WAIAU POWER PLANT
INSET 1
AIEA BAY
INSET 2
MAKALAPA SUBSTATION
MAKALAPA SUBSTATION
McGrew Point
EAST LOCH
NAVAL RESERVATION
Mokuiki
Mokunui
Foster Village
Makalapa Crater
Aliamanu
Hospital Point
Waipio Pt
Hickam Village
NAVAL GOLF COURSE RESERVATION
AIEA
Scale in Feet



ALIGNMENT DATA MAP

ALTERNATIVE ALIGNMENTS

- Alternative Alignment
- Alignment Segment Identifier
- Corridor Boundary
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

0 1000 2000 FEET

0 1/8 1/4 MILE

NORTH

FIGURE 2.2-3

Waiau - Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

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- It is not adjacent to pipelines.

- It is located over less recent alluvium than the alternative.

Segment D (Halawa Stream to Radford Drive). This segment includes alignment alternatives along Kam Highway and an alternative on North Road and Radford Drive in the Pearl Harbor Naval Base. The D2/D2b alternative was selected for the following reasons:

- It avoids the Pearl Harbor National Register District and U.S. Navy property.

- It is shorter than the D1 alternative.

- It follows a major road (Kam Highway).

- It is located farther away from housing than the alternative segment (D2a) on Kam Highway.

Segment E (Radford Drive). Only a single alignment alternative could be identified in the vicinity of Radford Drive between Kam Highway and Bougainville Drive because the areas north and south of Radford Drive are highly developed in residential and administrative uses within Navy property.

Segment F (Between Radford Drive and Makalapa Substation). Section F includes three alternatives between the Radford/ H-1 overpass and Makalapa Substation. Two of the alternatives required the existing Makalapa-Iwilei 138 kV transmission line to be extensively relocated to make room for the Waiau-Makalapa No. 2 138 kV Transmission Line. The F1 alignment along Bougainville Drive, Lawehana Street, and Malaai Street was selected for the following reasons:

- Adequate separation from existing 138 kV transmission lines can generally be assured, except near the intersection of Bougainville Drive and Lawehana Streets where one pole of the existing Makalapa-Iwilei 138 kV transmission line must be relocated from the east to the west side of Bougainville Drive.

- It does not cross extensive areas of Navy land.

- It does not cross the Navy Exchange Commissary Complex (a high-public-use area).

- It avoids housing areas.

Chapter 3
Existing Conditions and Potential Impacts

Chapter 3
EXISTING CONDITIONS AND POTENTIAL IMPACTS

The following sections describe existing conditions within and adjacent to the preferred alignment of the Waiau-Makalapa No. 2 138 kV Transmission Line and evaluate potential project impacts. Where appropriate, short-term impacts related to construction are distinguished from post-construction impacts.

Many of the potential impacts of the transmission line were anticipated during the course of the routing study (see Routing Report Chapters 4 through 7) and potential impacts were mitigated by avoidance (i.e., by selecting an alignment that minimized impacts on the environment and surrounding land uses). Where impacts (either temporary or permanent) could not be entirely avoided during the siting process, mitigation measures have been identified.

3.1 EXISTING LAND USE

3.1.1 Existing Conditions

The Waiau-Makalapa No. 2 138 kV Transmission Line will be located primarily in the alignments of existing 46 kV lines and or adjacent to state highways (Kam Highway, Radford Drive, and Bougainville Drive) and county roads (Lawehana and Malaai Streets). HECO's franchise allows it to place utility lines within the rights-of-way of state and county roads (subject to applicable safety, setback, and other regulations).

The new line will begin at HECO's Waiau Power Plant and follow the alignment of an existing 46 kV line along the makai side of Kam Highway to McGrew Point (Figure 3.1-1, Maps 1 and 2). Existing land use along the makai side of Kam Highway in this section is primarily commercial; however, Kam Highway forms the mauka edge of Pearl Harbor (Blaisdell) Park (a City and County of Honolulu park) and is adjacent to a few isolated single-family houses and apartment buildings. Along this section of the alignment, the makai side of Kam Highway was selected for the new line's alignment in preference to the mauka side in part because the mauka side, while still primarily commercial, has more extensive residential areas (see Section 7.2 of the Routing Report).

At McGrew Point, the existing 46 kV line cuts in a makai direction, across a partially developed portion of the proposed Aiea Bay State Recreation Area, to the U.S. Navy Richardson Recreation Center; in this section, the new line is proposed instead to continue along the makai edge of Kam Highway to the Kam Highway/Salt Lake Boulevard intersection. Land uses in this area are dominated by the Aiea Bay State Recreation Area properties (currently partially developed as a passive use park) and the Richardson Recreation Center on the makai side of Kam Highway. On the mauka side, the Kam Highway/Aiea interchange and Aloha Stadium are the dominant uses.

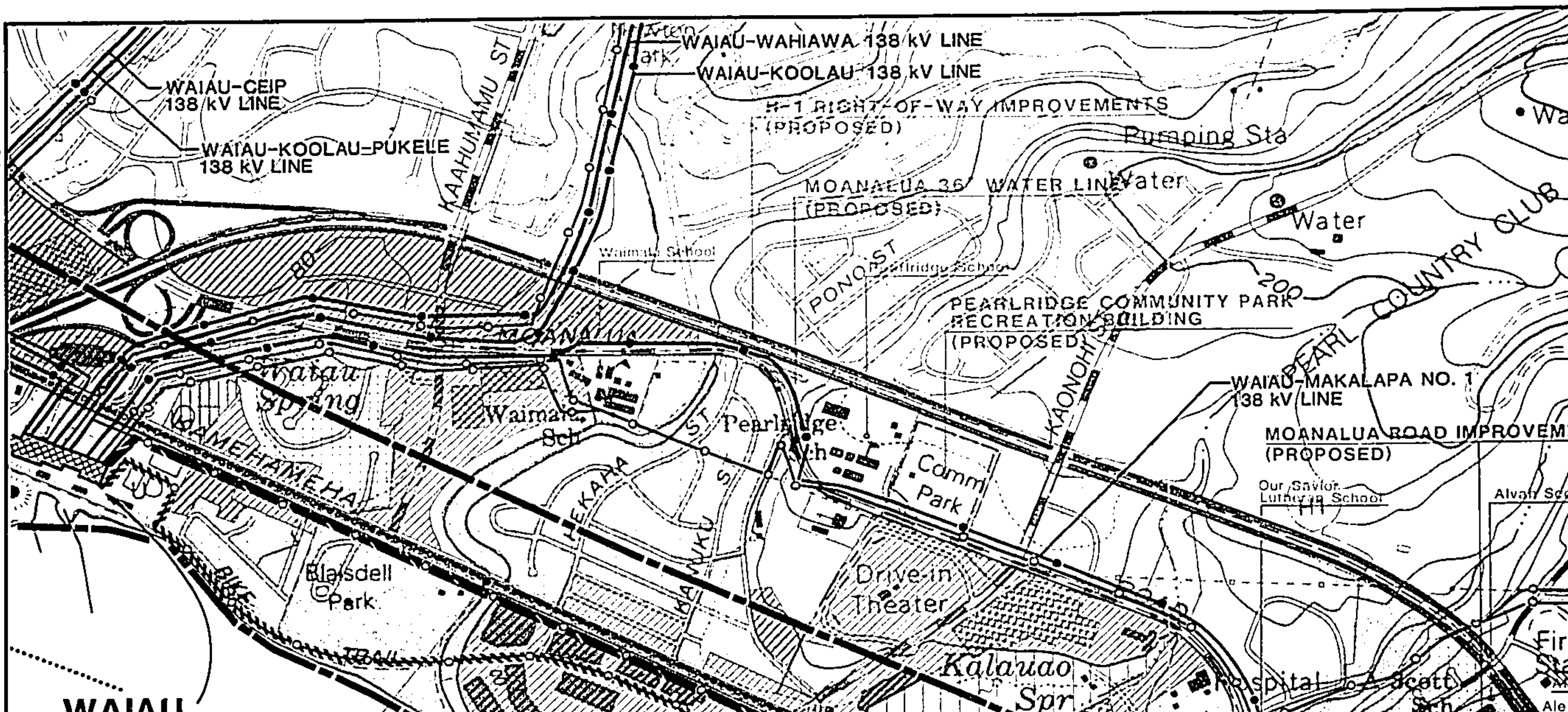
A number of underground utilities share the narrow strip of land between Aloha Stadium and the Pearl Harbor shoreline. Utilities located adjacent to the makai side of the preferred alignment in this area include two Chevron 8-inch oil pipelines; two GASCO gas lines; a city and county 8-inch sewer line, 24-inch water main, and 36-inch water main; one Navy underground telephone line; and one Army signal cable.

South of Aloha Stadium, the preferred alignment uses the alignment of an existing 46 kV line along the makai side of Kam Highway to a point approximately 1,500 feet north of Radford Drive, where it crosses to the mauka side of the highway. The mauka side of Kam Highway between Aloha Stadium and Radford Drive is primarily residential--both civilian multifamily (Puuwai Momi) and military single family (Flag Hill and Little Makalapa). The land makai of Kam Highway in this section is within the Pearl Harbor Naval Base Complex. Uses include the Richardson Recreation Area; supply, storage, and maintenance facilities (including a fuel tank farm); residential; and administration.

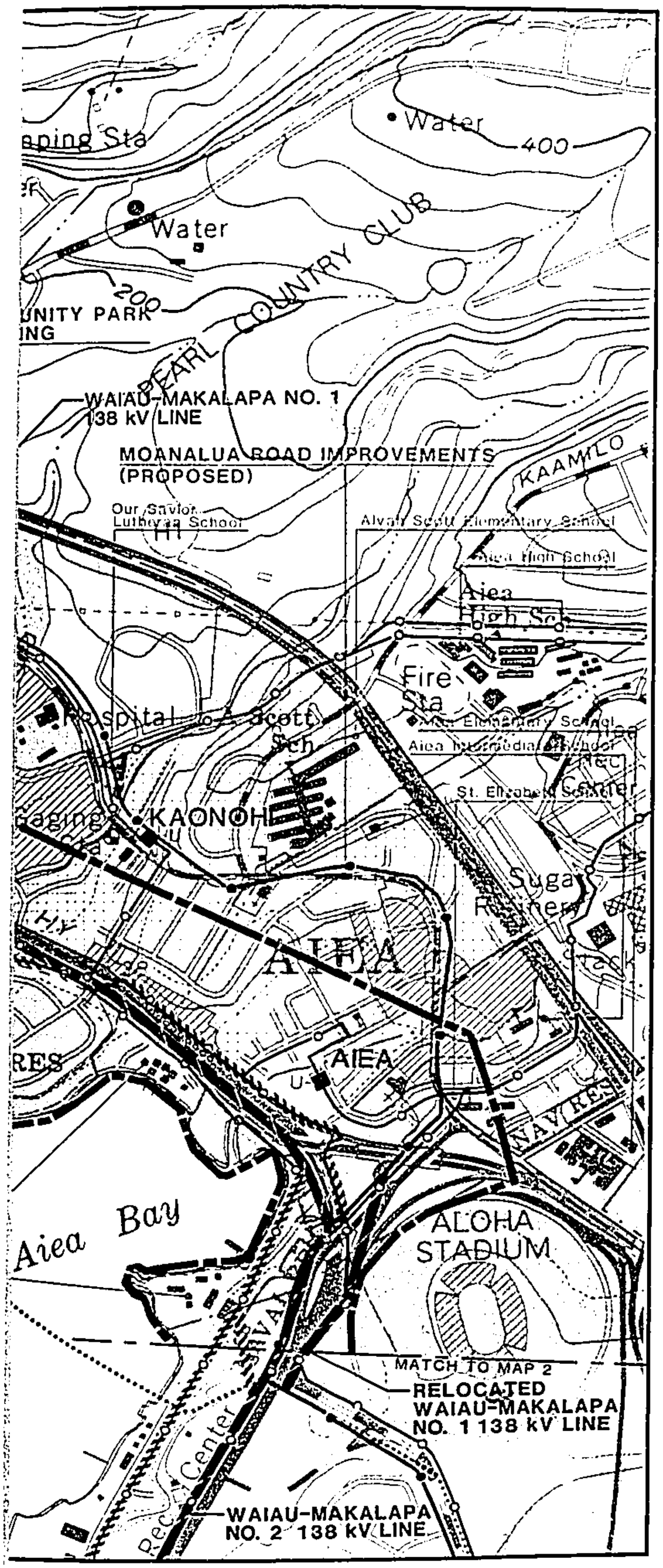
The preferred alignment uses the alignment of an existing 46 kV line along the mauka edge of the U.S.S. Arizona Memorial Visitor Center parking lot. It crosses from the makai to the mauka side of Kam Highway to avoid a five-story bachelor officers' quarters apartment complex that is located within 30 to 40 feet of the makai side of Kam Highway (on the mauka side of the highway, the closest houses are at least 50 feet from the preferred alignment).

The preferred alignment follows the north side of Radford Drive from Kam Highway across the H-1 freeway to Bougainville Drive. Existing uses on the north side of Radford Drive are primarily Navy administration facilities; on the south side, an open-space buffer separates the road from a housing area.

The preferred alignment follows the makai side of Bougainville Drive (the mauka side of the H-1 freeway) for



WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
H-1 RIGHT-OF-WAY IMPROVEMENTS (PROPOSED)
Pumping Sta
MOANALUA 36" WATER LINE (PROPOSED)
Water
PEARL COUNTRY CLUB
PEARLRIDGE COMMUNITY PARK RECREATION BUILDING (PROPOSED)
WAIAU-MAKALAPA NO. 1 138 kV LINE
MOANALUA ROAD IMPROVEMENTS (PROPOSED)
Our Savior Lutheran School
KAAHUMANU ST
MOANALUA
Waiau Spring
Waimalu Sch
Pearlridge Sch
Comm Park
KAMEHAMEHA
HEKAHA
KAONOHI
Blaisdell Park
Drive-in Theater
Kalauao Spr
Hospital
Scott Sch
Fire Sta
KAONOHI
WAIAU POWER PLANT
RAPID TRANSIT ALIGNMENT (PROPOSED)
Kalauao
NON-POTABLE WATER SYSTEM KALAUAO SPRINGS (PROPOSED)
EAST LOCH
RAPID TRANSIT STATION (PROPOSED)
AIEA
NAVAL RES
McGrew Point
HARBOR
Aiea Bay
PEARL
AIEA BAY STATE RECREATION AREA (PROPOSED)
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE



ALIGNMENT DATA MAP

EXISTING AND PROPOSED LAND USE

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

EXISTING LAND USE

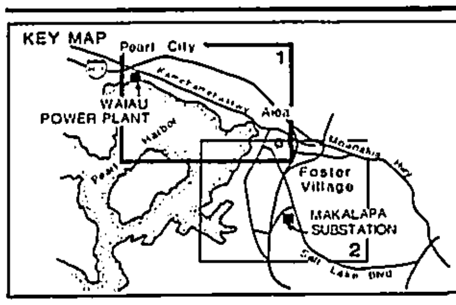
- Residential (Single Family)
- Residential (Multi-Family)
- Commercial
- Industrial
- Public and Semi-Public Facilities
- Parks Recreation and Preservation
- Agriculture
- Utilities
- Undeveloped Land
- Pipelines
- Energy Corridor

USES WITHIN MILITARY LANDS

- Housing
- Training and Operations
- Supply, Storage and Maintenance
- Administration, Community and Medical Facilities
- Recreation and Conservation Buffer

PROPOSED LAND USE

- Public and Private Proposed Projects



MAP 1

SCALE 0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 3.1-1

Waiau - Makalapa No. 2 Transmission Line Project

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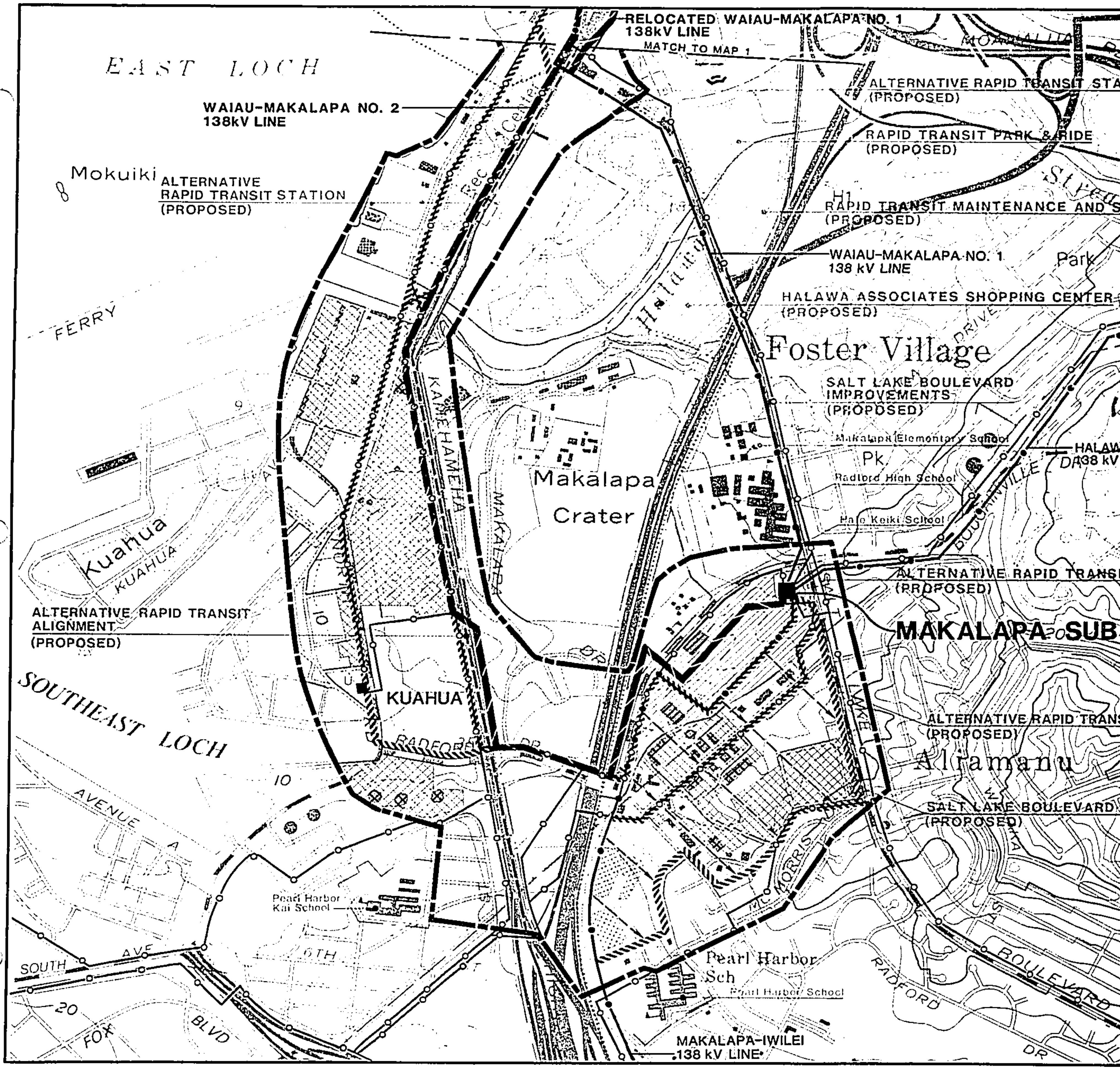
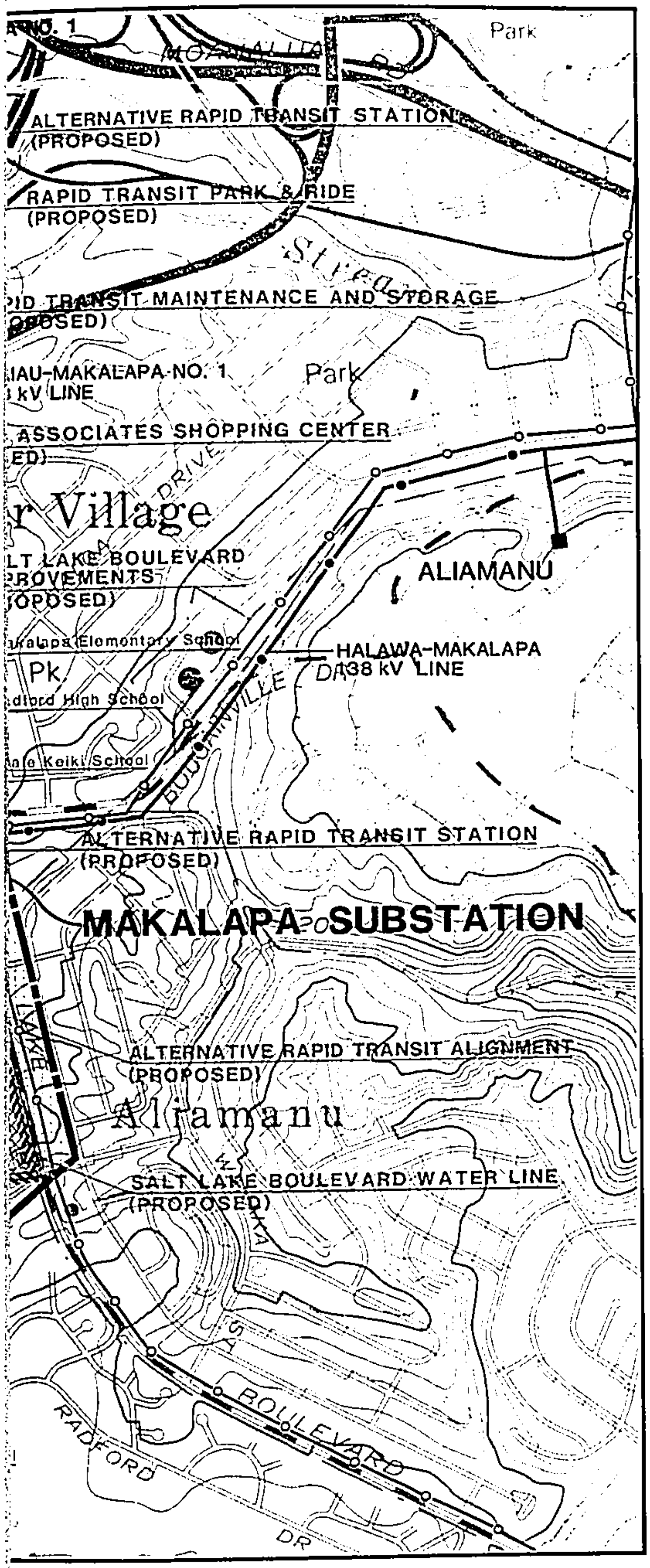


RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
ALTERNATIVE RAPID TRANSIT STA
(PROPOSED)
RAPID TRANSIT PARK & RIDE
(PROPOSED)
Mokuiki
ALTERNATIVE
RAPID TRANSIT STATION
(PROPOSED)
RAPID TRANSIT MAINTENANCE AND S
(PROPOSED)
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
HALAWA ASSOCIATES SHOPPING CENTER
(PROPOSED)
FERRY
Foster Village
SALT LAKE BOULEVARD
IMPROVEMENTS
(PROPOSED)
Makalapa Elementary School
Pk
Radford High School
Makalapa
Crater
Pala Keiki School
Kuahua
KUAHUA
ALTERNATIVE RAPID TRANS
(PROPOSED)
ALTERNATIVE RAPID TRANSIT
ALIGNMENT
(PROPOSED)
MAKALAPA SUB
KUAHUA
SOUTHEAST LOCH
ALTERNATIVE RAPID TRANS
(PROPOSED)
RADFORD DR
Aliamanu
SALT LAKE BOULEVARD
(PROPOSED)
AVENUE A
Pearl Harbor Kai School
SOUTH AVE
6TH
Pearl Harbor Sch
Pearl Harbor School
RADFORD DR
BOULEVARD
FOX BLVD
MAKALAPA-IWILEI
138 kV LINE



ALIGNMENT DATA MAP

EXISTING AND PROPOSED LAND USE

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

EXISTING LAND USE

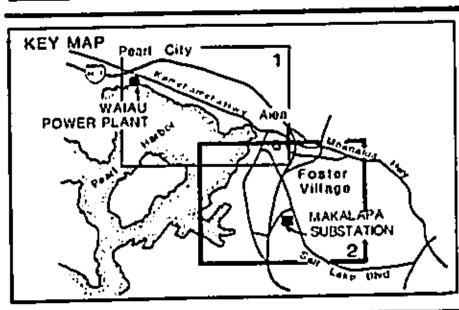
- Residential (Single Family)
- Residential (Multi-Family)
- Commercial
- Industrial
- Public and Semi-Public Facilities
- Parks Recreation and Preservation
- Agriculture
- U Utilities
- Undeveloped Land
- Pipelines
- Energy Corridor

USES WITHIN MILITARY LANDS

- Housing
- Training and Operations
- Supply, Storage and Maintenance
- Administration, Community and Medical Facilities
- Recreation and Conservation Buffer

PROPOSED LAND USE

- Public and Private Proposed Projects



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE
NORTH

FIGURE 3.1-1

Waiau - Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

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approximately 1,500 feet in undeveloped land that forms part of the Bougainville Drive right-of-way. Along this segment, the alignment parallels the underground pipelines of the Energy Corridor. The alignment then turns southeast, crossing Bougainville Drive to follow the north side of Lawehana Street and the south side of Malaai Street to Makalapa Substation. This portion of the alignment is entirely commercial; the alignment passes between two major retail outlets (Marsh Company and Costco).

3.1.2 Potential Impacts

The major impacts of the proposed project on existing land uses will occur during the construction phase. Construction-related impacts may include noise (addressed in Section 3.8) and temporary disruption of traffic (addressed in Section 3.7). Few post-construction impacts related to existing land uses have been identified. Potential impacts on recreation, housing, and other existing land uses are discussed in this section; visual effects of the project are discussed in Section 3.6, while health concerns related to electromagnetic fields are addressed in Section 3.9.

Post-construction effects on existing land uses. The proposed transmission line will generally be sited in the rights-of-way of State highways and city and county roads. In a few locations individual poles and/or portions of pole foundations may be located just outside the road right-of-way where necessary to avoid affecting existing underground utilities while observing State Department of Transportation setback requirements. The Department of Transportation requires poles to be set back a minimum of 2 feet from the face of the curb in urban areas along curbed sections of state highways other than freeways. This distance may be reduced where protective barriers are installed. The areas where pole and or foundation easements may be required include a few locations along Kam Highway between the Waiau Power Plant and McGrew Point (where easements would be acquired from private landowners) and along Kam Highway near Halawa Stream (where pole or foundation easements may be requested from the U.S. Navy). Exact locations will be determined during final survey and design.

At Aloha Stadium, the existing Waiau-Makalapa No. 1 138 kV Transmission Line must be relocated from the makai to the mauka side of Kam Highway in order to make room for the new transmission line on the east side of the highway. One pole of the relocated line will be placed in the retaining wall of the Aloha Stadium parking lot adjacent to Kam Highway.

No parking spaces will be eliminated and there will be no long-term impacts on Aloha Stadium activities.

The preferred alignment is adjacent to Pearl Harbor (Blaisdell) Park, Richardson Recreation Center, and a partially developed portion of the proposed Aiea Bay State Recreation Area. The new line will be located on Kam Highway on the mauka side of these parks. The new line will generally use the alignment of existing 46 kV electric lines and or distribution lines. Access to and use of the parks will not be affected.

Along Kam Highway between Waiau Power Plant and the intersection of Kam Highway and Salt Lake Boulevard, the new line will be sited adjacent to existing underground fuel, water, and sewer pipelines and communications cables. Care will be taken during siting and construction to avoid any damage to these utilities during or after construction. The preferred alignment crosses the state's Energy Corridor (near the intersection of Kam Highway and Salt Lake Boulevard) and parallels it where the transmission line alignment parallels the north side of Bougainville Drive. No structures will be placed within the Energy Corridor and no construction will be required within the corridor.

The potential for transmission poles to present a hazard to air traffic was checked with the Federal Aviation Administration. The preferred alignment lies entirely outside the air interference zones for Honolulu International Airport, Hickam Air Force Base, and the airfield at Ford Island; therefore, the new line will present no hazard to air traffic.

3.2 PROPOSED LAND USE

3.2.1 Existing Conditions

Two major projects are proposed near the proposed transmission line alignment (Figure 3.1-1).

The City and County of Honolulu Department of Transportation Services is currently analyzing alternatives for a fixed rail Rapid Transit System (RTS). The Draft EIS, planned to be issued in late 1989, will identify the locally preferred alternative. Within the Waiau-Makalapa No. 2 138 kV Transmission Line Project area, alternative alignments under investigation for the RTS include an alignment along the median of Kam Highway and another along the median of Salt Lake Boulevard (joining the Kam Highway alignment at Aloha Stadium). Stations are planned near Pearlridge Shopping

Center, Aloha Stadium, the U.S.S. Arizona Memorial, and the Makalapa Substation on Salt Lake Boulevard. Construction of the RTS will begin no earlier than 1993.

The State Department of Land and Natural Resources proposes to develop land owned by the State and the U.S. Navy along the Aiea Bay shoreline for recreational activities. The master plan for the Aiea Bay State Recreation Area has been developed and a Draft EIS has been prepared. Plans are currently being reviewed by state and federal agencies, including the U.S. Navy. The proposed transmission line alignment would run along Kam Highway, which forms the mauka edge of the proposed recreation area.

3.2.2 Potential Impacts

The proposed transmission line should have no significant impacts on either the proposed RTS or the Aiea Bay State Recreation Area.

The alternative alignments for the Waiau-Makalapa No. 2 138 kV Transmission Line were reviewed with the staff of RTS at several points during the identification and evaluation of transmission alignment alternatives. RTS staff concluded that if the transmission line is located on the edge of the highway alignment, there should generally be no conflict with the RTS alignment, which will be in the median of Kam Highway. There will be sufficient clearance between the transmission line conductors and the RTS structures to provide adequate safety.

A number of locations are being considered for RTS stations. Some of the stations may bridge the highway, with entrances on either side of the highway. The distances between transmission poles are generally sufficient (300 to 600 feet) so that poles can be sited in locations that avoid conflicts with RTS stations. HECO will coordinate its final design with RTS staff to avoid any conflict with rail or station locations.

The proposed transmission line will likewise have no impacts on the proposed Aiea Bay State Recreation Area. Poles will be located outside the park site, in the right-of-way of Kam Highway. Access to and use of the proposed park will not be affected.

3.3 GEOLOGICAL AND WATER RESOURCES

3.3.1 Existing Conditions

A geotechnical investigation surveyed the types of geologic and hydrologic features within the project area during the corridor instigation stage of the routing study (Appendix B). The characteristics of each factor were analyzed for their potential to constrain foundation and transmission line siting and design.

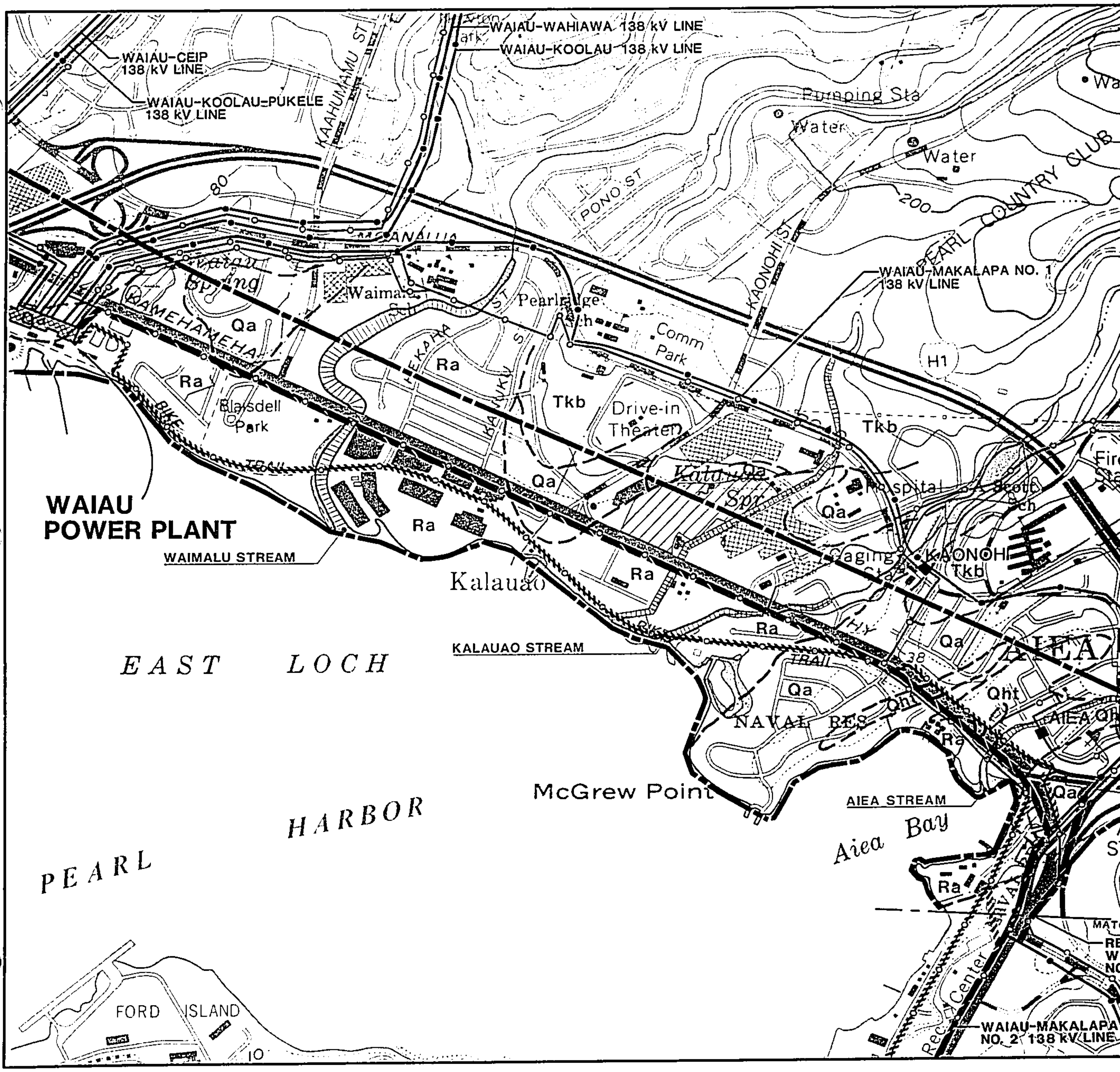
Five geologic formations exist in the project area: Koolau basalt (TKb), volcanic tuff (Qht), older alluvium (Qa), man-made fills (Rf), and recent alluvium (Ra) (Figure 3.3-1). Koolau basalt, older alluvium, and volcanic tuff are the most suitable of five formations for standard drilled pier foundations. The other geologic formations have moderate to poor suitability for foundation support, and pile type foundations may be necessary in some locations on both recent alluvium and man-made fills (Table 3.3-1). Pile foundations may also be used in wet soils near streams, springs, or flood-prone areas.

In the section of the alignment from the Waiau Power Plant to Aloha Stadium, the predominant geologic formation is recent alluvium, with smaller areas of older alluvium. From Aloha Stadium to the Makalapa Substation, volcanic tuff is predominant, with smaller areas of recent alluvium, older alluvium, and man-made fills.

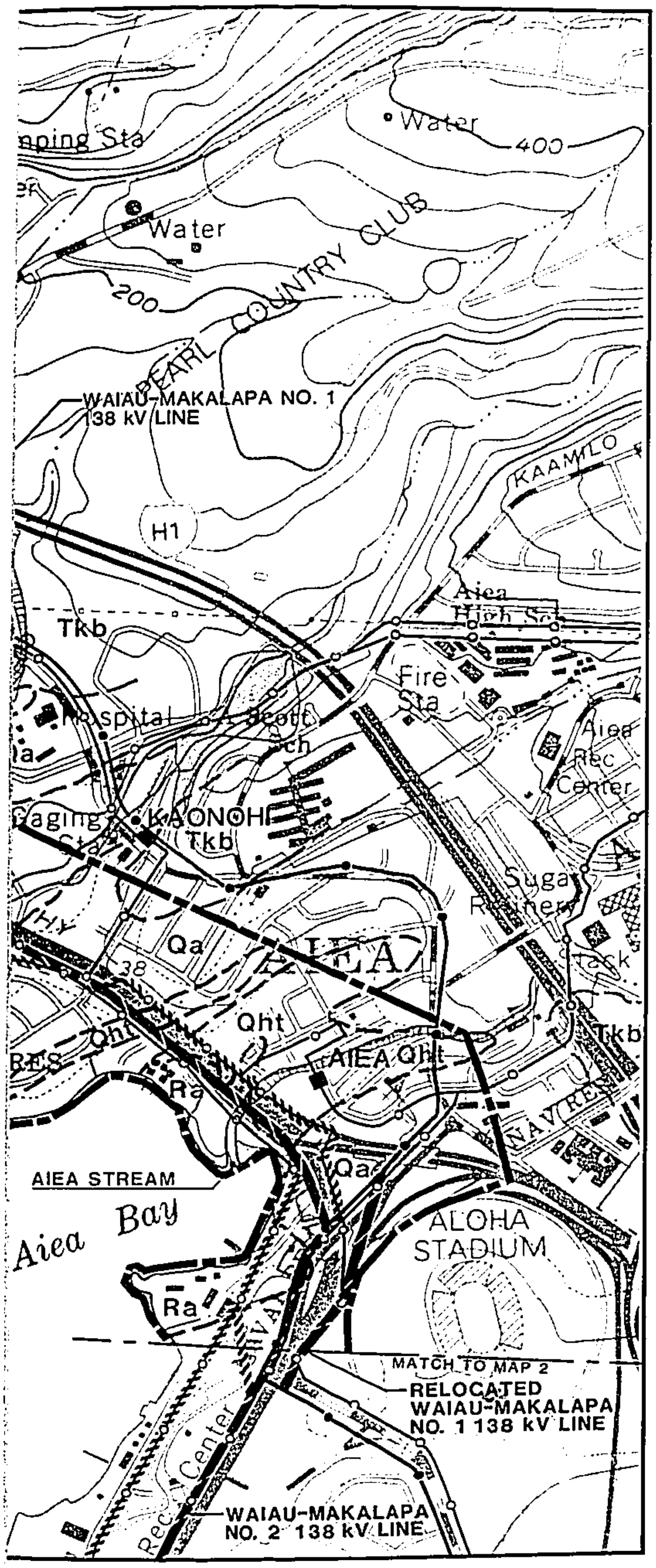
There are no areas of slopes with severe instability problems, slopes greater than 20 percent, or soils with high erosion potential in the project area.

No natural streambeds exist along the preferred alignment: all the waterways have been modified as open concrete-lined channels. From north to south, channels crossed by the alignment are: Waimalu Stream, an unnamed channel, Kalauao Stream, Aiea Stream, and Halawa Stream. The Kalauao Stream is unchannelized in the reaches mauka of Kam Highway, where the stream bed is surrounded by an area subject to inundation by a 100-year flood event, as defined on FEMA flood insurance rate maps.

There are two underground springs in the vicinity of the preferred alignment--one at Kalauao in the watercress farm near Pearlridge Shopping Center and one at Waiau on the mauka side of Kam Highway across from Waiau Power Plant. Neither of these springs is within the alignment itself and,



WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
WAIAU-MAKALAPA NO. 1 138 kV LINE
WAIAU-MAKALAPA NO. 2 138 kV LINE
WAIAU POWER PLANT
WAIMALU STREAM
KALAUAO STREAM
AIEA STREAM
EAST LOCH
PEARL HARBOR
McGrew Point
Aiea Bay
Kalauao
FORD ISLAND
NAVAL RES
PEARL COUNTRY CLUB
Pumping Sta
Water
PONO ST
KAONOHI ST
KAAHUMANU ST
KAMEHAMEHA
Blaisdell Park
Drive-in Theater
Comm Park
Hospital
KAONOHI
AIEA
H1



ALIGNMENT DATA MAP

GEOLOGICAL AND BIOLOGICAL

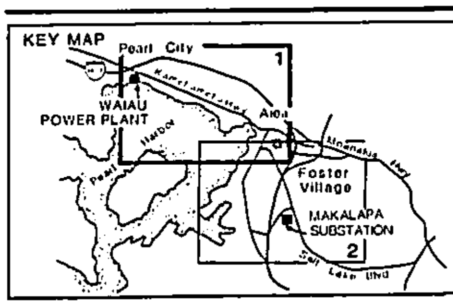
- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

GEOLOGICAL

Tkb	Koolau Basalt
Qht	Volcanic Tuff
Qa	Older Alluvium
Rf	Man-Made Fills
Ra	Recent Alluvium
	Stream
	Open-Lined Channel
	Spring
	Flood-Prone Area (100-year flood)

BIOLOGICAL

	Koa-Haole Scrub
	Mangrove Swamp
	Non-Woody Wetland
	Cultivated Wetland



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 3.3-1

Waiau – Makalapa No. 2 Transmission Line Project

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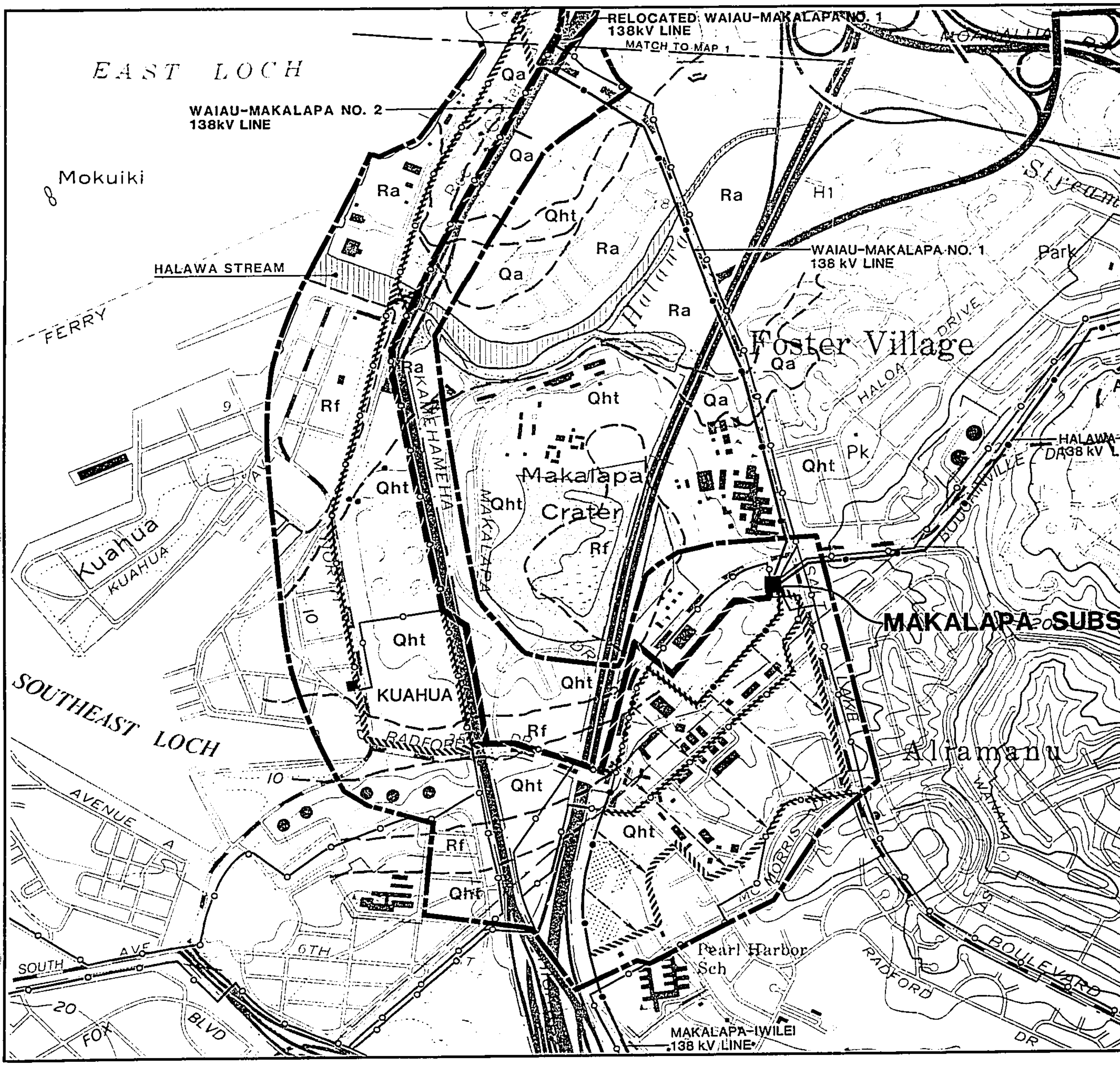
RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
HALAWA STREAM
FERRY
WAIAU-MAKALAPA NO. 1
138 kV LINE
Foster Village
Park
Makalapa
Crater
Kuahua
KUAHUA
SOUTHEAST LOCH
KAMEHAMEHA
MAKALAPA
MAKALAPA SUBS
HALAWA
138 kV L
Aliamanu
Pearl Harbor
Sch
MAKALAPA-IWILEI
138 kV LINE
AVENUE
SOUTH
AVE
6TH
FOX
BLVD
RADFORD
DR
BOULEVARD
HALOA
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Qht
Rf
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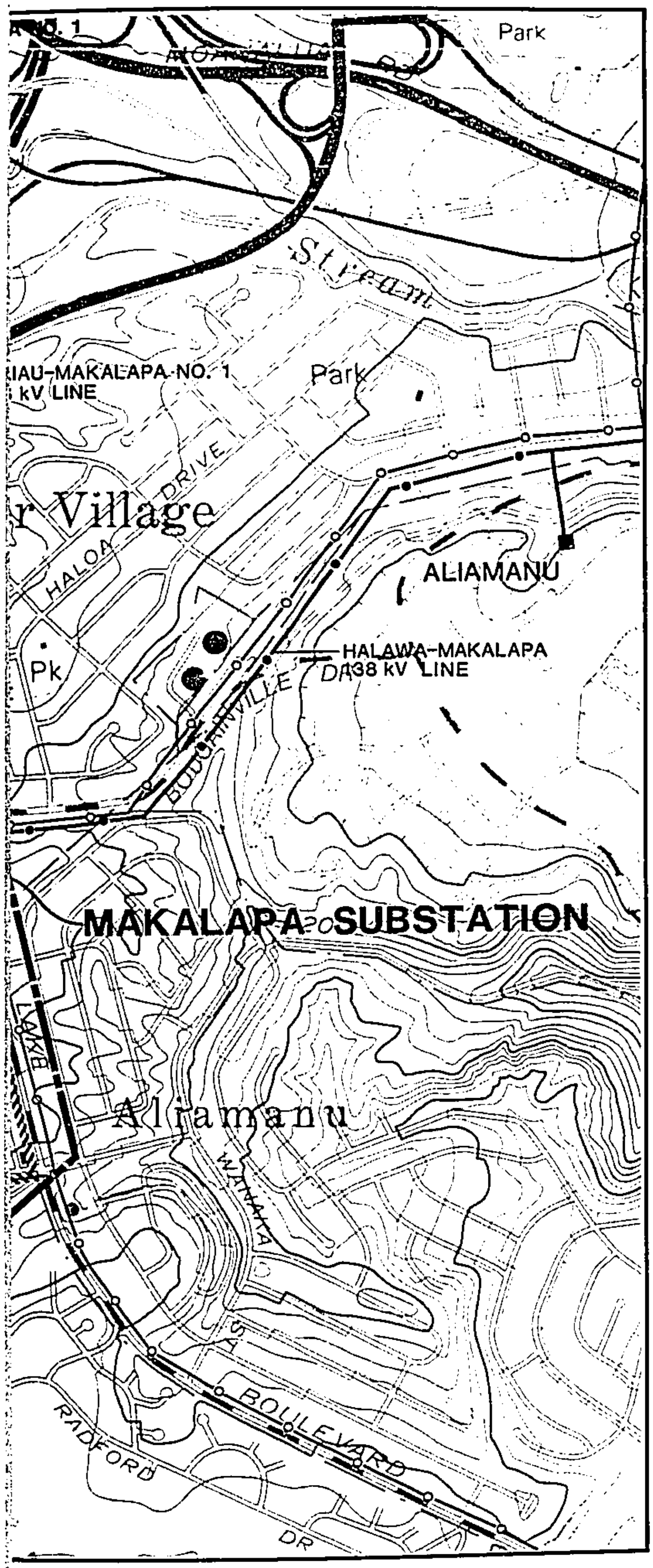
Pk



ALIGNMENT DATA MAP

GEOLOGICAL AND BIOLOGICAL

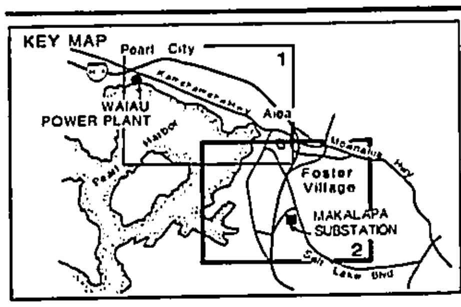
- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

GEOLOGICAL

- Tkb Koolau Basalt
- Qht Volcanic Tuff
- Qa Older Alluvium
- Rf Man-Made Fills
- Ra Recent Alluvium
- Stream
- Open-Lined Channel
- Spring
- Flood-Prone Area (100-year flood)

BIOLOGICAL

- Koa-Haole Scrub
- Mangrove Swamp
- Non-Woody Wetland
- Cultivated Wetland



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE
NORTH

FIGURE 3.3-1

Waiau - Makalapa No. 2 Transmission Line Project

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Table 3.3-1
GEOLOGIC FORMATIONS AND FOUNDATION SUPPORT SUITABILITY

Geologic Unit	Description	Foundation Support	Recommended Foundation Type
Koolau basalt (TKb)	Oldest unit consisting of interbedded pahoehoe and a'a flows of basaltic lava	Good	Drilled pier or caisson
Older alluvium (Qa)	Second oldest, consisting of terrigenous sediments, clayey silts, and silty clays	Moderate to good	Drilled pier
Volcanic tuff (Qht)	Consolidated volcanic ash "mud rock"	Good	Drilled pier
Recent alluvium (Ra)	Organic silt with varying amounts of sand and a few pockets of gravel or cobbles	Poor	Pile
Man-made fills (Rf)	Clays to gravels and intermediate mixtures of soils; soft or loose to hard or very dense; consistency variable	Moderate to poor	Pile

therefore, neither constrains the alignment or construction plans.

3.3.2 Potential Impacts

As described in Chapter 3 of the Routing Report, the installation of foundations for transmission line poles involves several steps that require earthwork. In addition to clearing and grubbing of the surface, the typical auger shaft for a pier-type foundation is 4 to 6 feet in diameter and 15 to 25 feet deep. Pile-type foundations (if required) involve pile-cap excavations approximately 10 to 14 feet by 13 to 18 feet by 15 feet deep; driving 6 to 12 piles 50 to 150 feet deep; tying the pile cap into the reinforced steel of the piles and pouring a concrete cap; and replacing the overburden (approximately 2 feet of soil). Soil not required for backfill will be trucked to a fill site.

Placing existing overhead 12 kV distribution lines underground along Kam Highway between Waiau Power Plant and McGrew Point will require digging a trench approximately 2 to 4 feet wide and 5 to 10 feet deep. Manholes will be established every 200 to 300 feet. Service connections (between the transformer and the customer) typically require trenches about 2 feet deep and 6 inches to 1 foot wide.

Although the earthwork necessary for the preparation of pole foundations and placing 12 kV lines underground is substantial, there will be no disturbance of geologic features and, because there are no areas of soils with high erosion potential, the earthwork should cause no significant erosion of soils by water or wind.

Because the areas where construction will occur are already developed and covered by impervious surfaces, surface disturbance will temporarily increase soil absorption and decrease the amount of surface runoff. However, there will be no permanent changes in absorption rates, drainage, or surface runoff.

Poles will be sited outside stream channels. No alterations to any stream channels should be required. No dredging or filling should be required, and there should be no discharges into surface waters nor any violations of any federal, state, or local water quality standards. The preferred alignment does not include any flood-prone areas. There should be no impacts on groundwater quantity or quality.

3.4 BIOLOGICAL RESOURCES

3.4.1 Existing Conditions

The biological resources of the project area were reviewed during the regional study stage of the routing process (Routing Report, Section 5.2, and Appendix D: Biological Resources Survey). Generalized vegetation types are presented in Figure 3.3-1.

Few undeveloped areas exist in the project area; those that do exist are small. The vegetation type present in most of the project area can be characterized as "urban complex." Plants in the urban complex are almost entirely species used for landscaping or other introduced species.

Small areas of wetlands along the Pearl Harbor shoreline at the proposed Aiea Bay State Recreation Area and Richardson Recreation Area consist of mangrove swamps (*Rhizophora mangle*) with bands of plants extending inland for some distance along the banks of Aiea Stream.

No sites within the project area have been identified as "Primary Habitat Areas" for endangered Hawaiian waterbirds by the U.S. Fish and Wildlife Service (1978). No rare, threatened, or endangered species designated by federal and or state government or sensitive plant native plant communities have been identified in the project area.

3.4.2 Potential Impacts

There should be no substantial impacts on biological resources from either the construction or operation of the proposed transmission line. As noted in Section 3.4.1, the land along the preferred alignment is largely developed and few or no undisturbed biological resources exist. In a few locations, individual trees may need to be trimmed or removed to maintain safe conductor distances. The amount of trimming required is determined by calculating the extreme position of conductors in high winds. Within the right-of-way, HECO requires that vegetation be kept a minimum of 10 feet from the extreme position (defined as the lowest position of the conductor at rest or its farthest position in high winds) of all 138 kV conductors and 8 feet from 46 kV and 12 kV conductors. In most locations, the new line will use the alignment of existing 46 kV lines and new vegetation removal should be minimal.

3.5 CULTURAL AND HISTORIC RESOURCES

3.5.1 Affected Environment

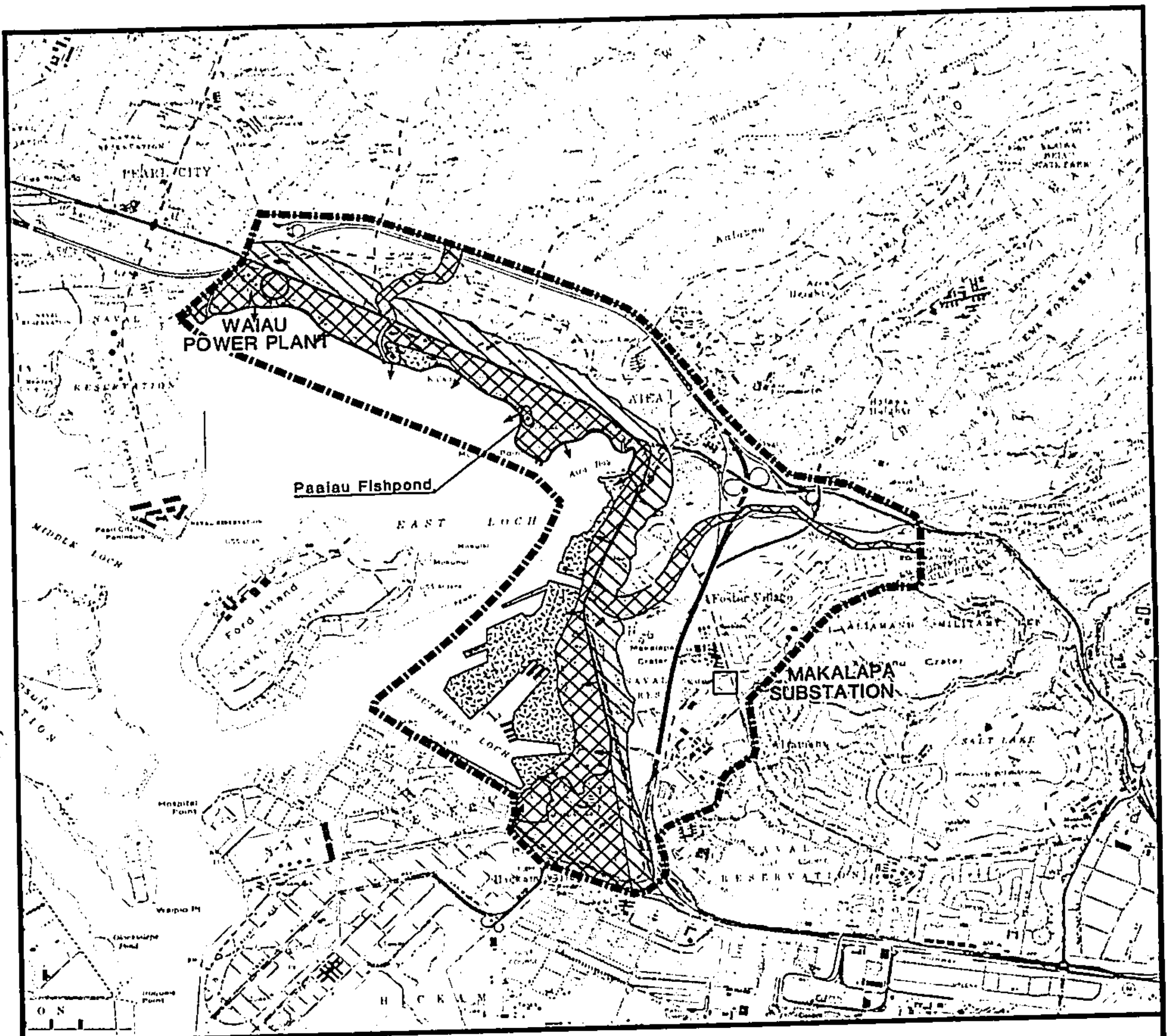
National Register District/National Historic Landmark. In 1964 the Pearl Harbor Naval Base was designated a National Historic Landmark by the Secretary of the Interior because of its crucial role in the nation's defense, and particularly for its role in World War II as the site of the air attack of December 7, 1941. With the establishment of the National Register of Historic Places in 1966, Pearl Harbor was also designated a Historic District.

The National Register designation provides for the protection of all facilities on the Naval base, including archaeological structures, fishponds, and subsurface materials. Any action taken within the boundary of the Pearl Harbor Naval Base must comply with the Pearl Harbor Historic Preservation Plan (1978). Historic Preservation guidelines were established in a Memorandum of Agreement (MOA) drafted in 1979 by the U.S. Navy archaeologist, the State Historic Preservation Program, and the State Advisory Council on Historic Preservation.

The structures in the Landmark are classified into three categories: (1) structures that make a major contribution to the historic character of the Naval complex and should be preserved where possible; (2) those that make a lesser contribution to the complex and need to be recorded if altered; and (3) those that make no contribution to the historic character of the Landmark. Any activities that affect structures in the first two categories must be reviewed and mitigative actions may be required in accordance with the MOA and the Pearl Harbor Historic Preservation Plan.

The boundary of the Pearl Harbor National Register District/ National Historic Landmark follows the shoreline of Pearl Harbor from ewa of the Waiau Power Plant to the Richardson Recreation Center (Figure 3.5-1). There the boundary turns inland to Kam Highway, and follows the makai side of Kam Highway south out of the project area. Slightly over one mile of the proposed transmission line alignment between Aloha Stadium and Radford Drive on Kam Highway is adjacent to the National Landmark boundary.

Cultural Resources Potential. The cultural resources potential of the project area was surveyed at the regional study stage of the routing study (Routing Report Section 5.2 and Appendix E: Cultural Resources Technical Report and Field Survey Report). The survey was completed by an



CULTURAL RESOURCES

- Study Area Boundary
- Unsurveyed Areas with Good Cultural Resource Potential
- Unsurveyed Areas with Moderate Cultural Resource Potential
- Unsurveyed Areas with Poor Cultural Resource Potential
- Fill Area with Poor Cultural Resource Potential
- National Historic Landmark Boundary

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

FIGURE 3.5-1

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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archaeologist working in cooperation with the State archaeologist and the State historian. A predictive model was used to identify areas of high, medium, or poor cultural resource recovery potential (Figure 3.5-1). Fill areas were distinguished from other unsurveyed areas because the potential for recovering cultural resources in fill areas is remote.

Unsurveyed Area with High Potential for Cultural Resource Recovery

This category includes areas where there is a relatively high probability that archaeological remains could be found if subsurface investigations were conducted. These areas were determined by the following criteria:

- Similar environmental settings in Hawaii have contained a high number of sites and other types of archaeological data.
- Known ethnographic and ethnohistoric data support the potential for locating subsurface archaeological remains.
- Shorelines and river/streambeds often have a high frequency of archaeological sites.

Unsurveyed Areas with Medium Potential for Cultural Resource Recovery

This category includes unsurveyed areas that are similar to areas where surveys have resulted in a moderate to low frequency of archaeological recovery.

Unsurveyed Areas with Poor Potential for Cultural Resource Recovery

This category includes unsurveyed areas with a poor likelihood of archaeological recovery.

The proposed transmission line alignment falls on the boundary between unsurveyed areas with high and medium potential for cultural resource recovery (drawn along Kam Highway). It should be noted that most of the preferred alignment is located on land that has been previously disturbed for road or building construction. Although the area in its undisturbed state might have had high or medium potential for cultural resource recovery, the likelihood of finding undisturbed resources has been considerably reduced by development.

3.5.2 Potential Impacts

The proposed line should have no impacts on historic or cultural resources. Although the preferred alignment parallels the boundary of the Pearl Harbor National Register District/National Historic Landmark along Kam Highway, no structures within the National Register District/National Historic Landmark will be altered or otherwise affected. Construction plans will be submitted for review and comment by the State Department of Land and Natural Resources Historic Preservation Program.

No other historic sites or cultural resources are known to exist along the preferred alignment. The transmission line will be built on land that has already been disturbed for road construction or other development; the likelihood of finding subsurface archaeological remains is very low. However, should archaeological remains be uncovered, the State Historic Preservation Program, Department of Land and Natural Resources, will be contacted for proper evaluation and disposition of the findings.

3.6 VISUAL RESOURCES

3.6.1 Existing Conditions

The Department of Land Utilization's Coastal View Study (City and County of Honolulu, Department of Land Utilization, 1987), describes the visual resources of the project area as follows:

> ***9.1.1 Section A of the South Shore Viewshed, Pearl Harbor***
>
> *The Pearl Harbor Section consists of the area surrounding Pearl Harbor including Waiaphu, Pearl City, and Aliamanu.*
>
> *The flat terrain and the built-up military facilities surrounding Pearl Harbor provide very little public viewing opportunities into this bay. The best views of the bay are from the upper residential areas of Pearl City and Waipio where an overview of the harbor can be seen.*
>
> *Even within its urban context, the development along the coastal roadways (Farrington Highway and Kam Highway) are fairly jumbled, representing low visual unity and urban intactness.*

Significant Roadway Views

PUC-1
Makai view into Pearl Harbor Park from Kam Highway at Pearl Harbor Park.

PUC-2
Makai view into Pearl Harbor from Kam Highway at Richardson Park.

Significant Stationary Views

Important pedestrian views into Pearl Harbor can be seen from Waipahu High School, Leeward Community College, at Pearl Harbor Park and at Richardson Park near the Aloha Stadium.

A field evaluation of visual resources within the project area was conducted during the corridor evaluation stage of the routing study (see Routing Report Section 6.3). The field evaluation of existing conditions described here was used as the basis for the evaluation of the visual impacts of the project.

From the Waiau Power Plant, the preferred alignment follows the makai side of Kam Highway. Development along this stretch of the preferred alignment features a wide variety of land uses, including shopping centers, individual retail and service establishments, gas stations, automobile dealerships, restaurants, fast food outlets, a few houses and apartment buildings, and recreational facilities at Pearl Harbor (Blaisdell) Park and the Navy's Richardson Recreation Center. The high public use of this area means that there are many viewers along this segment of the preferred alignment. The overall visual environment is highly diverse, with low visual unity and, thus, can better absorb the visual presence of overhead utilities than areas with greater visual unity.

Overhead utility lines already occupy both sides of Kam Highway for most of the alignment between the power plant and McGrew Point. The mauka side of the highway has distribution lines and telephone cables supported by wood poles approximately 45 feet tall. The makai side of the road has a 46 kV transmission line with distribution lines strung below, on poles approximately 55 feet high. From McGrew Point to Aloha Stadium, the preferred alignment continues to follow the makai side of Kam Highway, whereas the existing 46 kV transmission line cuts makai, across the proposed Aiea Bay State Recreation Area. Along this section (approximately 1,500 feet), the mauka side of Kam Highway has 46 kV, distribution, and telephone lines. The makai side has telephone and distribution lines.

For the entire distance from Waiau Power Plant to Aloha Stadium, views into Pearl Harbor from Kam Highway are very limited. The principal view into Pearl Harbor (identified as a Significant Stationary and Roadway view in the Coastal View Study) is across Pearl Harbor (Blaisdell) Park.

The visual character of the alignment between Aloha Stadium and Radford Drive is urban. The section has less commercial development than the alignment section between Waiau Power Plant and Aloha Stadium. The major uses (residential and the Pearl Harbor Naval Base) are set off by areas of open space and by trees and other landscaping. This section of the alignment has many viewers (including tourists), particularly in the vicinity of the U.S.S. Arizona Memorial. There is an existing 46 kV transmission line supported by wood poles approximately 50 feet tall along the makai side of the road. There are distribution and telephone lines on the mauka side of the road.

The Coastal View Study identified a Significant Roadway View into Pearl Harbor from Kam Highway at Richardson Recreation Center and a Significant Stationary View from the Richardson Center into Pearl Harbor. Most other views of Pearl Harbor are obscured by buildings and or landscaping on the makai side of Kam Highway.

The visual quality of the preferred alignment between the intersection of Radford Drive and Kam Highway and Makalapa Substation is urban, with residential and commercial uses predominant. In the vicinity of Radford Drive, open space buffers provide a contrast to the built-up character of much of the project area. In the Bougainville/Lawehana Street/Malaai Street area, large-scale retail development alternates massive warehouse buildings with parking lots. Although Radford Drive, Bougainville Drive, and Malaai Street are not generally travelled by tourists, many local residents, including military personnel, are viewers.

An existing 46 kV transmission line on the north side of Radford Drive has wooden poles approximately 50 feet high. The Makalapa-Iwilei 138 kV line (with steel poles approximately 100 feet high) follows the mauka side of Bougainville Drive.

3.6.2 Potential Impacts

Along Kam Highway from Waiau Power plant to Aloha Stadium, the proposed project would replace the existing wood poles on the makai side of the roadway with new steel structures up to 135 feet tall. These new poles would support the proposed 138 kV line as well as the existing 46 kV conductors. The distance between the new steel poles will be greater than that between the existing wood poles. Therefore, the project will result in fewer poles along the makai side of Kam Highway than currently exist there.

The overall effect will be a cleaner, more ordered visual environment, although the new steel structures may be considered dominant visual elements because of their mass and height as compared with existing conditions.

The view from Kam Highway across Pearl Harbor (Blaisdell) Park to Pearl Harbor should not be significantly affected by the new transmission line. The new line will replace an existing 46 kV line along Kam Highway. Viewers on Kam Highway will look beneath and between the new steel poles (spaced 300 to 600 feet apart) to the harbor.

As mitigation for the visual effect of the new transmission line, HECO is proposing (subject to PUC approval) to place underground the existing overhead 12 kV distribution lines and service connections along Kam Highway between Waiau Power Plant and McGrew Point. HECO has informed the City and County of Honolulu, GTE Hawaiian Tel, and Oceanic Cable Vision about HECO's plan to underground the distribution line along Kam Highway. If these entities agree to participate, street light feeders, telephone lines, and television cables may also be placed underground. If they decide not to participate, poles that carry cables for these services will remain on the makai side of Kam Highway; however many of the wooden poles will be shortened after the electric distribution lines are removed.

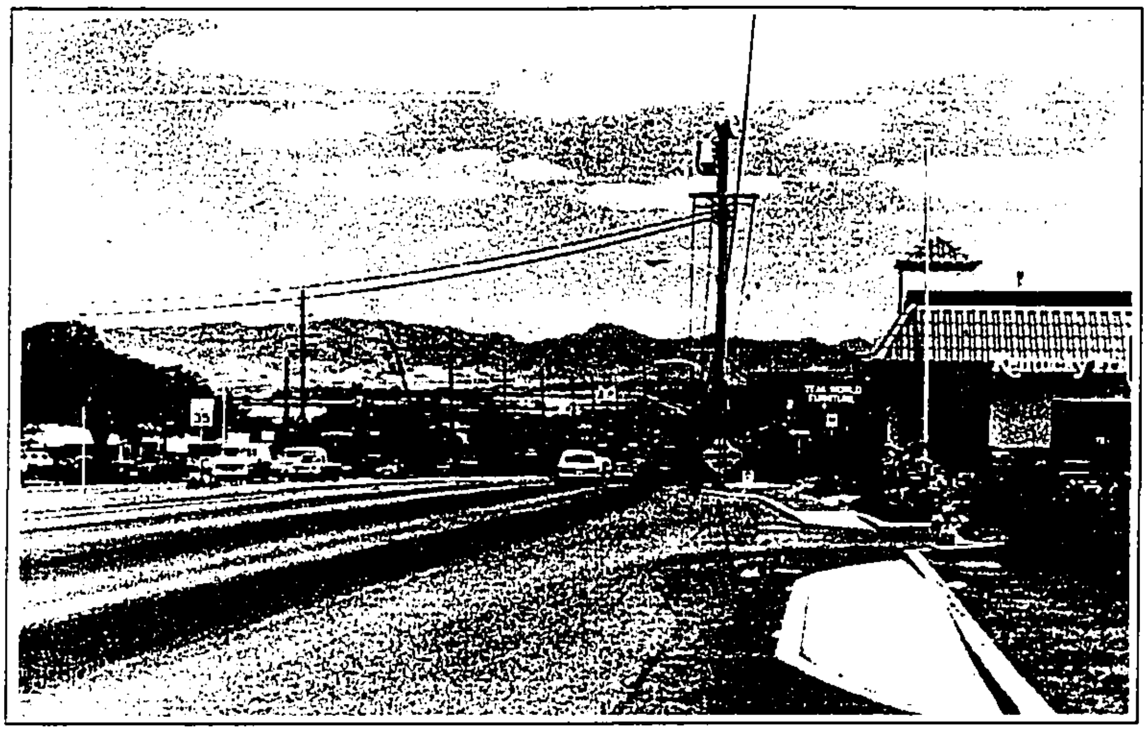
Simulations of the visual effect of the proposed project were developed to help evaluate the project's visual impacts. Viewpoint data were reviewed to identify the locations that best represent typical and critical public views. A computerized process generated digital models of the proposed transmission line and manipulated them to precisely match the perspective of color photographs of the selected views of existing (pre-project) conditions. Working directly on color enlargements, an artist transferred the computer images to the photographs and then retouched the photographs to accurately represent the location, scale, extent, and nature of all project features that the computer model identified as being visible in each view. This process provides highly reliable and realistic images of the proposed project.

Figure 3.6-1 simulates the visual impact of the project looking ewa along Kam Highway near McGrew Point. This simulation is based on the assumption that PUC will approve HECO's proposal for underground placement of existing overhead 12 kV distribution lines and service connections along the makai side of this section of Kam Highway. However, this simulation assumes that telephone lines, street light feeders, and television cables are not placed underground.

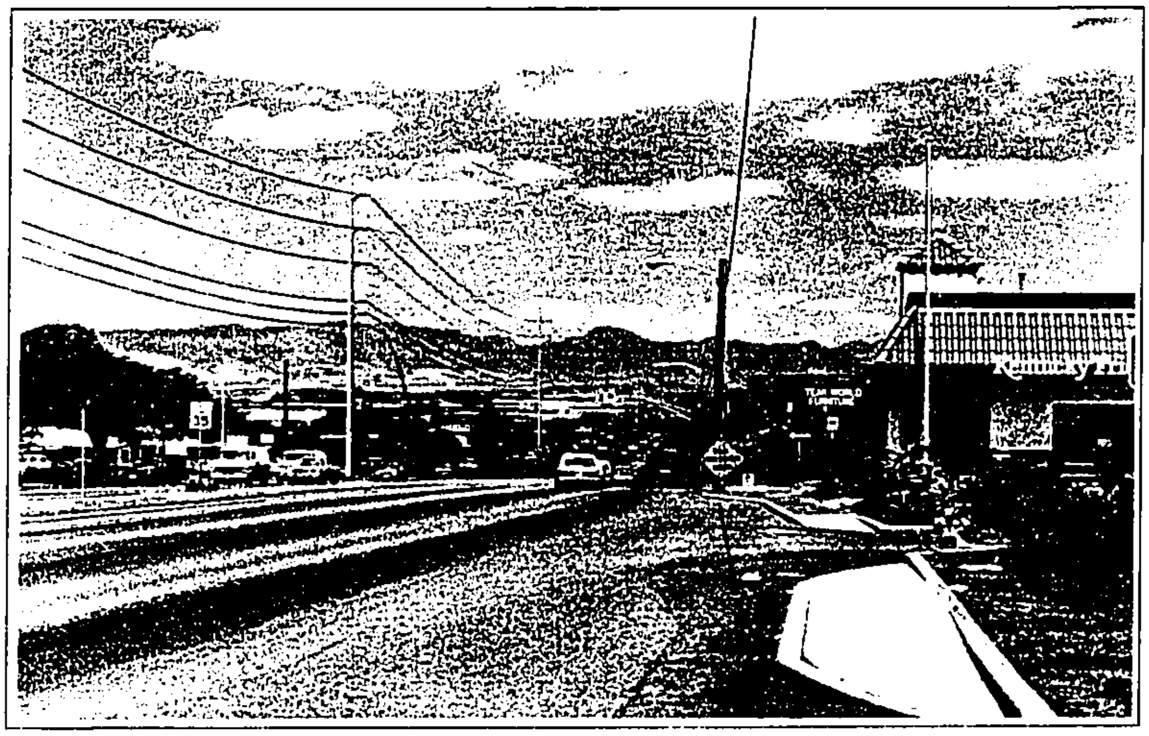
Along Kam Highway between Aloha Stadium and Radford Drive, the new line will generally replace an existing 46 kV line on wood poles (approximately 50 feet high) with taller (up to 135 feet) steel poles that will support 138 kV, 46 kV, and 12 kV lines. Some wooden poles that support 12 kV distribution lines will remain between the steel poles; however, they will be shortened because they will no longer support 46 kV lines. Although the new structures will be significantly taller than the poles they replace, there will be fewer because the steel poles will be spaced farther apart than the wood poles. The height and mass of the new steel structures will make them a dominant visual element along that section of Kam Highway. Nonetheless, in the few locations where views makai toward Pearl Harbor exist (as at the Navy Richardson Recreation Center), the new line will generally not interrupt the views: viewers will look beneath the conductors and between the widely spaced poles to the shoreline.

Figure 3.6-2 simulates the visual effect of the new line at the point north of Radford Drive where the line will cross from the makai to the mauka side of Kam Highway.

Between the Radford Drive/Kam Highway intersection and Makalapa Substation, the new line will again largely replace existing 46 kV transmission lines. The number of viewers in this section of the alignment is lower than in the sections along Kam Highway. In the section along Bougainville Drive, Lawehana Street, and Malaai Streets, the new line's visual impacts will be reduced because of the commercial environment of that area: the new line will be less visually prominent when viewed against the backdrop of the massive warehouse buildings along Bougainville Drive and Malaai Street.



Existing Conditions



Simulation of Proposed Project

FIGURE 3.6-1

VISUAL SIMULATION:
FROM KAMEHAMEHA HIGHWAY AT
McGREW POINT LOOKING EWA

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

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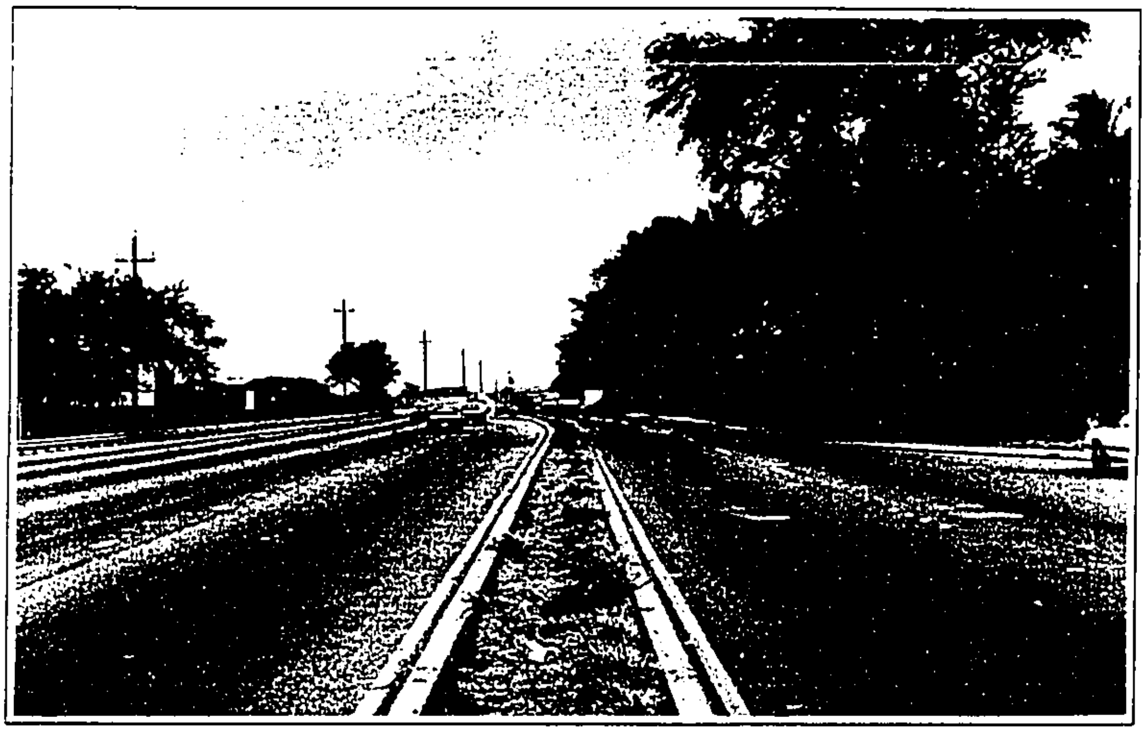
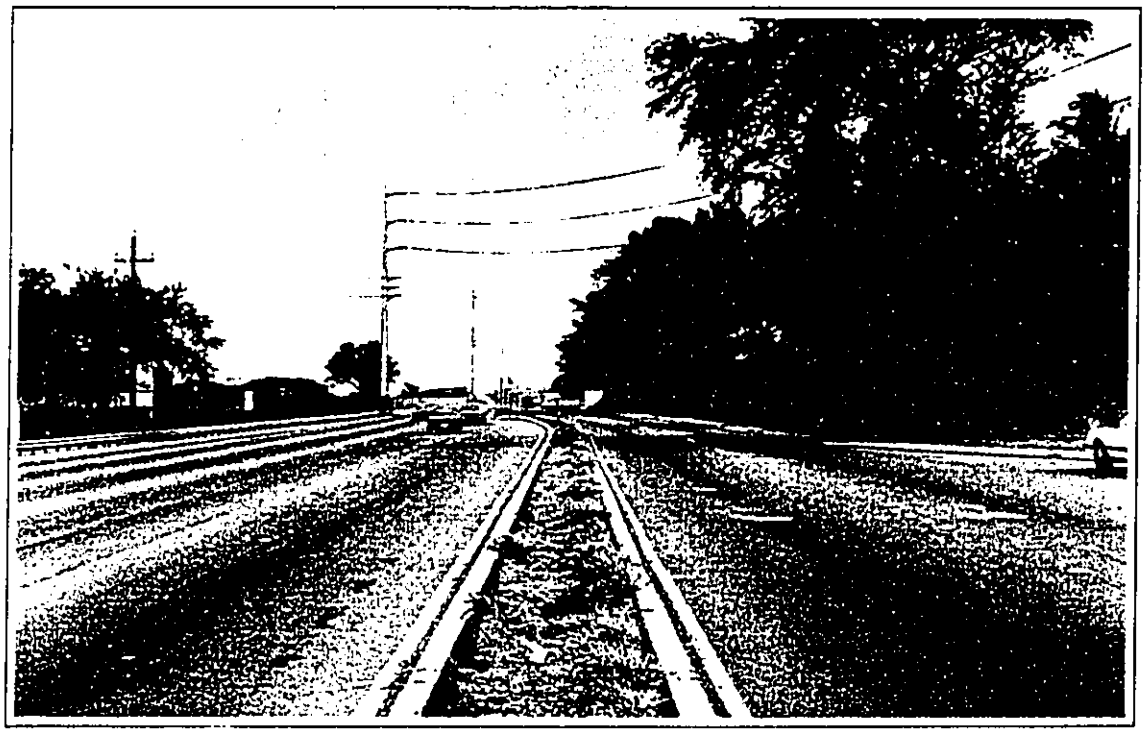


Existing Conditions



Simulation of Proposed Project

FIGURE 3.6-2

VISUAL SIMULATION:
FROM KAMEHAMEHA HIGHWAY NEAR
RADFORD DRIVE LOOKING NORTH

Waiau-Makalapa No. 2
Transmission Line Project

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3.7 TRAFFIC AND TRANSPORTATION

3.7.1 Existing Conditions

Most of the preferred transmission alignment lies within the right-of-way of Kam Highway, Radford Drive, and Bougainville Drive (state highways) and Lawehana Street and Malaai Street (county roads). Kam Highway is a major regional arterial. Table 3.7-1 shows recent peak hour and 24-hour traffic counts at selected locations on Kam Highway, Radford Drive, Bougainville Drive, and Lawehana Street.

3.7.2 Potential Impacts

Because the new line will be installed primarily in the rights-of-way of Kam Highway and other local roads, construction activities may temporarily disrupt traffic in some locations. Work on public roads must follow traffic control procedures prescribed by the Federal Highway Administration, the State Department of Transportation Highways Division, and the City and County of Honolulu Department of Transportation Services. Work adjacent to a state road or highway requires a Permit to Perform Work on State Highways, which must incorporate a Traffic Control Plan approved by the Highways Division. The City and County of Honolulu requires observation of state and federal traffic control regulations for any work on county roads.

According to state highway regulations, only one lane at a time may be closed on a multilane highway and, on a two-lane highway, wherever possible, lanes of adequate width in both directions must be provided. All lanes must be open to traffic during morning peak hours (generally 6:00 a.m. to 8:30 a.m.) and afternoon peak hours (generally 3:00 p.m. to 6:00 p.m.). HECO and its construction contractors follow state guidelines for the types of signs, lights, markers, position of traffic cones, areas coned off, and the use of flaggers and/or police officers (State of Hawaii Department of Transportation; U.S. Federal Highway Administration, 1978).

Coning off a lane of traffic is usually required during foundation, pole, and conductor installation phases of line construction, and will also be required when existing 12 kV lines are placed underground. At any one point along the new route, traffic might have to be interrupted for several days over the course of a few months.

Construction may be performed in a staggered manner, i.e., early stages of construction may continue in some sections

Table 3.7-1
PEAK AND 24-HOUR TRAFFIC VOLUMES

Location and Direction (Survey Date)	AM 1-Hour Peak Volume (Time)	PM 1-Hour Peak Volume (Time)	24-Hour Volume
Kam Hwy at Waiau Power Plant (8/8/88)			
Eastbound	1,789 (5:45-6:45)	1,145 (3:30-4:30)	18,064
Westbound	860 (8:00-9:00)	2,126 (3:30-4:30)	23,294
Kam Hwy at East Side of Kaonohi Street Intersection (2/14/89)			
Eastbound	3,553 (5:45-6:45)	1,956 (3;00-4:00)	37,835
Westbound	1,840 (8:00-9:00)	4,121 (4:30-5:30)	46,903
Kam Hwy at Halawa Bridge (2/13/89)			
Southbound	1,993 (6:15-7:15)	892 (3:45-4:45)	15,605
Northbound	615 (7:45-8:45)	1,965 (3:30-4:30)	14,410
Kam Hwy at North Side of Radford Drive Intersection (2/14/89)			
Southbound	1,416 (6:00-7:00)	1,090 (3:45-4:45)	14,496
Northbound	785 (6:45-7:45)	1,468 (4:45-5:45)	14,492
Radford Drive at East Side of Kam Hwy Intersection (2/14/89)			
Eastbound	760 (6:30-7:30)	1,352 (3:45-4:45)	13,489
Westbound	1,171 (6:15-7:15)	768 (3:45-4:45)	9,992
Bougainville Drive at South Side of Lawehana Street Intersection (2/13/89)			
Northbound	451 (7:15-8:15)	913 (4:14-5:15)	7,453
Southbound	897 (6:15-7:15)	631 (6:00-7:00)	9,042
Lawehana Street at East Side of Bougainville Drive Intersection (2/13/89)			
Eastbound	119 (7:15-8:15)	144 (3:15-4:15)	1,721
Westbound	68 (8:00-9:00)	138 (3:15-4:15)	1,455

Source: State of Hawaii, Department of Transportation, Highways Division, 1988-89.

of the line even when later stages, such as pole installation, have been completed in other sections of the line. Therefore, areas where coning off lanes of traffic may be required can shift among locations along the alignment over a period of several months.

The first activity that may require coning off a lane of traffic will be foundation installation. Typically, two to three foundations are installed at a time, requiring a single lane of traffic to be coned off for 1,000 to 1,500 feet for 2 to 3 weeks during the hours when construction is occurring. The next stage in the construction process, which may occur up to several weeks later, is pole installation. Approximately three poles per day can be installed, requiring coning off a single lane for approximately 700 to 1,300 feet. Conductor installation is done in sections approximately 1/2 to 1 mile long. Installing all conductors requires about 1 month per mile to complete. A single lane of traffic may be coned off for the period during the hours when construction is occurring. The entire construction process for the overhead 138 kV line is expected to take 12 to 14 months.

Existing overhead 12 kV distribution lines and service connections along portions of Kam Highway will be placed underground after the new 138 kV line has been placed in service. A lane of traffic may be coned off while the trench for the underground line is dug, while distribution cables are being installed, and while feeders are installed between the switch vaults and the transformers. This process may take 18 to 20 months to complete; however, disruption in any one location would be of much shorter duration.

3.8 AIR QUALITY AND NOISE

3.8.1 Existing Conditions

Air Quality. Air quality standards that apply to the project area are the National Ambient Air Quality Standards (EPA, 40 CFR 50, as amended) and those outlined in the State of Hawaii, Hawaii Administrative Rules Title 11, Chapter 59. No city/county air quality standards have been adopted for Oahu. Air quality is monitored by the Department of Health Division of Pollution Investigation and Enforcement. In recent years, there have been no exceedances for the regulated pollutants at monitoring stations near the study area (State Department of Health, May 1988).

Noise. As described in Section 3.7, most of the proposed transmission line alignment is located adjacent to a major state highway (Kam Highway) and other commercial routes. Traffic along these highways and roads is substantial (as shown in Table 3.9-1, 24-hour traffic counts along Kam Highway range from 14,000 to 47,000 vehicles) and is the major source of noise.

3.8.2 Potential Impacts

Air Quality. Minor amounts of two types of air emissions may result from construction activities--particulates from soil disturbance and emissions from heavy construction equipment. Ambient air quality at and surrounding each excavation sites will be affected temporarily during construction and regrading. Because construction activities will continually move from one section of the line to the next, particulate levels should not be highly concentrated in any one area. The contractor will be required to minimize airborne particulates through wind erosion control measures if soil and wind conditions indicate that this could become a problem. Emissions of pollutants from heavy vehicles and equipment used to excavate, transport equipment and supplies, and drive piles will be controlled with proper maintenance.

Noise. Foundation installation, pole erection, insulator and conductor stringing, and placing existing 12 kV distribution lines underground will increase noise levels in the immediate vicinity of the activity. Typical sound levels for construction equipment are compared with common noise sources in Table 3.8-1. Construction of each segment of the line will require the use of most of the construction equipment listed in Table 3.8-1 at some point during the construction process.

Pile foundation installation, which requires pile drivers, would result in louder noise levels than most other construction activities (up to 105 dBA measured at 50 feet). The sections of the alignment that may require pile (rather than standard pier) foundations are located primarily along sections of Kam Highway between the Waiau Power Plant and Aloha Stadium.

The noise impacts of the construction activities will be short term and periodic. Noise impacts at any one location will last only a few days at a time as various stages of the construction sequence are completed along each portion of the line. All construction activity will take place during daylight hours.

Table 3.8-1
COMPARISON OF TRANSMISSION LINE CONSTRUCTION
EQUIPMENT NOISE WITH OTHER COMMON SOUND LEVELS
(dBA)

Equipment	A-Weighted Sound Level at 50 Feet Unless Specified
Broadcasting studio	20
Human voice--soft whisper (15 feet)	30
Light auto traffic (50 feet)	50
Air conditioning unit (20 feet)	60
Air compressor	67
Freeway traffic	70
*Crawler tractor (29 to 199 hp)	72
*Wheeled tractor	72
Freight train	75
*Truck, pickup, and 4-wheel drive	77
*Concrete mixer, truck-mounted	78
*Crawler tractor (200 to 450 hp)	78
*Pulling machine	78
*Tensioning machine	78
*Truck, mounted with boring equipment	78
*Truck, flatbed	78
*Truck, rear dump	78
*Dozer	82
*Crane, mobile (15 to 20 ton)	83
*Paving breaker	85
*Pneumatic tools	85
*Crane, mobile (50 ton)	88
Human voice--shout (0.5 foot)	100
Jet takeoff (2,000 feet)	105
*Single-acting air compressor for pile driver	105
Auto horn (3 feet)	115
Jet takeoff (200 feet)	120

*Construction equipment.

Adapted from: Shell California Production, Inc. 1982.

Tomlinson, M. J. Pile Design and Construction Practice. Cement and Concrete Association, London. 1977.

Comparing the construction equipment sound levels in Table 3.8-1 with the current Oahu noise standards in Table 3.8-2 indicates that for selected periods, some construction activities, such as driving piles, are likely to violate the noise standard. If the construction noise level is expected to exceed the standard daylight acceptable level, HECO must apply for a noise permit or noise variance. The approval of the permit may require mitigation by muffling the sounds of construction equipment or limiting the time of use to a specified period. In addition, all heavy vehicles used during construction must comply with Title 11, Administrative Rules, Department of Health, Chapter 42, Vehicular Noise Control for Oahu.

Table 3.8-2
NOISE STANDARDS FOR OAHU
(dBA)

Zoning Districts	Allowable Noise Levels Daytime 7 a.m.-10 p.m.	Nighttime 10 p.m.-7 a.m.
Residential (R-1 through current R-7)	55	45
Preservation (P-1)	55	45
Apartment (A-1 through current A-5)	60	50
Hotel (H-1 and H-2)	60	50
Business (B-1 through current B-5)	60	50
Agricultural (AG-1 and AG-2)	70	70
Industrial (I-1 through current I-3)	70	70

Source: Community Noise Control for Oahu, Title 11, Chapter 43, Section 3, November 6, 1981.

3.9 ELECTRIC AND MAGNETIC FIELDS

Overhead transmission lines are a vital part of the system that provides electric service to homes and businesses in Hawaii. In recent years, interest has been growing about potential effects that may be associated with the environment around transmission lines--in particular, potential health effects of electric and magnetic fields. Because the issues are technically complex, HECO has prepared an information paper to explain the issues in less technical terms (Appendix C). The following subsection summarizes the major points of the technical report.

3.9.1 Transmission Line Voltage Classification

The high-voltage transmission or bulk power lines form the backbone of the electric energy distribution system. A network of about 332,000 circuit miles of transmission lines is in service in the United States. On Oahu, 170 circuit miles of 138 kV lines form the island's transmission system. The proposed Waiau-Makalapa No. 2 line will also be operated at 138 kV. This is the highest voltage classification used in Hawaii. The 138 kV voltage, however, is in the lowest voltage classification of transmission lines in operation in the mainland United States, where lines range up to 765 kV (1 kilovolt equals 1,000 volts).

3.9.2 Electric Fields

Electric fields are a result of the voltage or electric potential on an object. Any object with an electric charge on it has a voltage at its surface caused by the accumulation of more electrons on that surface as compared with another object or surface. The voltage effect is not limited to the surface but exists in the space surrounding the object. The change in voltage over distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). The electric field becomes stronger near a charged object and decreases rapidly with distance from an object.

Electric fields are a very common phenomenon. Static electric fields can result from taking off a sweater or walking across a carpet. Most household appliances and other devices that operate on electricity create electric fields. The electric field is a result of the voltage on the appliance and the field decreases rapidly with distance. The fields that result from point source household appliances generally decrease more rapidly with distance than fields from line sources such as power lines. Appliances need not be in operation to create an electric field; an electric field occurs whenever an appliance is connected to an electrical outlet. Typical values measured at 1 foot from some common appliances are shown in Table 3.9-1.

Table 3.9-1
TYPICAL ELECTRIC FIELD VALUES FOR HOUSEHOLD APPLIANCES
(at 12 inches)

Appliance	Electric Field Kilovolts/meter
Electric Blanket	0.25*
Broiler	0.13
Stereo	0.09
Refrigerator	0.06
Iron	0.06
Hand Mixer	0.05
Phonograph	0.04
Coffee Pot	0.03

*1 to 10 kV/m next to blanket wires (Enertech Consultants, 1985).

Source: Carstensen, 1985.

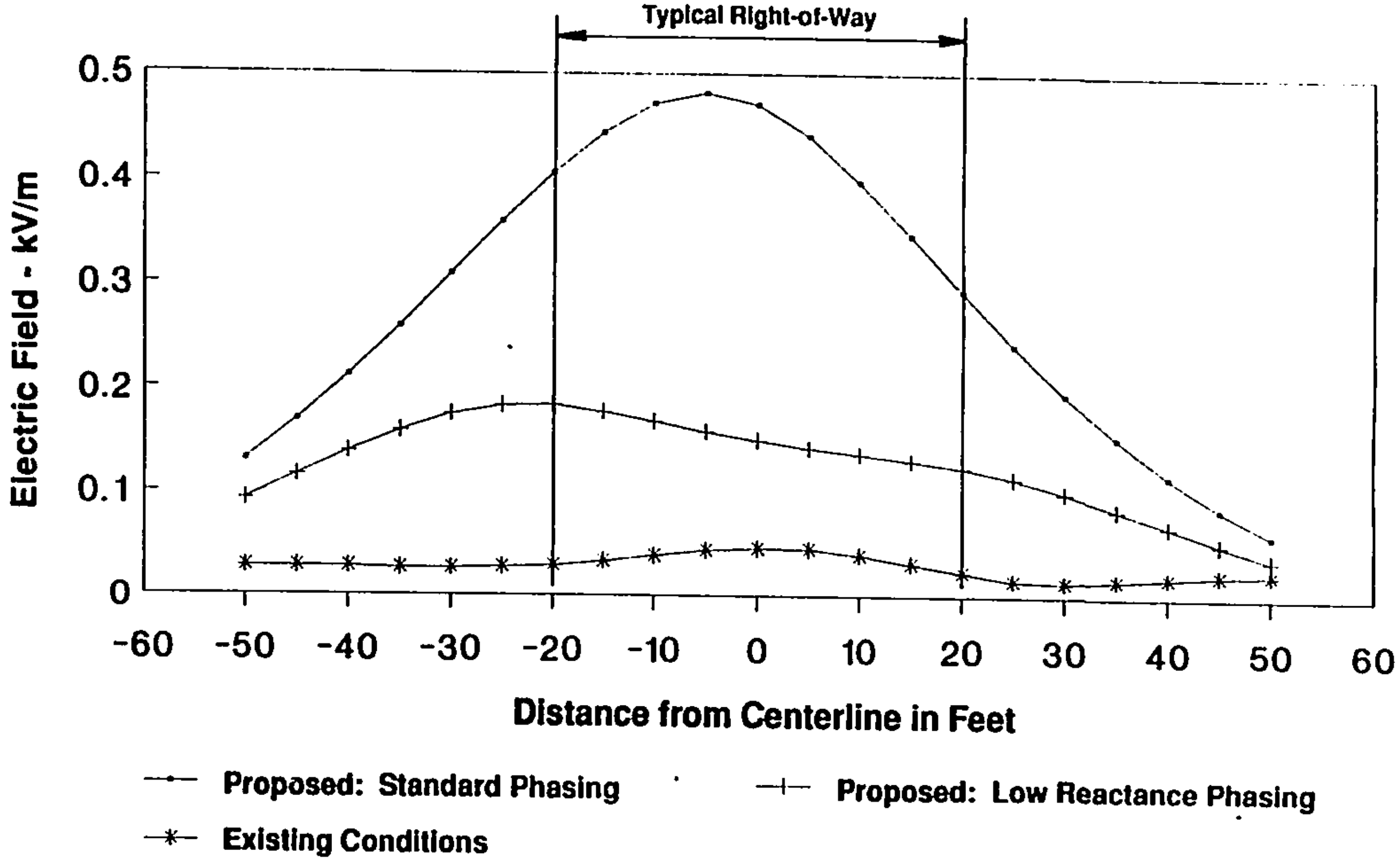
Electric field values were calculated for normal, everyday line loadings for both existing conditions (i.e., existing 46 kV and/or 12 kV lines) and for the proposed line. Because the configuration of the proposed line differs somewhat along the route (as illustrated in diagrams in Appendix C), three sets of field values were calculated (Figures 3.9-1 to 3.9-3). Between the Waiau Power Plant and McGrew Point, there will be a vertical array of three 138 kV conductors above a vertical array of three 46 kV conductors. Between Aloha Stadium and Radford Drive, the configuration will be similar, except that below the 46 kV conductors there will be a horizontal array of 12 kV distribution line conductors. Between Radford Drive and Makalapa Substation, the new line will consist of a vertical array of three 138 kV conductors only. These different line configurations will produce different field strengths. Figures 3.9-1 and 3.9-2 show typical existing field strengths for two locations along the existing 46 kV and/or 12 kV lines. The figures also show two sets of field values for the proposed line. "Proposed: Standard" illustrates the estimated field values near the proposed line if standard conductor installation were used.

Where 138 kV lines are installed on the same pole as lower-voltage lines, some arrangements of conductors ("low-reactance phasing") can reduce field strengths because the interaction of the different phases can reduce field strengths. In Figures 3.9-1 and 3.9-2, "Proposed: Low Reactance" illustrates estimated electric field values for the proposed line using low-reactance phasing. HECO proposes to use low-reactance phasing where possible in locations where the 138 kV line will share poles with lower-voltage conductors.

Figure 3.9-3 illustrates a location between Radford Drive and Makalapa Substation where there is not currently a lower voltage line and, therefore, there is no opportunity to use low-reactance phasing.

As Figures 3.9-1 to 3.9-3 illustrate, the electric field for the proposed Waiau-Makalapa 138 kV line will be about 0.4 to 1.8 kV/m directly under the conductors near midspan (assuming standard phasing). Field strengths would decline to about 0.07 to 1.2 kV/m within 20 feet to the right or left of the centerline (as defined by pole placement). The maximum electric field reported in the lateral profiles occurs in a relatively small area (about 5 percent of total area) near midspan, and near the location where the conductors sag closest to the ground.

If, as proposed, low-reactance phasing is employed for the alignments along Kam Highway (where both existing 46 kV conductors and the proposed 138 kV conductors will share the same poles), electric field strengths under the conductors near midspan would be approximately 0.05 to 0.15 kV/m, and would be approximately 0.03 to 0.18 kV/m 20 feet from the centerline.



NOTE: Existing configuration is 46 kV
Proposed configuration is 138 kV and 46 kV

FIGURE 3.9-1

ELECTRIC FIELD LATERAL PROFILE CASE NO. 1: WAIAU-MCGREW POINT

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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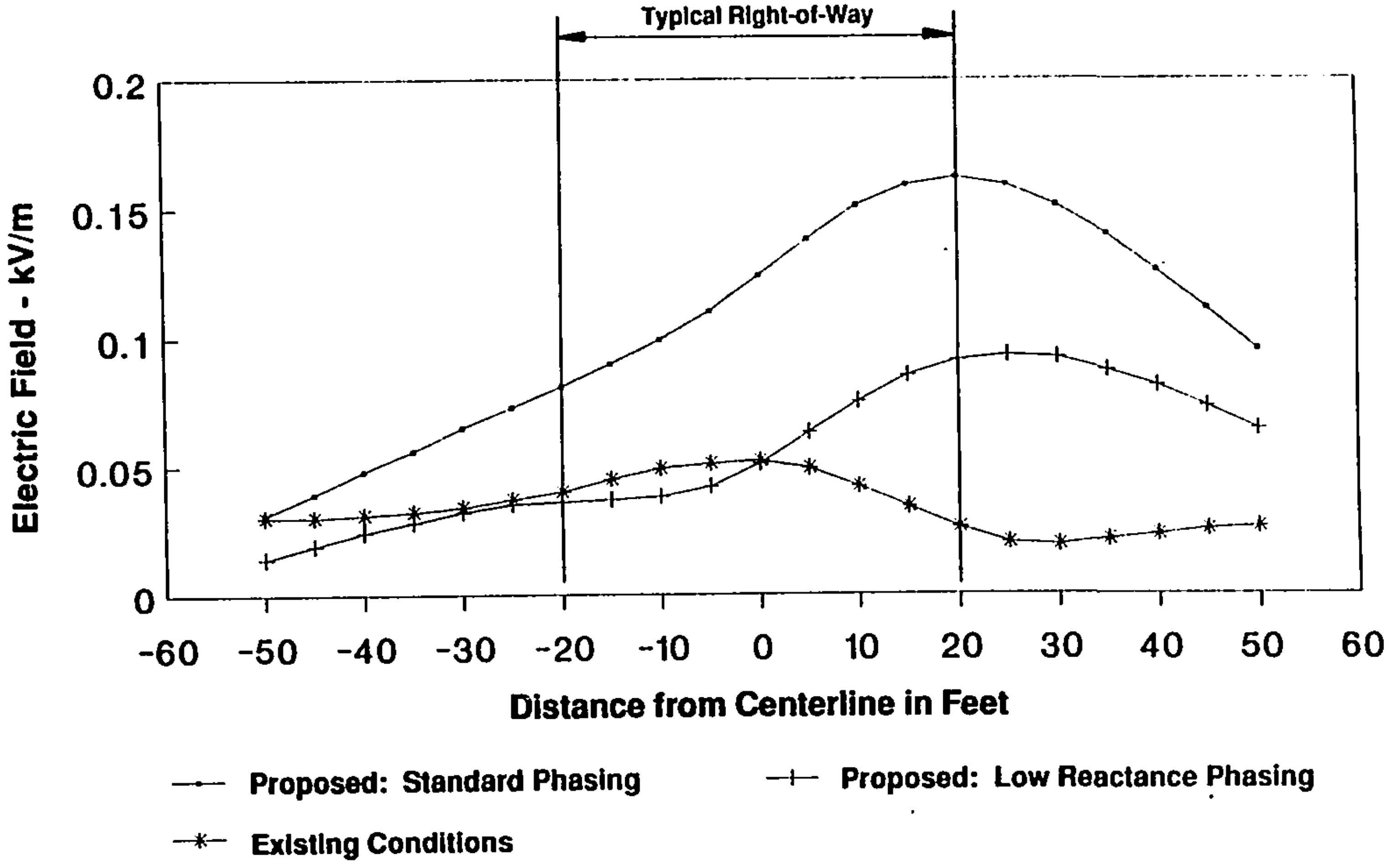

NOTE: Existing configuration is 46 kV and 12 kV
Proposed configuration is 138 kV, 46 kV, and 12 kV

FIGURE 3.9-2

ELECTRIC FIELD LATERAL PROFILE CASE NO. 2: ALOHA STADIUM -RADFORD DR.

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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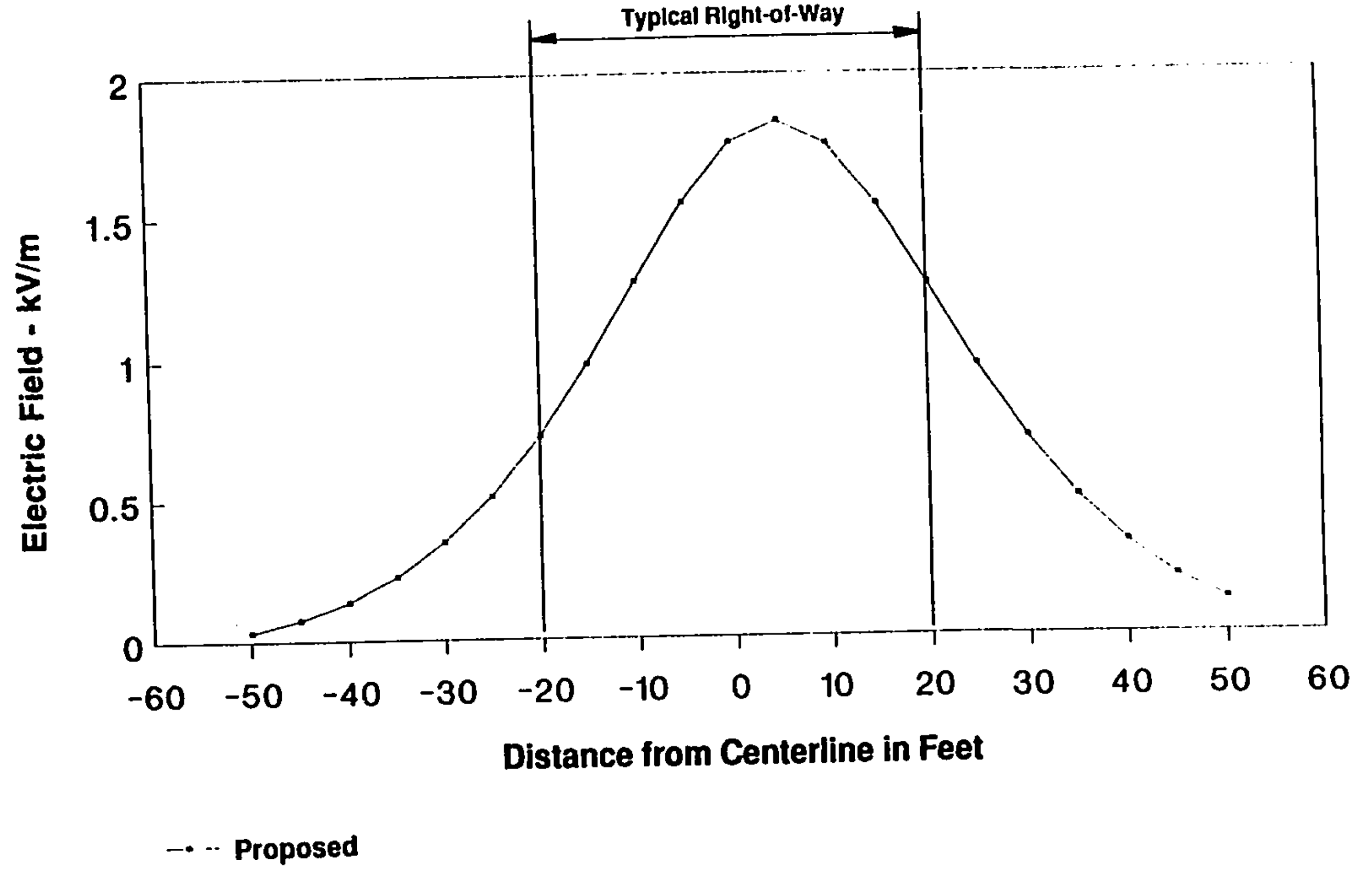

NOTE: Proposed configuration is 138 kV

FIGURE 3.9-3

ELECTRIC FIELD LATERAL PROFILE CASE NO. 3: RADFORD DR.-MAKALAPA SUBSTATION

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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3.9.3 Magnetic Fields

An electric current flowing in any conductor (electric equipment, household appliance, or other) creates a magnetic field. The most commonly used unit for measuring magnetic fields is the Gauss (mG is equal to one-thousandth of a Gauss), which is a measure of the magnetic flux density (intensity of magnetic field attraction per unit area).

The magnetic field under transmission lines is relatively low in comparison with measurements near many household appliances and other equipment. The magnetic field near an appliance decreases rapidly with distance from the appliance. The magnetic field also decreases with distance from line sources, such as powerlines, but not as rapidly as from appliances. Because the magnetic field is caused by the flow of an electric current, a device must be in operation to create a magnetic field. The magnetic fields of a large number of typical household appliances were recently measured by the Illinois Institute of Technology Research Institute (IITRI) for the U.S. Navy (Gauger, 1985) and by Enertech Consultants (Silva, 1988) for the Electric Power Research Institute (EPRI). Typical values of magnetic fields associated with household appliances are shown in Table 3.9-2.

Magnetic field values were calculated for normal, everyday line loadings for existing conditions (i.e., existing 46 kV and/or 12 kV lines) and the Waiau-Makalapa No. 2 138 kV Transmission Line at three locations along the preferred alignment (Figures 3.9-4 to 3.9-6). As was done for the electric field calculations, projected field values are shown for the proposed line for both standard phasing and low-reactance phasing.

The lateral plots for normal line loading show the magnetic field to be approximately 12 to 48 mG directly under the conductors near midspan (assuming standard phasing). Field strengths would decline to approximately 9 to 40 mG within 20 feet to the right or left of the centerline. If, as proposed, low-reactance phasing is employed for the alignments along Kam Highway (where the new line will have both 46- and 138 kV conductors on the same poles), magnetic field strengths under the conductors near midspan would be approximately 7 to 12 mG. Field strengths near these sections of the line would be 4 to 8 mG at a distance of 20 feet from the centerline.

Table 3.9-2
TYPICAL MAGNETIC FIELD VALUES FOR HOUSEHOLD APPLIANCES

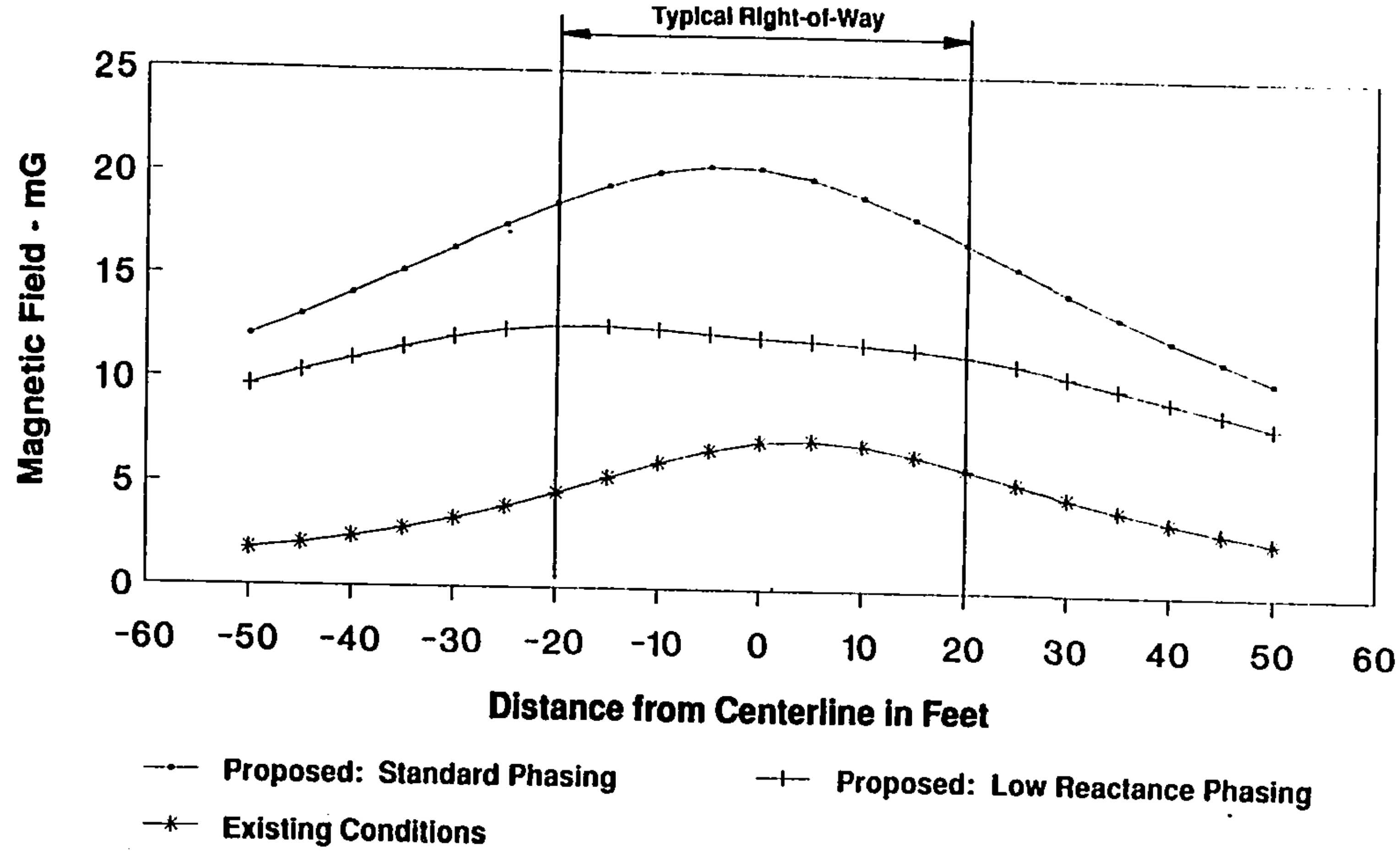
Appliance	Magnetic Field in milliGauss	
	12" Away	Maximum
Electric range	3-30	100-1,200
Electric oven	2-5	10-50
Garbage disposal	10-20	850-1,250
Refrigerator	0.3-3	4-15
Clothes washer	2-30	10-400
Clothes dryer	1-3	3-80
Coffee maker	0.8-1	15-250
Toaster	0.6-8	70-150
Crock pot	0.8-1	15-80
Iron	1-3	90-300
Can opener	35-250	10,000-20,000
Mixer	6-100	500-7,000
Blender, popper, processor	6-20	250-1,050
Vacuum cleaner	20-200	2,000-8,000
Portable heater	1-40	100-1,100
Fans/blowers	0.4-40	20-300
Hair dryer	1-70	60-20,000
Electric shaver	1-100	150-15,000
Color television	9-20	150-500
Fluorescent fixture	2-40	140-2,000
Fluorescent desk lamp	6-20	400-3,500
Circular saws	10-250	2,000-10,000
Electric drill	25-35	4,000-8,000

Source: Gauger, 1985.

Under emergency conditions, the proposed 138 kV line could operate under a maximum loading that would temporarily increase magnetic field values directly beneath the conductors to the range of about 25 to 170 mG (depending on line configuration and location). At a distance of 20 feet from the centerline, the magnetic fields would measure 14 to 143 mG. It should be noted that these conditions would be very rare and of short duration.

3.9.4 Health Effects of Electric and Magnetic Fields

Although most studies in the 1960s and 1970s found no obvious harmful effects from typical transmission line electric and magnetic fields, some recent reports have suggested an association between exposure to magnetic fields and adverse health effects, including cancer. However, no association between electric fields and health effects has been found by any of the studies. The overall evidence for effects caused by magnetic fields is inconclusive and studies are under way to obtain more definitive information. Although most of the



NOTE: Existing configuration is 46 kV
Proposed configuration is 138 kV and 46 kV

FIGURE 3.9-4

MAGNETIC FIELD LATERAL PROFILE CASE NO. 1: WAIAU-MCGREW POINT

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
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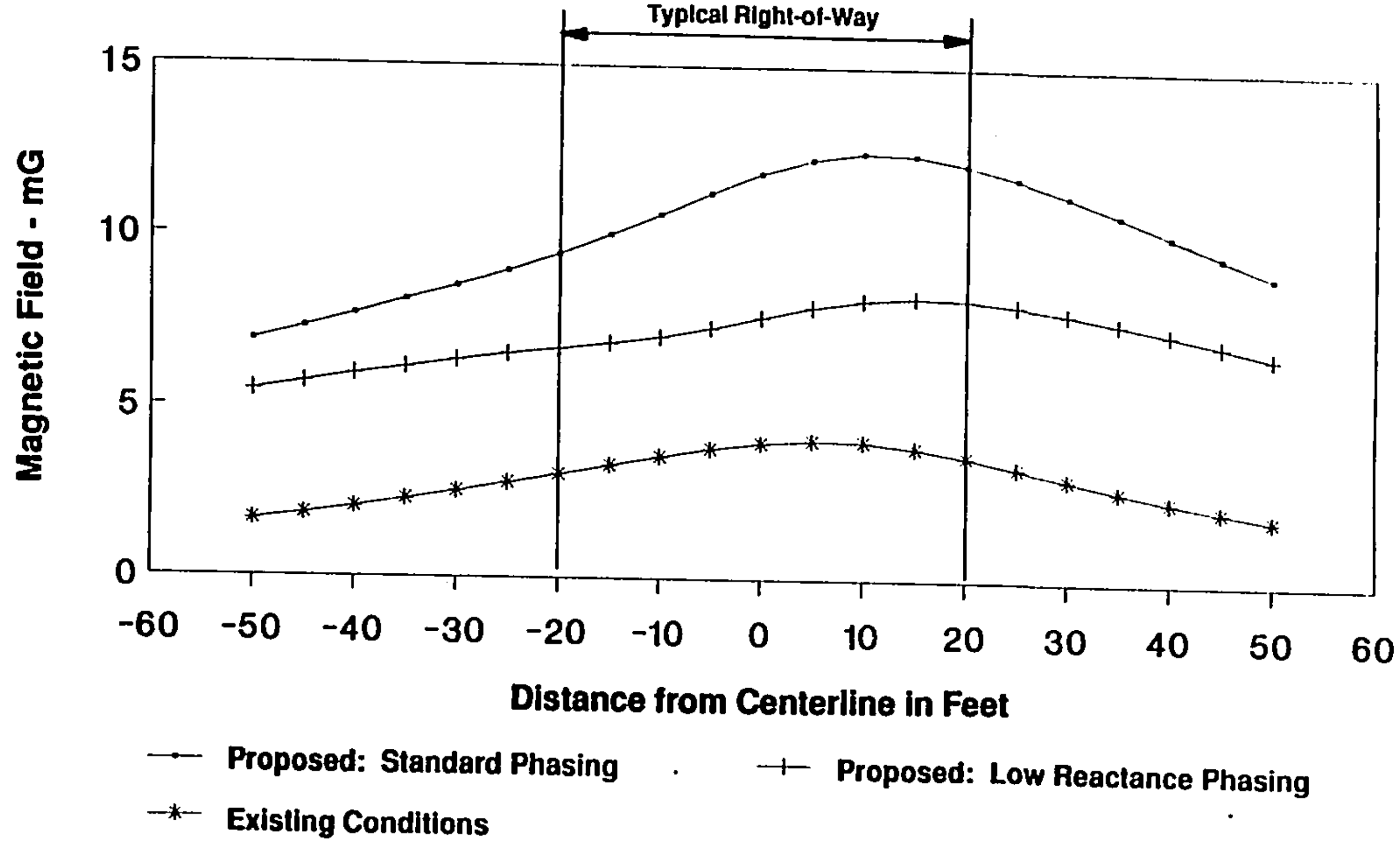


NOTE: Existing configuration is 46 kV and 12 kV
Proposed configuration is 138 kV, 46 kV, and 12 kV

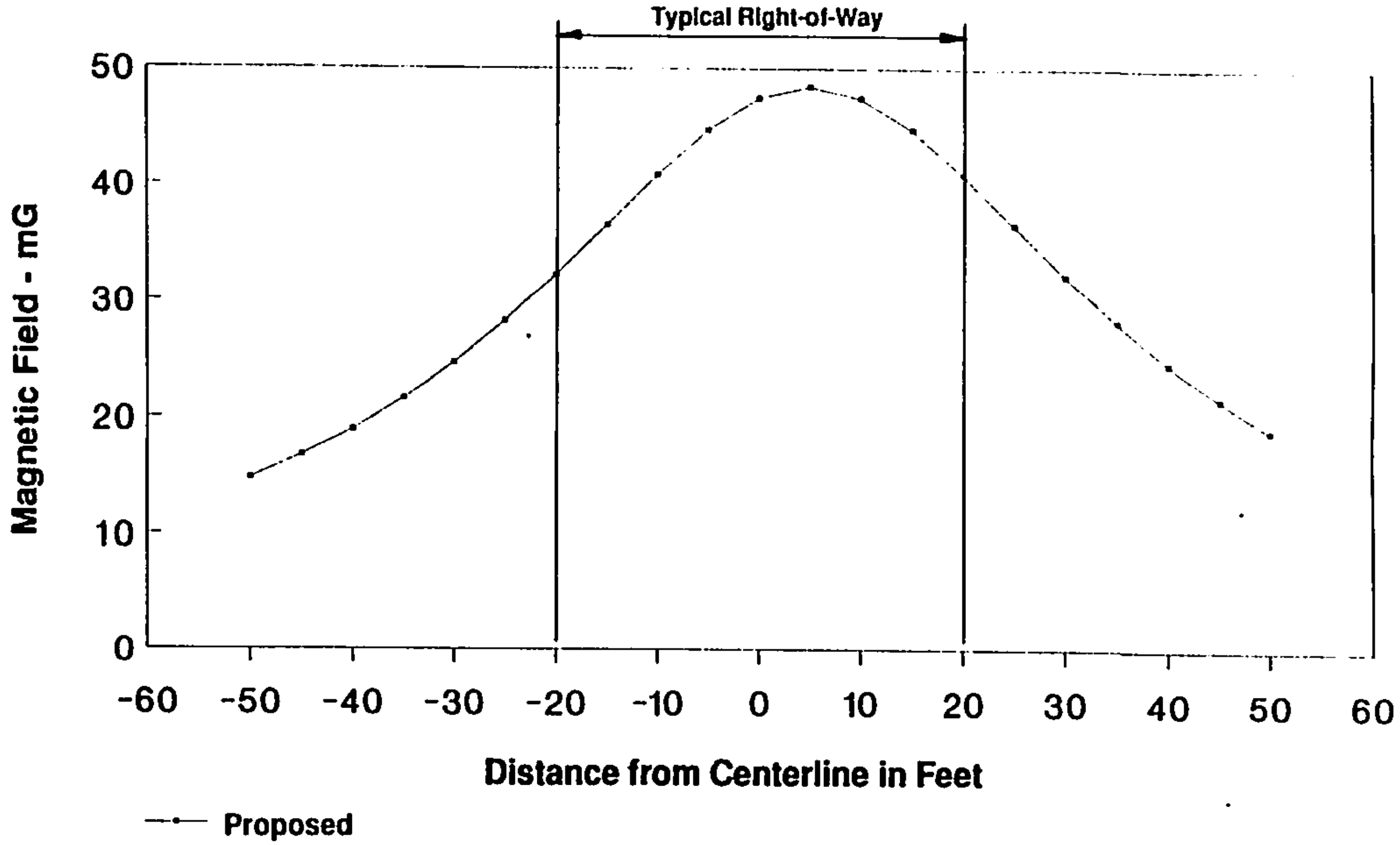
FIGURE 3.9-5

MAGNETIC FIELD LATERAL PROFILE CASE NO. 2: ALOHA STADIUM-RADFORD DR.

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL



NOTE: Proposed configuration is 138 kV

FIGURE 3.9-6

MAGNETIC FIELD LATERAL PROFILE CASE NO. 3: RADFORD DR.- MAKALAPA SUBSTATION

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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research has been provoked by concern about the effects of the large (extra high voltage--EHV) 765 kV transmission lines, some of the recent research results are of interest in assessing potential health concerns for 138 kV lines.

The most recent research consists of sixteen studies and two follow-on projects conducted during the period from 1985 through 1987. These studies, administered by the New York State Power Lines Project (1987), were undertaken "to determine whether there are health hazards associated with electric and magnetic fields produced by 60-Hz power transmission lines (especially 765 kV lines)." The $5 million research effort was funded by electric utilities that serve New York state and supervised by a Scientific Advisory Panel reporting to the New York State Health Department. In general, the field strengths used in the laboratory studies were designed to be many times stronger than fields caused by the large 765 kV lines.

The studies generally fall into the broad areas of epidemiology, laboratory animal, and cellular research. None of the studies showed significant adverse effects on reproduction, growth, or development resulting from exposure to the laboratory-created electric or magnetic fields. The studies also showed no significant evidence of genetic or chromosomal damage that might lead to inherited effects or that might cause cancer. Two of the project's epidemiological studies, however, also examined the effects of generally lower-voltage distribution lines. These two studies, of childhood cancer in Denver and adult cancer in Seattle, have generated much public interest.

The Denver Study

The Denver study (Savitz, 1987) was designed to repeat and improve upon an earlier (1979) study by Wertheimer and Leeper (also in Denver) that had shown an association between residences near distribution lines and the incidence of childhood cancer. Savitz evaluated the incidence of cancer among children living in homes near electric distribution lines. Both direct measurements and distribution "wiring codes" were used to characterize field strengths within houses. Measurements were taken with appliances turned on ("high power condition") and with appliances turned off ("low power condition"). The distribution wiring codes were used as a surrogate for the exposure over time to magnetic fields within the home caused by external power lines near the home. The wiring codes were based in general on the types, numbers, and diameters of conductors, the distance from house to powerline, and the number of nearby service drops.

The New York Scientific Advisory Panel interpreted Savitz' Denver study to imply a positive correlation between the incidence of childhood cancer, especially leukemia, and magnetic field exposure when low power condition magnetic field measurements or wire codes were used as indicators of exposure. The correlation was stronger for the wiring code indicator than for the field measurements indicator. The evidence suggested a possible increase in the incidence of childhood cancers from about 1 in 10,000 children to about 2 in 10,000. However, no correlation was found with measured high power condition magnetic fields, or with the fields that were estimated to have occurred at the residences of birth of the sample group.

The Seattle Study

The other epidemiological cancer study funded by the New York State Power Lines Project (Stevens, 1987) was conducted in the Seattle area. The design of this study shared many features with the Denver study. Exposure to magnetic fields was assessed by field measurements and by the same wire coding system; however, the Seattle study focused on a possible correlation with adult, rather than childhood, cancers. In the Seattle study, the New York Scientific Panel found that "regardless of how exposure was characterized, no relationship with leukemia incidence was disclosed" (New York Power Lines Project, 1987). In other words, this study found no association between adult cancer and magnetic field exposure.

In evaluating the research results, the New York Scientific Advisory Panel cautioned that research has not found any biological mechanisms that could explain the role of magnetic fields in the development of cancer. The panel also noted that methodological uncertainties exist in quantifying magnetic field exposure levels. The panel concluded that the findings to date could not and should not be translated into specific recommendations for regulating right-of-way widths, line heights, or the location of lines near homes.

Office of Technology Assessment Background Paper

A comprehensive background paper on the biological effects of electric and magnetic fields (Office of Technology Assessment [OTA], 1989) was recently prepared for the U.S. Congress' Office of Technology Assessment. This paper discusses the present state of knowledge about the health effects of extremely low frequency (ELF) electric and magnetic fields. A brochure (Carnegie Mellon University, 1989) was also prepared that summarizes the OTA paper and various policy options.

The OTA paper provides a good overview of the sources and nature of electric field and magnetic field exposures. It points out that we do not yet know what field attribute, or combination of attributes (if any), could produce public health effects. The assumption that "more is worse" may not be true. Because of this, field strength standards "can not be adequately supported by the science that is now available."

The OTA paper also provides a summary of the basic areas of research: cellular experiments, whole animal experiments, exposure assessment, and epidemiological studies. Using the review of the scientific literature the paper states that:

> *"As recently as a few years ago, scientists were making categorical statements that on the basis of all available evidence there are no health risks from human exposure to power-frequency fields. In our view, the emerging evidence no longer allows one to categorically assert that there are no risks. But it does not provide a basis for asserting that there is a significant risk.*
>
> *If exposure to fields does turn out to pose a health risk, it is unlikely that high voltage transmission lines will be the only sources of concern. Power-frequency fields are also produced by distribution lines, wall wiring, appliances, and lighting fixtures. These nontransmission sources are much more common than transmission lines and could play a far greater role than transmission lines in any public health problems."*

3.9.5 Electric Field and Magnetic Field Standards

General transmission line safety standards are imposed by the State of Hawaii Public Utilities Commission General Order No. 6 (Rules for Overhead Electric Line Construction) and the National Electrical Safety Code (NESC). The Waiau-Makalapa No. 2 138 kV Transmission Line will comply with these codes and standards. However, these standards are currently not written to address concerns about health effects of electric and magnetic fields.

There are no national standards in the United States for electric or magnetic field exposure. A few states have some form of electric field standard, and one state (Florida) has a magnetic field standard. These standards (summarized in Table 3.9-3) are all based on field strengths within or at the edge of transmission line rights-of-way. The widths of these rights-of-way vary greatly, according to the voltage of the lines and the regulatory requirements of each state.

Table 3.9-3
STATE REGULATIONS THAT LIMIT FIELD STRENGTHS ON TRANSMISSION LINE RIGHTS-OF-WAY (ROW)

	Field Limit
Electric Fields	
Montana	1 kV/m at edge of ROW in residential areas
Minnesota	8 kV/m maximum in ROW
New Jersey	3 kV/m at edge of ROW
New York	1.6 kV/m at edge of ROW
North Dakota	9 kV/m maximum in ROW
Oregon	9 kV/m maximum in ROW
Florida	10 kV/m maximum for 500 kV lines in ROW 2 kV/m maximum for 500 kV line at edge of ROW 8 kV/m maximum for 230 kV and smaller lines in ROW 3 kV/m maximum for 230 kV and smaller lines at edge of ROW
Magnetic Fields	
Florida	200 mG for 500 kV lines at edge of ROW 250 mG for double-circuit 500 kV lines at edge of ROW 150 mG for 230 kV and smaller lines at edge of ROW

Source: OTA (1989) and Carnegie Mellon University (1989).

Comparing the standards with the field strengths predicted for the Waiau-Makalapa No. 2 138 kV Transmission Line is problematic. The proposed line will largely be sited along existing roadways (where HECO's franchise entitles it to site utility lines). In most locations, no right-of-way easement will need to be acquired and, therefore, no edge-of-right-of-way values can be predicted to compare with the standards. As an illustration of predicted values for normal line loadings, electric field strengths 20 feet from the centerline will be 0.03 to 1.7 kV/m, and magnetic field strengths will be 7 to 41 mG.

The standards listed in Table 3.9-3 are generally acknowledged not to be health-based standards because the existing body of knowledge does not support the establishment of health-based standards. Where states have set standards, they have generally done so for equity reasons, with the intent of keeping future conditions about the same as past conditions. In this way, no radically new conditions are created until more is known about the effects of electric and magnetic fields.

The Public Utilities Commission of the State of California recently addressed the issue of electric and magnetic field standards (California PUC, 1989). In 1988, the California State Legislature passed Senate Bill 2519 that called for the California Public Utilities Commission and the State Department of Health Services to conduct a study of potential health effects related to electric and magnetic fields and to make recommendations regarding further study and regulation. The report to the California legislature concludes:

> *It is recommended that California take no action at the present to regulate electric and magnetic fields around electric power facilities. Any such actions are premature given current scientific understanding of the health issue. Too little is known presently to be able to determine where or what rules would provide useful protection.*

3.9.6 Other Transmission Line Electrical Factors

Corona

Corona is the physical manifestation of energy loss, and can transform energy into very small amounts of light, sound, radio noise, chemical reaction, and heat. Because energy loss is uneconomical, corona has been studied since the early part of this century. Consequently, it is well understood by engineers and steps to minimize it are major factors in line design. The line designer can control corona with good design practices, and it is usually not a problem for lines rated at 230 kV and lower.

The engineering design of the proposed Waiau-Makalapa No. 2 138 kV Transmission Line produces very low conductor surface gradients (because of the lower 138 kV line voltage and use of larger conductors). The corona performance of the HECO 138 kV line will be as good as, or better than other lines in this voltage classification (Institute of Electrical and Electronic Engineering [IEEE], 1972, 1971; Chartier, 1976; and EPRI, 1982). It is expected that the proposed 138 kV line will have little or no corona activity under most operating conditions.

Audible Noise

During corona activity, transmission lines (mainly 345 kV and above) generate a small amount of sound energy. This audible noise from the line can barely be heard in fair weather conditions on the higher voltage lines and usually not at all on lines at 138 kV. During foul weather, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops. Audible noise decreases rapidly with distance away from the line. Noise levels on the HECO system are low and have not been a problem. This is to be expected because audible noise is almost never reported on 138 kV transmission lines. Calculated audible noise levels in foul weather for the Makalapa No. 2 138 kV Transmission Line are about 10 to 12 dBA, lower than ambient levels in a typical soundproofed radio or television broadcast studio.

Radio and Television Interference

Overhead transmission lines do not, as a general rule, interfere with normal radio or TV reception. As described in the corona section, corona discharges can sometimes generate unwanted electrical signals. There are two potential sources of interference--corona and gap discharges. Corona may affect AM radios, while gap discharge can affect television, as well as radio reception. Corona activity is minimized because of proper line design and is, therefore, almost never a source of interference especially on lines smaller than 230 kV. The design of the 138 kV line is such that television interference levels will be extremely low (lower than on many previous 138 kV lines on the mainland where television interference has not been a problem).

Gap discharges are a very different problem. They are caused by electrical discharges between broken or poorly fitting hardware (i.e., insulators, clamps, brackets, etc.). Hardware is designed and installed to be problem-free, but gunshot damage, wind motion, corrosion damage, etc., sometimes can create a gap discharge condition. When this condition develops, intermittent gaps at connection points between hardware items allow small electrical discharges to occur between the gaps. This phenomenon is not limited to transmission lines and can often be found on distribution lines. The discharges act as small "transmitters" at frequencies that may be received on some radio and television receivers. Gap discharge sources can be located by HECO engineers and repaired.

HECO engineers design all transmission lines to be as free as possible from corona and other sources of interference. Radio/television interference complaints are recorded, evaluated, and investigated when necessary; corrective measures are taken as required.

Ozone

Ozone is another possible by-product of the higher-voltage transmission lines that has raised some concern. Ozone (O_3) can be formed from charged air molecules through the combination of three oxygen atoms. Ambient ozone levels in rural areas are typically around 10 to 30 parts per billion (ppb) at night and may peak during the day at around 100 ppb. In urban areas, concentrations greater than 100 ppb are common. Cities like Los Angeles may peak at 500 ppb. The National Ambient Air Quality Standard for Oxidants (of which ozone is usually 90 to 95 percent) is 120 ppb, not to be exceeded as a peak concentration on more than 1 day a year.

A theoretical "worst case" ozone level increase in the vicinity of a transmission line would occur in the following conditions: heavy rains, light winds blowing exactly parallel to the line, and 10 or more continuous hours of these conditions. Close to the Waiau-Makalapa 138 kV line, calculated ozone levels would be about 0.003 ppb. Concentrations below about 1.0 ppb are impossible to measure with even the most sensitive instrumentation. Nitrogen oxides can also be generated by transmission lines but on a scale much smaller than ozone and, thus, the problem is even less significant. Therefore, ozone and nitrogen oxide are not problems for 138 kV transmission lines.

Cardiac Pacemakers

One electric field concern for the 345 kV and larger lines has been the possibility of interference with cardiac pacemakers. There are two general types of pacemakers: asynchronous and synchronous. The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference since it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker pulses only when its sensing circuitry determines pacing is necessary. Interference may result from the transmission line electric field causing a spurious signal on the pacemaker's sensing circuitry. However, when these pacemakers detect a spurious signal, such as a 60-Hz signal, they are programmed to revert to an asynchronous or fixed pacing mode of operation. Cardiovascular specialists do not consider prolonged asynchronous pacing a problem. Some pacemakers are designed to operate that way. Periods of operation in this mode are commonly induced by cardiologists to check on pacemaker performance. So, while the transmission line electric field may interfere with the normal operation of some pacemakers, the result of the interference is both not harmful and of short duration.

The electric fields associated with the Waiau-Makalapa 138 kV line are far below levels that are reported as capable of affecting pacemaker operation (about 2 to 9 kV/m) and would, therefore, pose no hazards for pacemaker operation (University of Rochester, 1985, and IITRI, 1979).

3.9.7 Conclusions

Research to date has not demonstrated evidence of health hazards caused by 138 kV transmission lines similar to the line that HECO is proposing to construct for the Waiau-Makalapa No. 2 138 kV Transmission Line Project. HECO continues to review and evaluate all scientific research on the health effects of transmission lines, and will consider the results of that research in its transmission line decisions. HECO also continues to support the scientific research on the health effects of transmission lines sponsored by EPRI. HECO's goal is to provide electric power to the people of Oahu while maintaining the highest safety standards for its employees and the public.

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

Chapter 4
RELATIONSHIP TO STATE AND COUNTY LAND USE PLANS AND POLICIES

4.1 PLANS AND POLICIES

The State Land Use Law, the Hawaii State Plan, the State Functional Plan for Energy, and the City and County of Honolulu General Plan, Development Plan, and Land Use Ordinance are the principal guides to community land use plans, policies, and goals on Oahu. The following paragraphs describe how the project is compatible with these plans, policies, and goals. Figure 4.1-1 (Maps 1 and 2) illustrates land jurisdiction and regulation in the project area.

State Land Use Law (HRS Chapter 205)

Constructing a transmission line is a permitted use in all but the Conservation Land Use District. The preferred alignment does not cross any land in the Conservation Land Use District.

Hawaii State Plan (HRS Chapter 226, Revised 1987)

The Hawaii State Plan revised objective that is most directly relevant to the proposed project is Section 226-18, Objectives and Policies for Facility Systems--Energy/Telecommunications, which reads as follows:

(a) *Planning for the State's facility systems with regard to energy/telecommunications shall be directed towards the achievement of the following objectives:*

(1) *Dependable, efficient, and economical statewide energy and telecommunication systems capable of supporting the needs of the people.*

(b) *To achieve the energy/telecommunication objectives, it shall be the policy of this State to ensure the provision of adequate, reasonably priced, and dependable power and telecommunication services to accommodate demand.*

The proposed project supports these policies because the principal goal of the Waiau-Makalapa No. 2 138 kV Transmission Line is to assure the dependable, efficient, and economic provision of electricity to growing demands on Oahu.

Section 226-18(c)(4) states that:

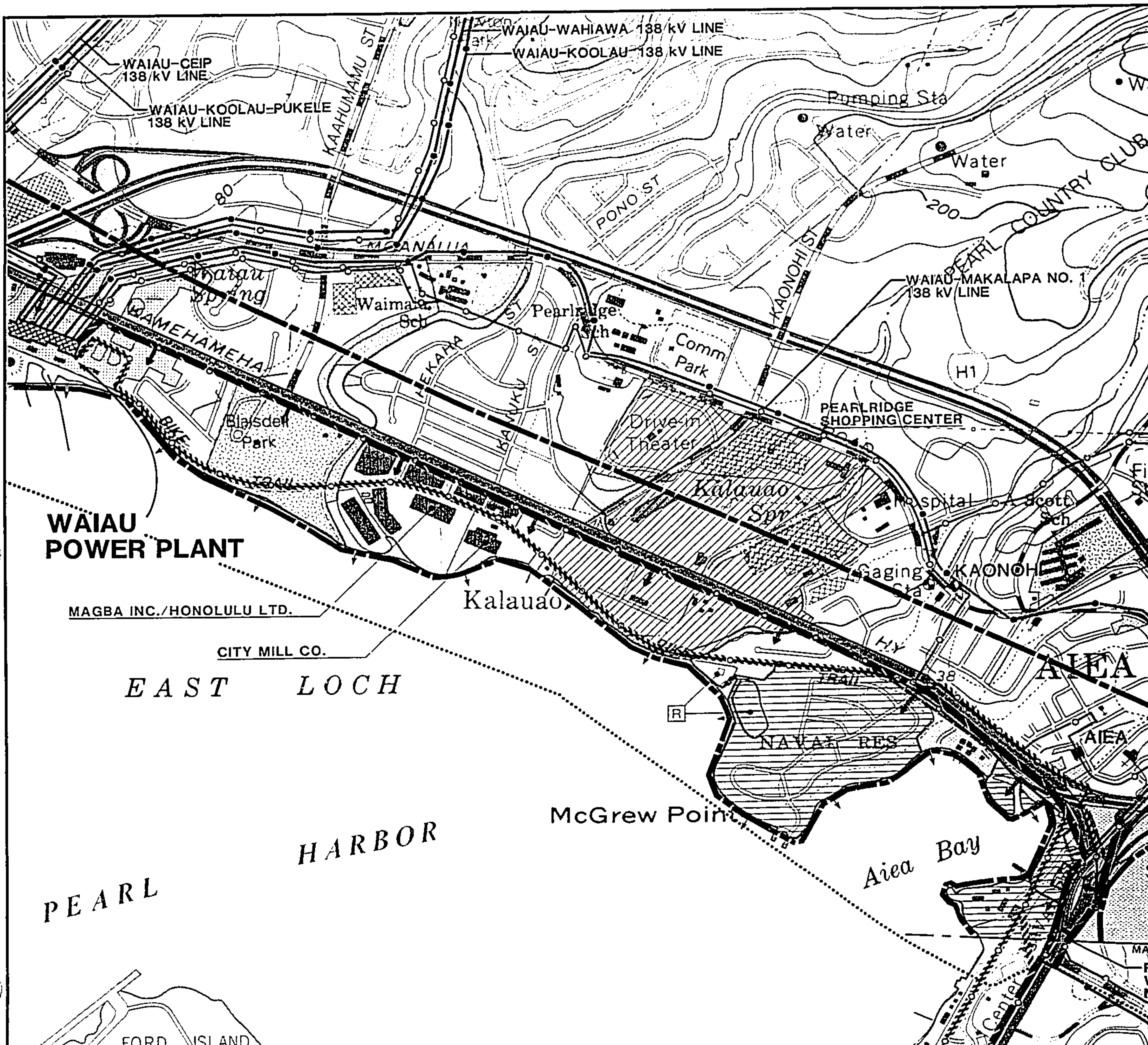
> (c) *To further the energy objectives, it shall be the policy of this State to:*
>
> (4) *Ensure that the development or expansion of power systems and sources adequately consider environmental, public health and safety concerns, and resource limitations.*

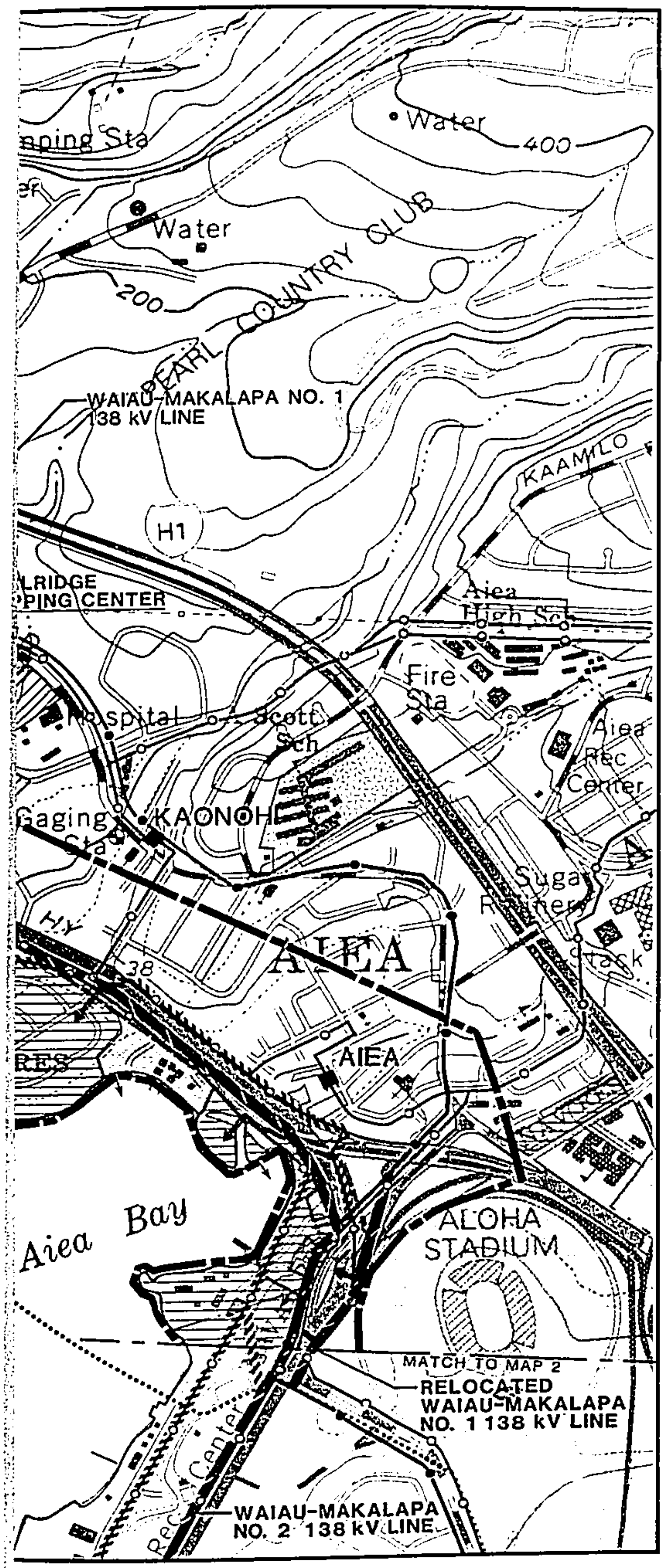
Comprehensive planning and analysis support HECO's development of the project. The Routing Report and Environmental Assessment record the environmental, public health, safety, and other resource considerations that are fundamental to the planning of the project, the evaluation of alignment alternatives, and the selection of the preferred alignment.

The Routing Report and Environmental Assessment also document that this project complies with Section 226-11(b)(2-4), <u>Objectives and Policies for the Physical Environment--Land-Based, Shoreline, and Marine Resources</u>:

> (b) *To achieve the land-based, shoreline, and marine resource objectives, it shall be the policy of this State to:*
>
> (2) *Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.*
>
> (3) *Take into account the physical attributes of areas when planning and designing activities and facilities.*
>
> (4) *Manage natural resource and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.*

The water-based activities and natural areas along the shorelines were avoided during the route selection process and existing physical attributes of the study area were considered. For example, existing rights-of-way and linear facilities were considered an opportunity for siting the new line in order to minimize impacts on existing land uses.


WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
KAAHUMANU ST
Pumping Sta
Water
Water
PONO ST
KAONOHI ST
200
PEARL COUNTRY CLUB
80
MOANALUA
Waiau Spring
Waimalu Sch
Pearlridge Sch
Comm Park
WAIAU-MAKALAPA NO. 1 138 kV LINE
H1
KAMEHAMEHA
HEKAHA ST
KAUHUKU ST
PEARLRIDGE SHOPPING CENTER
Blaisdell Park
Drive-in Theater
BIKE
TRAIL
Kalauao Spr
Hospital
A. Scott Sch
WAIAU POWER PLANT
Gaging Sta
KAONOHI
Kalauao
MAGBA INC./HONOLULU LTD.
CITY MILL CO.
HY
38
AIEA
EAST LOCH
R
NAVAL RES
AIEA
McGrew Point
HARBOR
Aiea Bay
PEARL
FORD ISLAND
10
Rec Center
WAIAU-MAKALAPA NO. 2 138 kV LINE



ALIGNMENT DATA MAP

LAND JURISDICTION AND REGULATION

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

LAND JURISDICTION

MILITARY LANDS

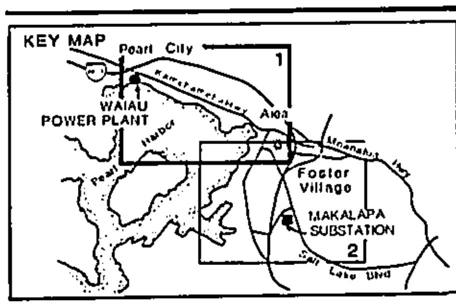
- Navy

STATE, CITY/COUNTY & PRIVATE LANDS

- State of Hawaii
- City/County of Honolulu
- Hawaiian Electric Co.
- Bishop Estate
- Other Private Parcels (≥5 Acres)
- Other Private Parcels (<5 Acres)

LAND REGULATION

- G Conservation [General (G) Subzone]
- R Conservation [Resource (R) Subzone]
- Special Management Area Boundary
- Energy Corridor
- National Historic Landmark Boundary



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

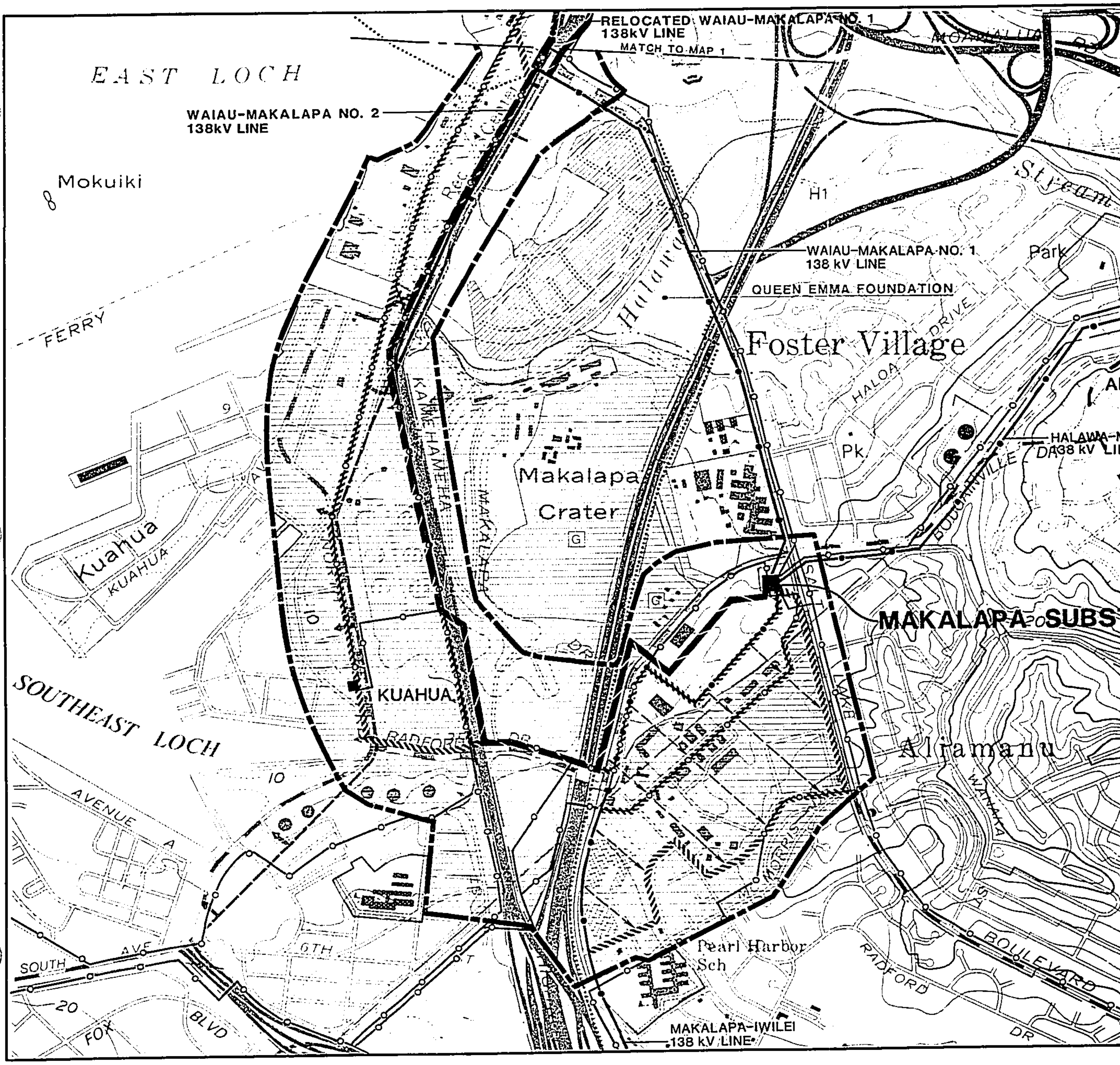
FIGURE 4.1-1

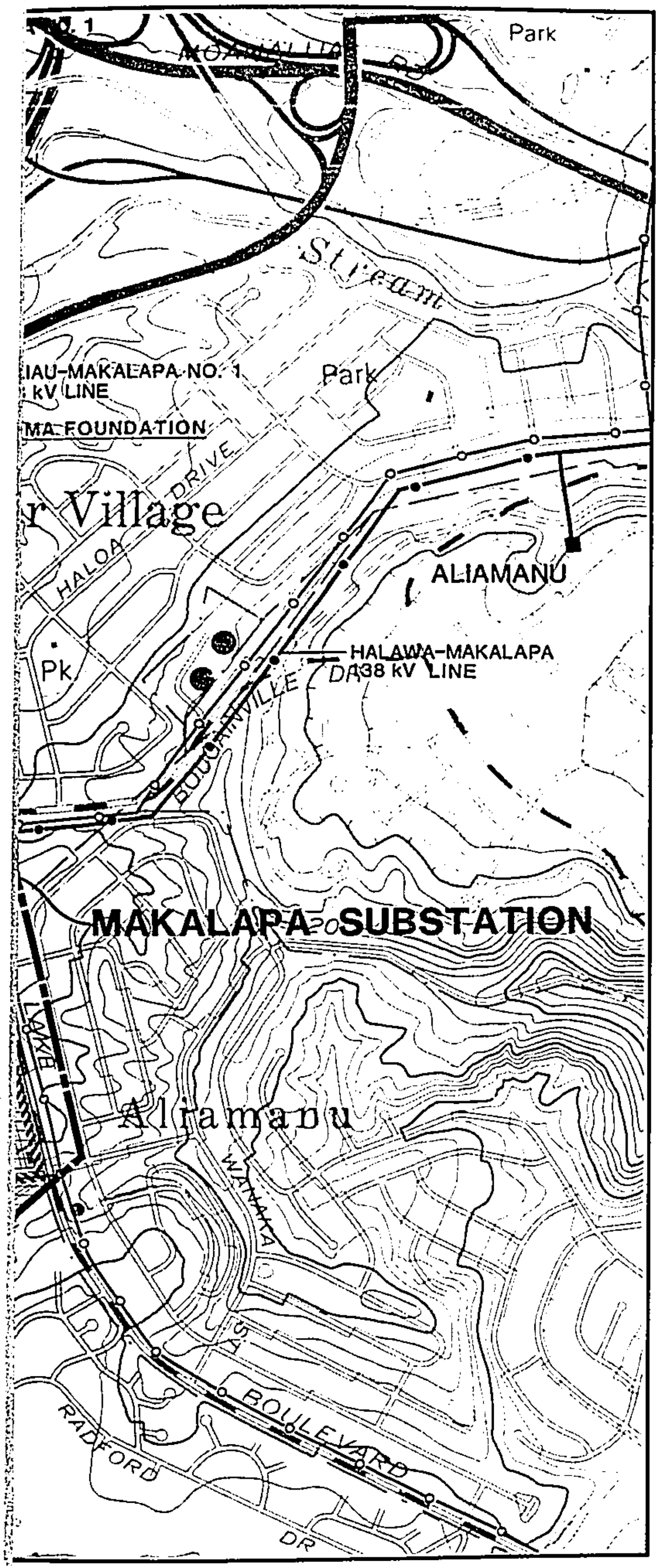
Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

10/89


RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
H1
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
QUEEN EMMA FOUNDATION
FERRY
Foster Village
HALOA DRIVE
Pk
HALAWA-
138 kV
Makalapa
Crater
Kuahua
KUAHUA
MAKALAPA SUBS
SOUTHEAST LOCH
KUAHUA
RADFORD DR
Aliamanu
AVENUE A
Pearl Harbor
Sch
SOUTH AVE
6TH
20
FOX BLVD
MAKALAPA-IWILEI
138 kV LINE
RADFORD DR
BOULEVARD



ALIGNMENT DATA MAP

LAND JURISDICTION AND REGULATION

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

LAND JURISDICTION

MILITARY LANDS

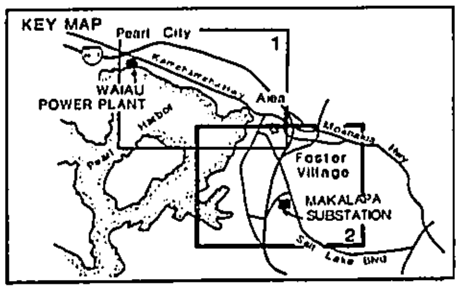
- Navy

STATE, CITY/COUNTY & PRIVATE LANDS

- State of Hawaii
- City/County of Honolulu
- Hawaiian Electric Co.
- Bishop Estate
- Other Private Parcels (≥5 Acres)
- Other Private Parcels (<5 Acres)

LAND REGULATION

- G Conservation [General (G) Subzone]
- R Conservation [Resource (R) Subzone]
- Special Management Area Boundary
- Energy Corridor
- National Historic Landmark Boundary



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 4.1-1

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

10/89

State Energy Functional Plan

The State Energy Functional Plan (State of Hawaii, Department of Planning and Economic Development, 1984) addresses objectives, policies, and implementing actions in the following areas:

- State Energy Organization and Program Management
- Alternate Energy Resource Development
- Energy Conservation
- Land Use and Support Facility Systems Planning
- Management of Petroleum-Based Energy Supply

The proposed project does not conflict with any of the objectives, policies, and implementing actions of the State Energy Functional Plan, which addresses generation and conservation rather than transmission issues.

City and County of Honolulu General Plan

The General Plan (City and County of Honolulu, Department of General Planning, 1988) objective that is most directly relevant to the proposed project is in Objective C, Policies 1 and 3, of "Transportation and Utilities":

> *Objective C:* *To maintain a high level of service for all utilities.*
>
> > *Policy 1:* *Maintain existing utility systems in order to avoid major breakdowns.*
> >
> > *Policy 3:* *Plan for the timely and orderly expansion of utility systems.*

The Waiau-Makalapa No. 2 138 kV Transmission Line is designed to increase the reliability of electric service to existing and future electrical customers, and thus supports this objective of the General Plan.

Objective D, Policy 4, of "Transportation and Utilities" is also relevant to the proposed project:

> *Objective D:* *To maintain transportation and utility systems that will help Oahu continue to be a desirable place to live and visit.*
>
> > *Policy 4:* *Evaluate the social, economic, and environmental impact of additions to the transportation and utility systems before they are constructed.*

The Routing Report and Environmental Assessment document the extensive analysis of social, economic, and environmental impacts of the project and alternative alignments that contributed to the selection of the preferred project alignment.

> <u>Policy 5</u>: *Require the installation of underground utility lines wherever feasible.*

HECO's distribution lines (12 kV) are commonly installed underground and, in some areas (such as downtown Honolulu and Waikiki), 46 kV lines are also installed underground. However, only a small section of HECO's 138 kV transmission system will be undergrounded (i.e., approximately 2 miles between the Iwilei Street and School Street Substations and the Archer Substation, now under construction). Undergrounding 138 kV lines involves extensive excavation and poses a greater risk to biological and cultural resources than an overhead line. Underground construction also would disrupt traffic for a longer period than overhead construction. After the line is operational, locating and repairing faults would be more time-consuming, with greater disruption to traffic. The costs of constructing an underground line also are substantially higher than the costs of an overhead line, with greater potential for the need to request a rate increase from PUC to cover the high construction and maintenance costs.

Chapter 2 of the Routing Report analyzes the undergrounding options in detail and concludes (for some of the reasons just cited), that installing the proposed 138 kV line underground is not feasible for this project. However, HECO does propose (subject to PUC approval) to place existing overhead 12 kV distribution lines underground along the makai side of Kam Highway between the Waiau Power Plant and McGrew Point.

The General Plan Chapter on "Natural Environment" includes several policies related to the proposed project:

> <u>Objective A</u>: *To protect and preserve the natural environment.*

All of the preferred alignment is located on developed land. The impacts of the proposed project on the natural environment will be minimal.

Objective B of "Natural Environment" addresses scenic views and natural resources:

Objective B: To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.

Policy 1: Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fish ponds, and bays; and reefs and offshore islands.

Adverse effects on natural resources will be minimal because the preferred alignment is located on land that has already been developed and the new line will generally replace existing 46 kV poles.

Policy 2: Protect Oahu's scenic views, especially those seen from highly developed and heavily traveled areas.

Policy 3: Locate roads, highway, and other public facilities and utilities in areas where they will least obstruct important views of the mountains and the sea.

The Waiau-Makalapa No. 2 138 kV Transmission Line will be located in a highly urbanized area with few scenic or important views of the mountains and the sea. The principal views toward the sea are of Pearl Harbor. However, within the study area, the shores of Pearl Harbor are largely developed and/or blocked from views along major roadways by development between the roadways and the shoreline. Section 3.6 of the Environmental Assessment, Visual Resources, describes potential visual impacts of the project.

Objective A of "Physical Development and Urban Design" addresses planning for development:

Objective A: To coordinate changes in the physical environment of Oahu to ensure that all new developments are timely, well designed, and appropriate for the areas in which they will be developed.

Policy 1: Plan for the construction of new public facilities and utilities in the various parts of the island according to the following order or priority: first, in the primary urban center; second, in Ewa; and third, in the urban fringe and rural areas.

The proposed project is located in the primary urban center and its purpose is to provide reliable electric service to the primary urban center as well as to other load centers on Oahu.

City and County of Honolulu Development Plan

The proposed project does not conflict with any elements of the City and County Development Plan Common Provisions or Special Provisions for the Primary Urban Center. According to the Department of General Planning, the only electric utility facilities that must be listed in the Public Facilities Map are power generation facilities and major substations (Eugene Connell, March 14, 1988).

City and County of Honolulu Land Use Ordinance

The proposed project does not conflict with any elements of the Land Use Ordinance (LUO) (City and County of Honolulu Department of Land Utilization, 1984). The LUO, which establishes zoning for the city and county, provides for the siting of transmission lines as a Conditional Use, Type 1, in all land use districts in which the transmission line alignment is located.

4.2 SPECIAL MANAGEMENT AREA

As part of the Hawaii Coastal Zone Management program, the City and County of Honolulu Department of Land Utilization (DLU) designates and administers the Special Management Area along the coast of Oahu. Any "development, the valuation of which exceeds $65,000 or which may have substantial adverse environmental or ecological effect" (Revised Ordinances of Honolulu, Section 33-1.3) within the designated Special Management Area requires a Special Management Area Use Permit (SMA Use Permit) issued by the DLU.

Portions of the preferred alignment for the Waiau-Makalapa No. 2 138 kV Transmission Line are located in or adjacent to the SMA (Figure 4.1-1). The Waiau Power Plant, where the new line begins, is located within the SMA and, therefore, the new line is within the SMA from the power plant to Kam Highway (a distance of approximately 200 feet).

Between the power plant and the Aiea interchange, the SMA boundary is located along the makai edge of the Kam Highway right-of-way. Because the proposed transmission line will generally be located within the Kam Highway right-of-way, it will be located outside the SMA for most of this section. The only exception may be in a few locations where avoiding existing underground utilities (while observing State Department of Transportation setback requirements) requires placing individual poles or portions of the foundation just outside the Kam Highway right-of-way. The exact placement of any poles or foundations to be located outside (makai) of the right-of-way of Kam Highway will be determined during final survey and design. Any such poles and or foundations would be within the SMA.

At the Aiea interchange, the SMA boundary crosses to the mauka side of Kam Highway, and remains on the mauka side of the highway to a point just south of Halawa Stream where Kam Highway turns more directly south. At that point, the SMA boundary angles across Navy property to join North Road, which it follows south out of the project area. The preferred transmission line alignment will be within the SMA from the Aiea interchange to the point south of Halawa Stream where the SMA boundary leaves Kam Highway.

Section 33-3.2, "Review Guidelines," lists the following guidelines to be used by the City and County of Honolulu for developments proposed in the Special Management Area:

> *(A) Adequate access, by dedication or other means, to publicly owned or used beaches, recreation areas, and natural reserves is provided to the extent consistent with sound conservation principles.*

The proposed transmission line will in no way impede access to beaches, recreation areas, or natural reserves. The line will be sited to avoid permanently affecting any rights-of-way for pedestrians or vehicles.

> *(B) Adequate and properly located public recreation areas and wildlife preserves are reserved.*

The proposed transmission line is not a consumptive use of land, and uses compatible with transmission line safety and security, including recreation, will continue within the transmission right-of-way.

> *(C) Provisions are made for solid and liquid waste treatment, disposition, and management that will minimize adverse effects upon Special Management Area resources.*

The proposed transmission line will not generate solid or liquid waste other than any excess backfill from foundation excavations, which will be trucked to a landfill.

(D) Alterations to existing land forms and vegetation, except crops, and construction shall cause minimum adverse effect to water resources and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation, or failure in the event of earthquake.

The proposed transmission line will involve minimal alterations to existing land forms and vegetation (see Sections 3.3 and 3.4). There will be minimal impact to water resources (Section 3.3), scenic and recreational amenities (Sections 3.1 and 3.6), and minimum danger of floods, erosion, or siltation (Section 3.3). The project will require little or no fill or other major earthwork (Section 3.3), so there will be no danger from landslides or failure in the event of earthquake.

(2) No development shall be approved unless the council has first found that:

(A) The development will not have substantial, adverse environmental or ecological effect except as such adverse effect is minimized to the extent practicable and clearly outweighed by public health and safety, or compelling public interest. Such adverse effect shall include, but not be limited to, the potential cumulative impact of individual developments, each one of which taken in itself might not have a substantial adverse effect, and the elimination of planning options.

The Environmental Assessment reviews all potential adverse environmental impacts and demonstrates that adverse environmental or ecological effects are minimal.

(B) The development is consistent with the objectives and policies set forth in Section 33-3.1 and area guidelines contained in Section 205A-26, Hawaii Revised Statutes.

The objectives and policies cited in Section 33-3.2, Revised Ordinances of Honolulu "shall be those contained in section 205A-2, Hawaii Revised Statues." Section 205A-2 of the Hawaii Revised Statutes sets out the objectives and policies of the Coastal Zone Management program and the Special Management Areas.

(b) Objectives.
(1) Recreational resources;

(A) Provide coastal recreational opportunities accessible to the public.

As described in Sections 3.1 and 3.2 of the Environmental Assessment, the proposed transmission line will not interfere with the use of any existing recreational areas nor will it interfere with the development of future recreational areas.

(2) Historic resources;
(A) Protect, preserve, and where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

As discussed in Section 3.5, the only known historic resource in the project area is the Pearl Harbor National Register District/National Historic Landmark. The proposed transmission line will use the alignment of an existing 46 kV electric line adjacent to the Historic District/Landmark. Although the project may require siting one or more poles or foundations just inside the boundary of the Historic District/Landmark, no structures within the Historic District/Landmark will be altered.

(3) Scenic and open space resources;
(A) Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

The proposed transmission line will not affect the use or quality of coastal scenic or open space resources. Where it is within the SMA, the project is located adjacent to major highways and other roads and will generally use the alignment of existing 46 kV electric lines.

(4) Coastal Ecosystems;
(A) Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

As documented in Section 3.4 of the Environmental Assessment, a biological survey of the project area revealed few areas of natural plant or animal communities within or adjacent to the preferred alignment. There is no habitat for rare, threatened, or endangered species and no sensitive plant communities have been identified.

(5) Economic uses;
(A) Provide public or private facilities and improvements important to the State's economy in suitable locations.

As documented in Chapter 1 of the Environmental Assessment, the proposed transmission line is essential for transmission system reliability and to serve local and islandwide load. The Routing Report documents how engineering, environmental, and other considerations led to the selection of the preferred transmission line alignment as a suitable location for the project.

(6) Coastal hazards;
(A) Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion and subsidence.

The proposed project is not located in any area subject to tsunami, storm waves, stream flooding, or erosion. Foundation designs will be tailored to the soil conditions at each pole location to maximize foundation stability.

(7) Managing Development;
(A) Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

The routing study process for this project made extensive use of public participation, including public workshops and presentations to neighborhood boards (as documented in Chapter 8 of the Routing Report).

(c) Policies
(1) Recreational resources;
(A) Improve coordination and funding of coastal recreation planning and management
(B) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:
(i) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
(ii) Requiring replacement of coastal resources having significant recreational value, including but not limited to surfing sites and

sandy beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;

(iii) *Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*

(iv) *Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*

(v) *Encouraging expanded public recreational use of county, State and federally owned or controlled shoreline lands and waters having recreational value;*

(vi) *Adopting water quality standards and regulating point and nonpoint sources of pollution to protect and where feasible restore the recreational value of coastal waters;*

(vii) *Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, artificial reefs for surfing and fishing; and*

(viii) *Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, county planning commissions; and crediting such dedication against the requirements of section 46-6.*

The proposed transmission line will not affect the use of any existing coastal recreational resources nor will it interfere with the development of new coastal recreational resources. The only existing or proposed recreation areas adjacent to the proposed transmission line where it is located within the SMA are the proposed Aiea Bay State Recreation Area and the Navy Richardson Recreation Center. Where the preferred alignment is located adjacent to the Richardson Recreation Center and the proposed Aiea Bay State Recreation Area, poles for the new transmission line will be placed within the right-of-way of Kam Highway, and access to or use of the recreation areas will not be affected. As described in Section 3.3 of the Environmental Assessment, there will be no significant effects on coastal water quality.

(2) *Historic resources;*
- (A) *Identify and analyze significant archaeological resources;*
- (B) *Maximize information retention through preservation of remains and artifacts or salvage operations; and*
- (C) *Support state goals for protection, restoration, interpretation, and display of historic resources.*

As noted in Section 3.5 of the Environmental Assessment, a cultural resources survey was conducted during the regional study stage of the routing study. The only site on the national or state register of historic sites within the project area is the Pearl Harbor National Register District/ National Historic Landmark. The proposed transmission line will use the alignment of an existing 46 kV electric line adjacent to the Historic District/Landmark. Although the project may require siting one or more poles or foundations just inside the boundary of the Historic District/Landmark, no structures within the Historic District/Landmark will be altered. Although most of the proposed transmission line alignment is on land that has already been extensively disturbed, if any evidence of cultural resources is discovered during excavation for pole foundations, work will be interrupted until the extent and significance of the resource have been evaluated by an archaeologist.

(3) *Scenic and open space resources*
- (A) *Identify valued scenic resources in the coastal zone management area;*
- (B) *Insure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;*
- (C) *Preserve, maintain, and where desirable, improve and restore shoreline open space and scenic resources; and*
- (D) *Encourage those developments which are not coastal dependent to locate in inland areas.*

The visual impacts of the new transmission line are described and simulated in Section 3.6 of the Environmental Assessment. The new line will generally use the alignment of existing 46 kV electric lines and it will be located in a developed urban area. Views of the shoreline in the project area from Kam Highway are few. The Coastal View Study identifies a single significant roadway view within the sections of the preferred alignment that are located within the SMA: the view from Kam Highway at Richardson Recreation Center. Views of Pearl Harbor from Kam Highway should not be affected by the proposed transmission line because transmission poles are widely spaced (300 to 600 feet), and conductors will be high enough above the ground (generally 50 feet or more) so that views to the coast will not be impaired.

The proposed transmission line will not remove or affect in any other way shoreline open space.

(4) Coastal Ecosystems;

- *(A) Improve the technical basis for natural resource management;*
- *(B) Preserve valuable coastal ecosystems of significant biological or economic importance*
- *(C) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and*
- *(D) Promote water quantity and quality planning and management practices which reflect the tolerance of fresh water and marine ecosystems and prohibit land and water uses which violate state water quality standards.*

A biological resource survey of the project area (Appendix D) identified no significant biological communities within the preferred transmission line alignment. As discussed in Section 3.3 of the Environmental Assessment, no stream channels will be altered and there will be no other impacts on coastal water ecosystems or water quality.

(5) Economic uses;

- *(A) Concentrate in appropriate areas the location of coastal dependent development necessary to the State's economy;*
- *(B) Insure that coastal dependent development such as harbors and ports, visitor industry facilities, and energy generating facilities are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and*

(C) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
(i) Utilization of presently designated locations is not feasible;
(ii) Adverse environmental effects are minimized; and
(iii) Important to the State's economy.

The Waiau-Makalapa No. 2 138 kV Transmission Line Routing Report documents the consideration of social, visual, and environmental impacts that guided the evaluation of alternative alignments and the selection of the preferred alignment. The proposed 138 kV transmission line will largely use the alignment of existing 46 kV electric lines.

(6) Coastal hazards;
(A) Develop and communicate adequate information on storm wave, tsunami, flood, erosion, and subsidence hazard;
(B) Control development in areas subject to storm wave, tsunami, flood, erosion, and subsidence hazard;
(C) Ensure that developments comply with requirements of the Federal Flood Insurance Program;
(D) Prevent coastal flooding from inland projects.

The preferred alignment is not located in any areas subject to storm wave, tsunami, flood, or erosion. Foundation designs will be tailored to the soil conditions at each pole location to maximize foundation stability. No poles will be located in flood-prone areas and, therefore, the project will conform with the requirements of the Federal Flood Insurance Program. The project will not cause or contribute to coastal flooding.

(7) Managing development;
(A) Effectively utilize and implement existing law to the maximum extent possible in managing present and future coastal zone development;
(B) Facilitate timely processing of application for development permits and resolve overlapping or conflicting permit requirements; and

(C) Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life-cycle and in terms understandable to the general public to facilitate public participation in the planning and review process.

The routing study process for this project made extensive use of public participation, including public workshops and presentations to neighborhood boards (as documented in Chapter 8 of the Routing Report).

After incorporating by reference the objectives and policies contained in HRS Section 205A-2, Section 33-3.2 of the Revised Ordinances of Honolulu continues with the following guidelines:

(C) The development is consistent with the County General Plan, development plans, zoning and subdivision codes, and other applicable ordinances.

Section 4.1 addresses consistency with plans, policies, codes, and other applicable ordinances, and demonstrates that the proposed project is consistent with them.

(3) The council shall seek to minimize, where reasonable:

(A) Dredging, filling, or otherwise altering any bay, estuary, salt marsh, river mouth, slough, or lagoon.

The proposed project will not involve dredging, filling, nor will it otherwise affect any bay, estuary, salt marsh, river mouth, slough, or lagoon (see Section 3.3).

(B) Any development that would reduce the size of any beach or other area usable for public recreation.

The proposed project will not reduce the size of any beach or other area usable for public recreation (see Section 3.1).

(C) Any development that would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the Special Management

Area and the mean high tide line where there is no beach.

The proposed project will not reduce or impose restrictions upon any of the lands cited in this paragraph of the SMA guidelines.

(D) *Any development that would substantially interfere with or detract from the line of sight toward the sea from the state highway nearest the coast.*

As discussed in Section 3.6, the preferred alignment will introduce structures between the state highway nearest the shoreline (Kam Highway) and Pearl Harbor. However, the new line will generally use the alignment of existing 46 kV electric lines, and the new line will not substantially detract from the shoreward views from the highway.

(E) *Any development that would adversely affect water quality, existing areas of open water free of visible structures, existing and potential fisheries and fishing grounds, wildlife habitats, or potential or existing agricultural uses of land.*

The proposed project will not affect water quality (Section 3.3), areas of open water free of visible structures (Section 3.6), fisheries and fishing grounds (Section 3.4), wildlife habitats (Section 3.4), or agricultural land (Section 3.1).

Chapter 5
Permits Required

Chapter 5
PERMITS REQUIRED

This chapter discusses the federal, state, and county discretionary permits or authorizations that may be required because of the location or design of the Waiau-Makalapa No. 2 138 kV Transmission Line Project (Table 5.1-1). It also identifies permits and approvals that are not required because the preferred alignment avoids areas where constructing the line would trigger the requirement. Routine construction permits are not discussed here.

5.1 FEDERAL PERMITS AND APPROVALS

The new line will use the alignment of existing transmission lines crossing Aiea and Halawa Streams and the poles of the new line will replace the poles of existing lines. Construction will not alter any existing stream channels and will not affect the navigable waters of the United States. Consultation with a representative of the U.S. Army Corps of Engineers permit branch indicates that Sections 10/404 are not applicable. A formal written confirmation will be provided by the Corps after a review of conceptual plans for the stream crossing points (personal communication, W. Kanai, U.S. Army Corps of Engineers, September 29, 1989).

Consultation with a representative of the Airports Division, Department of Transportation, indicates that the routing will not require approval under Federal Aviation Administration (FAA) Advisory Circular 70/7460-1G, Chapters 4, 5, and 9. The circular governs objects penetrating the air interference zone within navigable airspace and objects interfering with air navigation facilities (personal communication, H. Sumida, Department of Transportation, Highways Division, March 1988).

5.2 STATE PERMITS AND APPROVALS

The Waiau-Makalapa No. 2 138 kV Transmission Line will be developed within areas designated by the state as part of the Urban District. The project will not require any changes to the state's Land Use Boundaries.

Segments of the project (adjacent to Kam Highway, Radford Drive, and Bougainville Drive) will require placement of transmission lines and poles within state-owned rights-of-way along state highways and will require a Permit to Perform Work Within a State Highway. The permit is an administrative authorization issued by the State Department

Table 5.1-1
WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE PROJECT
REQUIRED PERMITS

Agency	Permit/Authorization	Authority	Description	Applicability to Project
State				
Department of Health	Noise Variance	HRS 342, Title 11 Administrative Rules, Chapter 43	Required for any activity generating noise exceeding permitted levels or at other than permitted times	Applicable
Department of Transportation, Highways Division	Permit to Perform Work on a State Highway	HRS 264 and applicable administrative rules	Required for any work within the state highway rights-of-way	Applicable (requires preparation of an EA)
State Public Utility Commission (PUC)	a. Authorization to Construct	a. HRS 269 and PUC General Order No. 7	a. Required approval for construction of projects in excess of $0.5 million	Applicable (follows all other federal, state, and county permits)
	b. Approval for Construction in a Residential Area	b. HRS 269 and applicable administrative rules	b. Required approval for any utility greater than 46 kV in a residential area	
	c. Exemption from General Order No. 6 requirements relating to conflicting lines	c. HRS 269 and PUC General Order No. 6	c. Required approval where electric lines are closer than specified distances	
City and County				
Department of Land Utilization (DLU) and County Council	Special Management Area permit	HRS 205-A, Ordinance No. 84-4, as amended	Establishes guidelines, objectives, and conditions for development within the Special Management Area	Applicable (SMA application made to DLU, which makes its recommendation to the County Council for further action)
Department of Land Utilization	Conditional Use Permit, Type I	HRS 46, Ordinance No. 86-96, as amended	Required of Type B utility installations (including the construction of 138 kV transmission lines) within state agricultural and urban districts	Applicable (action by the director of DLU follows action on the Special Management Area permit)
Department of Public Works	Permit for Construction Within a County Road Right-of-Way	Article 1, Chapter 20, as amended, City and County of Honolulu Revised Ordinances	Required for any work within the county road right-of-way	Applicable (review of construction plans)
Department of Transportation Services	Street Usage Permit	HRS 286, Ordinance No. 4650 (76)	Required for any work within the county road right-of-way	Applicable (review of construction plans)

of Transportation, Highways Division. Published notice and a public hearing are not required. Consultation with a representative of the Highways Division indicates that compliance with Hawaii Revised Statute 343 will be required and that an environmental assessment will be a prerequisite to action on the permit. The Highways Division will review the environmental assessment in order to determine whether there are significant impacts caused by the project and will make a determination that will be either a negative declaration or a determination that an environmental impact statement should be prepared. The review of the environmental assessment may precede the submittal of the application for a permit (personal communication, Morris Arakaki, Department of Transportation, September 19, 1989).

A single transmission pole will be located within the retaining wall of the state-owned Aloha Stadium and will require approval of the Board of Land and Natural Resources. The Stadium Authority has recommended approval of the pole location. The recommendation will be sent to the Department of Land and Natural Resources for environmental and substantive review, and then to the Board. Because of the minor nature of the action, the Department of Land and Natural Resources is expected to categorize the easement request as exempt from further environmental analysis and to recommend that the Board grant the easement (personal communication, Dean Uchida, Department of Land and Natural Resources, September 15, 1989).

Along Kam Highway, the preferred alignment parallels the boundary of the Pearl Harbor Historic District, which is on both the state and federal registries of historic places. The State Department of Land and Natural Resources Historic Preservation Program is responsible for the review of construction in the vicinity of a site designated on either the state or federal registries. The state's review requires notice of intention to work on a site 90 days in advance and submittal of plans depicting the nature of the proposed construction and the location with respect to any sites on the state or federal registries. Construction plans will be submitted to the Department for review and comment.

Because portions of the route crossing Aiea and Halawa Streams along existing transmission line corridors will use the alignment of existing lines, and because the new line is not expected to alter any existing stream channels, the project is not expected to require a Stream Channel Alteration Permit. The routing crosses the State Energy Corridor; however, no construction within the Energy Corridor is required. Nonetheless, the Department of Transportation, Harbors Division, which has jurisdiction of the Energy Corridor, should review the project before construction begins. No portion of the project is proposed in the state's Conservation District; therefore, a Conservation District Use Application will not be required. It is anticipated that the state's Coastal Zone Management Consistency Review will not be necessary because federal approvals are not required.

The Department of Health Administrative Rules specify (Chapter 43, Community Noise Control for Oahu) that daytime noise levels must not exceed 55 dBA in areas zoned Residential and 60 dBA in areas zoned Apartment. Because noise in excess of 60 dBA may be generated during construction in areas along the preferred alignment that are zoned Apartment or Residential, a noise variance will be required. The noise variance is issued by the state Department of Health within 30 days of application.

State Public Utility Commission (PUC) authorization under PUC General Order 7 is required for the project because the construction cost exceeds $500,000. HECO will need PUC approval for underground placement of 12 kV distribution lines and service connections along portions of Kam Highway because such placement is counter to HECO tariff conditions, which conform to PUC General Order No. 7. PUC approval is also required for construction of a utility line greater than 46 kV within a residential area. HECO will also request an exemption from PUC General Order No. 6 requirements relating to conflicting lines because the location of several poles in the Bougainville Drive/Lawehana Street area will not meet PUC separation criteria. PUC's consideration of the project will follow all other federal, state, and county approvals affecting the design and location of the project.

5.3 COUNTY PERMITS AND APPROVALS

The preferred route for the Waiau-Makalapa No. 2 138 kV Transmission Line has the appropriate county land use designations and will not require any amendments to the county's General Plan, Development Plan, or zoning designations for the corridor.

A county Special Management Area Permit will be required for the portions of the Waiau-Makalapa No. 2 138 kV Transmission Line that are within the SMA established under the Coastal Zone Management Program (see Chapter 4). The permit application is submitted to and reviewed and processed by the Department of Land Utilization. The Department will forward its recommendation to the City Council, which is the approving authority.

A county Conditional Use Permit Type I is required for 138 kV lines, substations, power generation, and base yards in either the urban or agricultural districts. Type I permit applications do not require a public hearing. Action on the county SMA must precede the action on the Conditional Use Permit.

Segments of the project will require the placement of transmission line poles within county-owned rights-of-way along county roadways and will require a Street Usage Permit and a Permit to Construct Within a County Road Right-of-Way. The Street Usage Permit is an administrative authorization issued by the county's Department of Transportation Services after review of construction plans and proposed traffic control measures. The Permit to Construct Within a County Road Right-of-Way (also known as a trenching or excavation permit) is an administrative authorization issued by the County Department of Works after review of construction plans by the Department, the Board of Water Supply, the Department of Transportation Services, and utilities. Consultation with a representative of the Department indicates that its review may be conducted concurrently with the Department of Land Utilization's processing of the Conditional Use Permit, with the action on the Public Works permit following action on the Conditional Use Permit.

A county Shoreline Setback Variance will not be required because no portion of the project is located within the area 40 feet mauka of the shoreline.

Chapter 6
Determination

Chapter 6
DETERMINATION

The proposed action will not lead to any significant changes in the use of the project area.

During project construction, traffic will be disrupted in some locations and there will be increased noise from construction activities. These impacts will be short term--they will last no longer than the construction phase.

The long-term impacts will be minor. Along most of the preferred alignment, the new line will replace existing 46 kV overhead electric lines. Visual impacts along Kam Highway will be mitigated by placing existing overhead 12 kV distribution lines between Waiau Power Plant and McGrew Point underground (subjct to PUC approval). Although there is no conclusive evidence of significant health risks from electromagnetic fields of 138 kV transmission lines, public concern about electric and magnetic fields is being addressed by using low-reactance phasing, where feasible, to reduce the electric and magnetic field strengths.

The long-term benefits of the project will be substantial. The new transmission line will assure the reliability of Oahu's transmission grid and reduce the likelihood of future outages. It will also provide transmission capacity to serve the growing electrical loads in the Aiea/Foster Village/Pearl Harbor areas as well as throughout the island.

Routing Report

WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE PROJECT

ROUTING REPORT

Prepared for
HAWAIIAN ELECTRIC COMPANY, INC.

Prepared by
CH2M HILL

May 1990

WAIAU-MAKALAPA NO. 2
138 kV TRANSMISSION LINE PROJECT

ROUTING REPORT CONTENTS

CONTENTS
(continued)

CONTENTS
(continued)

Chapter 1
System Requirements

Chapter 1
SYSTEM REQUIREMENTS

1.1 PROJECT PURPOSE AND NEED

The Waiau-Makalapa No. 2 138 kV Transmission Line is needed for two reasons:

1. To assure the reliable delivery of power by preventing the overload of the existing Waiau-Makalapa No. 1 line during an emergency condition. An additional path for power flow is required to provide adequate transmission line capacity during outages caused by lightning, fires, vehicular accidents, or high winds, and during periods when other lines are out of service for routine maintenance.

2. To provide additional transmission capacity to meet growing demands for power in the Pearl Harbor, Foster Village, and Aiea areas, as well as throughout the island.

The reasons for the project--system reliability and load growth--are discussed in more detail in the following sections.

1.2 EXISTING POWER GENERATION AND TRANSMISSION SYSTEM

The Hawaiian Electric Company, Inc. (HECO) provides nearly all the electricity for a population of 817,000 on the island of Oahu. It maintains service to approximately 250,000 metered accounts through its generation, transmission, and distribution systems. The system peak load to date (which occurred in November 1989) was 1,090 megawatts (MW).

1.2.1 Generation Resources

HECO serves nearly all of Oahu's electricity requirements with oil-fired units at Kahe (649 MW capacity), Waiau (501 MW), and Honolulu (116 MW)--a total capacity of 1,266 MW. Nonfirm power (i.e., power provided on an as-available basis) is purchased from Oahu Sugar Company. Hawaiian Independent Refinery Incorporated, Waialua Sugar Company, and the Hawaiian Electric Renewable Systems (HERS) windfarm located in Kahuku. Figure 1.2-1 illustrates the locations of the three HECO power plants and the interconnecting 138 kilovolt (kV) transmission system. Table 1.2-1 shows the ratings of HECO's generating units.

Table 1.2-1
HECO GENERATING UNIT RATINGS

Power Plant/Generating Units		Normal Capacity (MW)
Honolulu Power Plant		
Unit No. 8		58
Unit No. 9		58
	Subtotal	116
Waiau Power Plant		
Unit No. 3		50
Unit No. 4		50
Unit No. 5		58
Unit No. 6		57
Unit No. 7		92
Unit No. 8		92
Unit No. 9		52
Unit No. 10		50
	Subtotal	501
Kahe Power Plant		
Unit No. 1		88
Unit No. 2		84
Unit No. 3		92
Unit No. 4		93
Unit No. 5		146
Unit No. 6		146
	Subtotal	649
Total firm generating capacity		1,266

Source: HECO Engineering Department, 1989.

NOTE:
KP: Kalaeloa Partners, Limited Partnership
AES-BP: Applied Energy Services-Barbers Point
HERS: Hawaiian Electric Renewable Systems
H-POWER: Honolulu Resource Recovery Venture

FIGURE 1.2-1

GENERATION AND 138kV TRANSMISSION SYSTEM

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

1.2.2 Transmission and Distribution

As HECO's power is generated, transformers step up the voltage to 138 kV. Power then flows through the main (138 kV) transmission grid. The higher voltage allows efficient transmission of large amounts of power to all major load centers. Transmission substations at these major load centers have transformers that step down the 138 kV voltage to HECO's 46 kV subtransmission voltage. Local area substations further reduce the voltage from 46 kV to HECO's 12 kV local distribution voltage. Figure 1.2-1 illustrates the locations of the nine existing 138 kV substations. Substations are also located at the Waiau Power Plant and the Kahe Power Plant.

The 138 kV transmission grid consists of 170 circuit miles of overhead lines. The overhead system is designed to withstand most environmental hazards and remain continuously in service. A sophisticated system of circuit breakers can remove faulted lines from service while power continues to flow through alternate routes.

HECO does not currently operate any 138 kV underground lines. However, a 2-mile line from the Iwilei Street and School Street Substations to the Archer Substation is proposed as an underground 138 kV line. It will be installed underground because the route crosses two special design districts--the Hawaii Capital District and the Punchbowl Expanded Historical, Cultural, and Scenic District--within which all powerlines must be installed underground.

The 46 kV subtransmission system, with 665 circuit miles and 113 substations, is the middle link in the power delivery system. The 46 kV network also uses circuit breakers and includes multiple lines to each 46 kV substation to maintain reliability at the distribution level.

HECO's distribution system contains nearly 3,000 circuit miles of 12 kV and 4 kV lines and feeders. This extensive network delivers power at utilization voltage to more than 250,000 customer meters. Distribution feeders typically fan out from the 46/12 kV distribution substations along streets and alleys, either overhead or, where necessary, underground. Individual customers are connected to the distribution network through small step-down distribution transformers sized for the particular load and voltage required by the customer.

1.2.3 Reliability

Recent Systemwide Outages

HECO has historically provided a high level of electric service reliability and, until 1983, the island had not experienced a complete electrical blackout for 40 years. An incident on July 13 of that year precipitated a comprehensive investigation that resulted in a diagnostic review of HECO's system reliability prepared by the consulting firm of Stone and Webster (1984). The series of events that caused the blackout illustrate why HECO uses contingency analysis for transmission system planning.

In 1982, Hurricane Iwa caused considerable damage to HECO's system, including damage to two of the four 138 kV circuits in the common transmission corridor between Kahe and Waiau. On July 13, 1983, one of these plus another major 138 kV line were out of service for repairs. On that date, a cane-field fire was burning adjacent to the Kahe-CIP 138 kV transmission line. The resultant smoke and hot gases caused a persistent arcing fault (short circuit), which eventually caused circuit breakers to remove the line from the grid. With two 138 kV lines already out of service for repair, the short circuit on the Kahe-CIP line caused severe system instability, leading to automatic shutdown of the generation units and an islandwide blackout.

More recently, on September 10, 1988, approximately two-thirds of Oahu experienced a blackout. The circumstances surrounding this outage were similar to those of the 1983 outage. While two 138 kV circuits (one from Kahe) were out of service so that two wooden structures could safely be replaced with stronger steel structures, a conductor failure on the CIP-Kahe-Waiau 138 kV circuit caused it to trip out. The Kahe-Halawa No. 1 138 kV circuit then became overloaded, and this left only one of the four circuits leading from the Kahe Power Plant in service. This overload led to an automatic shutdown of most of the island's generating units and caused a blackout that lasted for up to 7 hours in some locations.

These incidents emphasize the need for the new transmission line.

Recommended Improvements

As a result of the July 13, 1983, islandwide blackout, the governor of Hawaii and the mayor of the City and County of Honolulu petitioned the Public Utilities Commission to order HECO to perform a comprehensive investigation of the blackout and to make recommendations to prevent a recurrence. The resultant report (Stone and Webster, 1984) recommended more than 90 actions to improve overall system reliability.

HECO has already implemented most of the recommended actions. For example, the recommended Makalapa-Iwilei 138 kV line was completed in 1985 at a cost of $9 million. Another major system addition planned by HECO is the Waiau-CIP 138 kV transmission line (to be completed by 1993).

Since the 1983 blackout, HECO's System Planning Department has conducted studies to assure the reliability of Oahu's transmission system while meeting increasing system demand. These studies predicted that as system loads approach 1,200 MW, the Waiau-Makalapa No. 1 138 kV Transmission Line would overload during emergency conditions. The proposed Waiau-Makalapa No. 2 138 kV Transmission Line will prevent such an overload. The proposed line reflects HECO's adoption of revised contingency-planning criteria for its transmission system planning.

The Waiau-Makalapa No. 2 138 kV Transmission Line will respond to another Stone and Webster recommendation to improve reliability. The study recommended the addition of new 138 kV lines in a second, separate power corridor between the Kahe-CIP area and the major load center in the downtown area. The Waiau-Makalapa No. 2 138 kV transmission line will form part of a key link between generation and loads.

The proposed Waiau-Makalapa No. 2 138 kV Transmission Line is one of HECO's comprehensive measures to improve system reliability. Other measures include:

- Training transmission line crews in "live line" maintenance, in which the 138 kV line remains energized while insulators are changed and other maintenance is performed
- Revising load-shedding procedures; that is, procedures to reduce demand in the case of an emergency to lessen the risk of outages

CORRECTION

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

Recommended Improvements

As a result of the July 13, 1983, islandwide blackout, the governor of Hawaii and the mayor of the City and County of Honolulu petitioned the Public Utilities Commission to order HECO to perform a comprehensive investigation of the blackout and to make recommendations to prevent a recurrence. The resultant report (Stone and Webster, 1984) recommended more than 90 actions to improve overall system reliability.

HECO has already implemented most of the recommended actions. For example, the recommended Makalapa-Iwilei 138 kV line was completed in 1985 at a cost of $9 million. Another major system addition planned by HECO is the Waiau-CIP 138 kV transmission line (to be completed by 1993).

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- Training transmission line crews in "live line" maintenance, in which the 138 kV line remains energized while insulators are changed and other maintenance is performed

- Revising load-shedding procedures; that is, procedures to reduce demand in the case of an emergency to lessen the risk of outages

- Replacing existing wood structures in certain areas with steel structures that better withstand high wind speeds

1.3 FUTURE LOADS

Load growth is expected to be significant and steady over the next two decades throughout the island of Oahu. During the last 3 years (1985 to 1988), load growth has been particularly rapid, increasing by 137 MW from the 1985 peak. For the first time in its history, HECO's system peak load exceeded 1,000 MW (Figure 1.3-1) in 1987. The peak of 1,030 MW in that year was an increase of 4.5 percent over the 1986 peak. In 1988, the peak of 1,068 was 3.7 percent higher. A forecast of future loads is updated semiannually by HECO's Forecast Planning Committee. Factors considered in the load forecasts include historical data on loads and population growth, projected future development, increases in population, and new industries. Load forecasts are typically prepared for 5- and 20-year periods.

Figure 1.3-1 shows the actual peak electrical loads for the period 1978 through 1988, and the projected loads for the next 5 years, 1989 to 1993. The figure shows that, between 1978 and 1985, peak system loads were relatively constant, averaging 935 MW. Since 1985, the HECO system has experienced an average annual increase of 4.2 percent in peak system loads from 1985 through 1988. During the next 5 years (1989 to 1993), loads are expected to increase more slowly (at an average of about 2.3 percent per year). For the remainder of the 20-year period (1993 to 2008), load growth is expected to be slightly slower, at an average of 2.0 percent per year. Peak loads during the 1993 to 2008 period are expected to increase from 1,222 MW to 1,652 MW (HECO, May 1989).

The reasons for recent rapid load growth include the general recovery and expansion of Oahu's economy over the 1986 to 1988 period, lower electricity prices, a decline in the amount of energy conservation equipment installed (caused in part by the expiration of federal tax credits in 1985), and real growth in energy consumption.

1.4 FUTURE SYSTEM REQUIREMENTS

1.4.1 Power Generation

New generation resources will be required in 1989 because of the growth in demand for electricity. In September 1987, HECO withdrew its application with the Hawaii Public

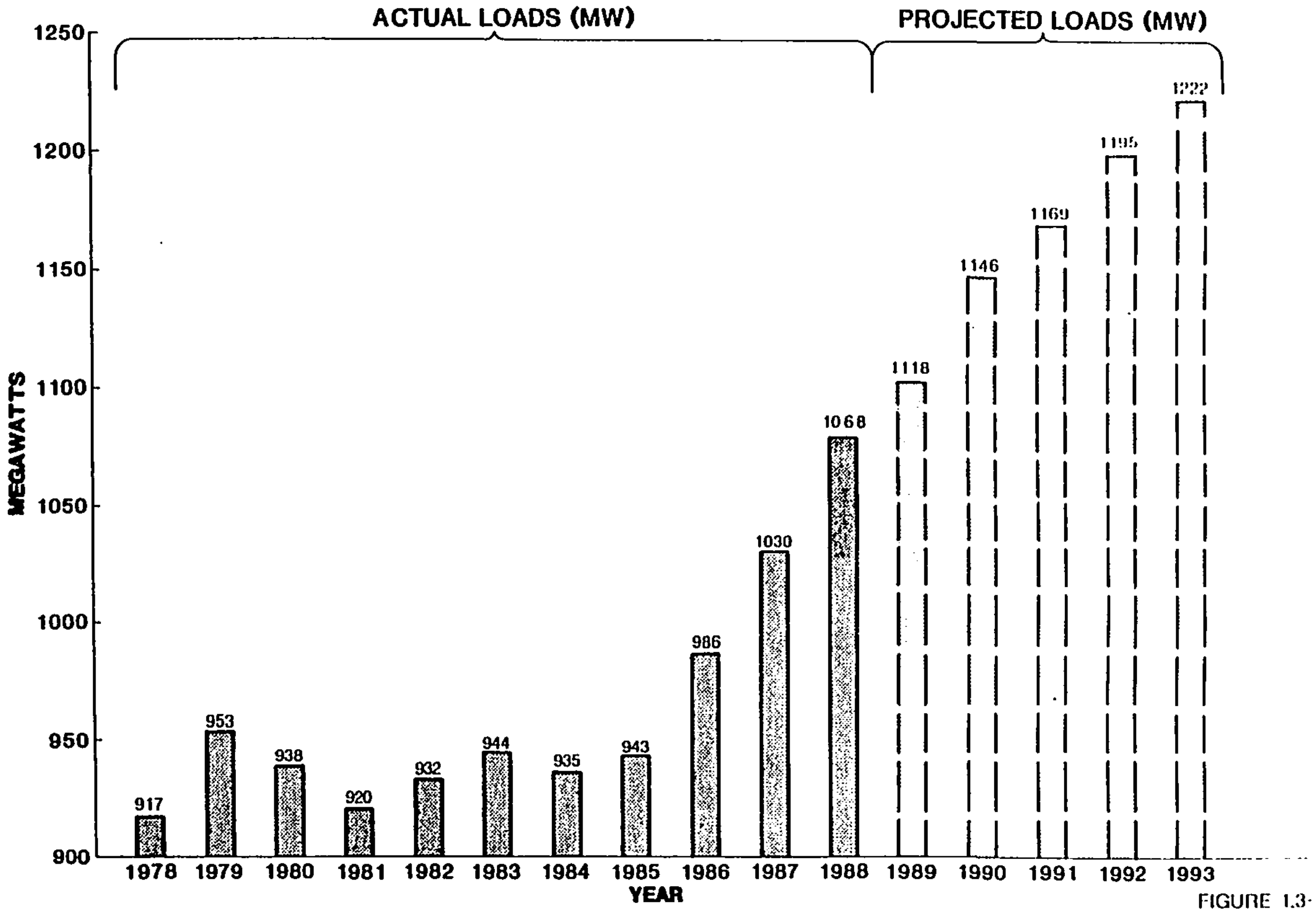

FIGURE 1.3-1

PEAK ELECTRICAL LOADS
ACTUAL AND PROJECTED 1978-1993
(HECO FORECAST - MAY 1989)

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

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Utilities Commission for the construction of a new 146 MW generating unit at the Kahe Power Plant. HECO is now planning to purchase power from entities that propose to build and operate power plants in Campbell Industrial Park (CIP) (Table 1.4-1 and see Figure 1.2-1). Kalaeloa Partners Limited Partnership (KP) proposes to construct and operate a 185 MW, combined-cycle plant that will consist of two oil-fired combustion turbines and one steam turbine. The first combustion turbine will be in service in 1989 and the second, including the steam unit, in 1990.

Table 1.4-1
HECO PLANNED GENERATION ADDITIONS

	Plant 1	Plant 2	Plant 3
Owner/Operator	Kalaeloa Partners Limited Partnership	Applied Energy Services-Barbers Point	Honolulu Resource Recovery Venture
Type	Combined cycle, two combustion turbines, one steam turbine	Coal	Refuse/waste heat recovery
Total capacity (MW)	185	180	60
In-service date	Phase 1: 1989 Phase 2: 1990	1992	1990

Source: HECO Engineering Department, 1988.

The second proposed plant will be constructed and operated by Applied Energy Services-Barbers Point (AES-BP) of Arlington, Virginia. AES-BP plans to have a 180 MW coal-burning plant on-line by late 1992. AES-BP will construct a conveyor system to transport coal from Barbers Point Deep Draft Harbor to the plant site.

A third plant, a 60 MW refuse/waste heat recovery unit, will be operated by Honolulu Resource Recovery Venture (H-Power). This plant is planned to be in service by 1990.

HECO plans to purchase power instead of building its own generation facilities, for primarily economic reasons. However, the new generation sources at the Campbell Industrial Park will also improve HECO's system reliability by contributing to geographical dispersion of power sources and by diversifying generation types.

1.4.2 Transmission

HECO plans a number of transmission system improvements over the next 20 years in order to improve system reliability and to meet projected load growth. The major elements of HECO's transmission system capital improvement program include:

- Construction of the proposed Waiau-Makalapa No. 2 138 kV Transmission Line and completion of associated substation termination work
- Construction of the proposed Waiau-CIP double-circuit 138 kV transmission line and completion of associated substation termination work
- Construction of the Ewa Nui 138 kV substation
- Modification of the Kahe and CIP substations to establish a Kahe-CIP No. 2 transmission line
- Integration of the new private CIP generation resources into the HECO grid
- Construction of the proposed Archer 138 kV substation and the proposed Archer to Iwilei and Archer to School Street 138 kV transmission lines

Chapter 2
Transmission Alternatives

Chapter 2
TRANSMISSION ALTERNATIVES

Four technologies were evaluated for a 138 kV transmission line between Waiau Power Plant and Makalapa Substation: overhead lines (both over land and over water), underground cables, and submarine cables. The following analysis describes the basic elements of these four alternative transmission technologies and compares the environmental and economic considerations of construction and maintenance for each alternative.

2.1 OVERHEAD TRANSMISSION LINE OVER LAND

2.1.1 Transmission Line Features and Design Standards

Conventional overhead 138 kV construction consists of stranded aluminum conductors supported by monopole structures (wood or steel), multipole structures (wood, steel, or aluminum), or lattice structures (steel). The conductors are electrically insulated from the structure with porcelain or polymer/fiberglass insulators (Figure 2.1-1). HECO transmission lines are designed in accordance with the Public Utilities Commission's (PUC's) General Order No. 6 (GO-6) "Revised Rules for Overhead Electric Line Construction" (State of Hawaii, Department of Regulatory Affairs, 1969). GO-6 specifies spacing, clearance, and strength requirements for overhead electric line construction to ensure safe and efficient service.

2.1.2 Support Structures

The type of support structure selected depends principally on the topography and land uses in and around the proposed right-of-way. Lattice steel and multipole wood structures are used in remote areas or mountainous terrain, where span lengths are long (600 to 1,200 feet). The cost per mile is relatively low; however, the steel towers can be visually intrusive. Tubular steel poles (Figure 2.1-1) are selected in developed areas where the route is expected to be highly visible and the span lengths are moderate (300 to 600 feet). Wood poles are used for lower-voltage subtransmission and distribution lines where the span lengths are shorter (up to 500 feet). Wood poles and tubular steel poles require guy wires for support at angles; however, steel poles may be designed to be self-supporting. Both lattice steel towers and tubular steel poles can be painted to blend with or complement the surrounding environment. For aesthetic reasons, HECO's standard practice is to install tubular steel poles rather than wood poles through developed areas. The poles selected for the proposed Waiau-Makalapa No. 2 138 kV Transmission Line are tubular steel.

2.2 OVERHEAD TRANSMISSION LINE ACROSS PEARL HARBOR

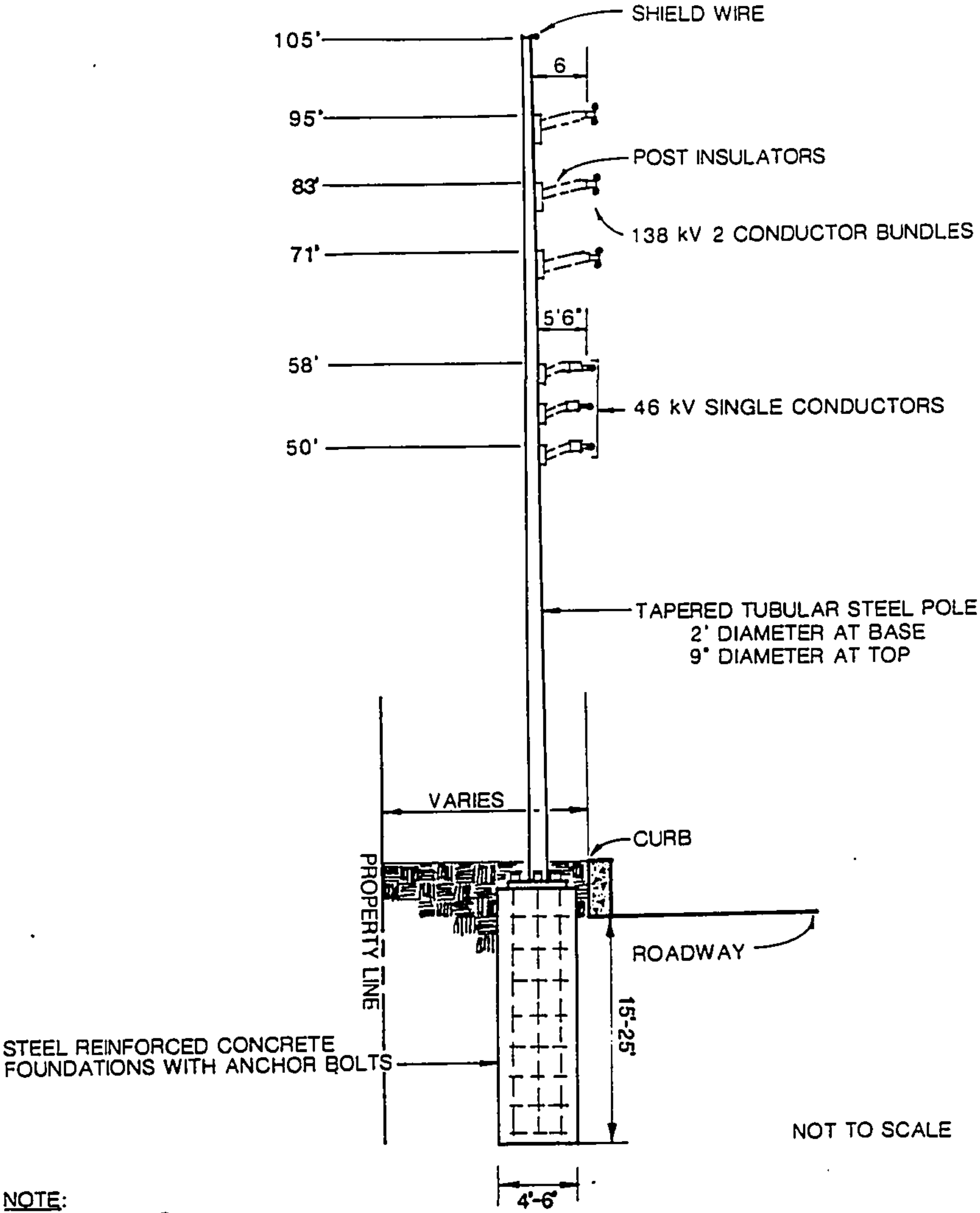
During initial public meetings on the Waiau-Makalapa No. 2 138 kV Transmission Line Project, HECO was asked about the feasibility of routing segments of the new line across Pearl Harbor on poles located within the waters of the harbor. The advantage of this alternative is that the route would avoid some residential, commercial, and park areas near Kamehameha Highway (Kam Highway).

If HECO sited the new Waiau-Makalapa No. 2 138 kV Transmission Line across water, it would probably employ tubular steel poles mounted on concrete piles (Figure 2.2-1). The concrete pile structure would consist of six to twelve concrete piles set into the floor of Pearl Harbor. The pile cap mounted on top of the piles would be set several feet above the high-tide water level in order to protect the poles from waves generated by storms within the normally calm harbor. This alternative would require an overland segment between the shore of Pearl Harbor and Makalapa Substation (up to 2.5 miles over land).

2.3 UNDERGROUND TRANSMISSION CABLE

Most underground transmission cable systems in the United States are the high-pressure fluid-filled pipe system (HPFF) (Electric Power Research Institute, 1975). Other systems include low-pressure fluid-filled (LPFF), or self-contained fluid-filled cables, and gas and solid dielectric cables. Gas dielectric systems are used in situations where short, high-capacity lines are needed and generally they are not used for long-distance transmission. LPFF self-contained cables require a duct for each cable and require larger excavations and higher overall costs. In solid dielectric systems, each circuit consists of a pipe that encloses conductors encased in polyethylene insulation. The reliability of solid dielectric systems has not yet been adequately demonstrated. Although solid dielectric cable systems are commonly used for lower-voltage lines (115 kV or lower), they are rarely used for higher-voltage lines such as the Waiau-Makalapa No. 2 138 kV Transmission Line.

HPFF systems are the most reliable systems available today. Their good operating record and physical ruggedness make them particularly applicable in urban areas. This system is being proposed by HECO for its new 2-mile Iwilei to Archer



NOTE:
TYPICAL SPANS
300-600 FEET

STRUCTURE SHOWN USED ADJACENT TO ROADWAY

FIGURE 2.1-1

TYPICAL 138 kV SINGLE CIRCUIT STRUCTURE

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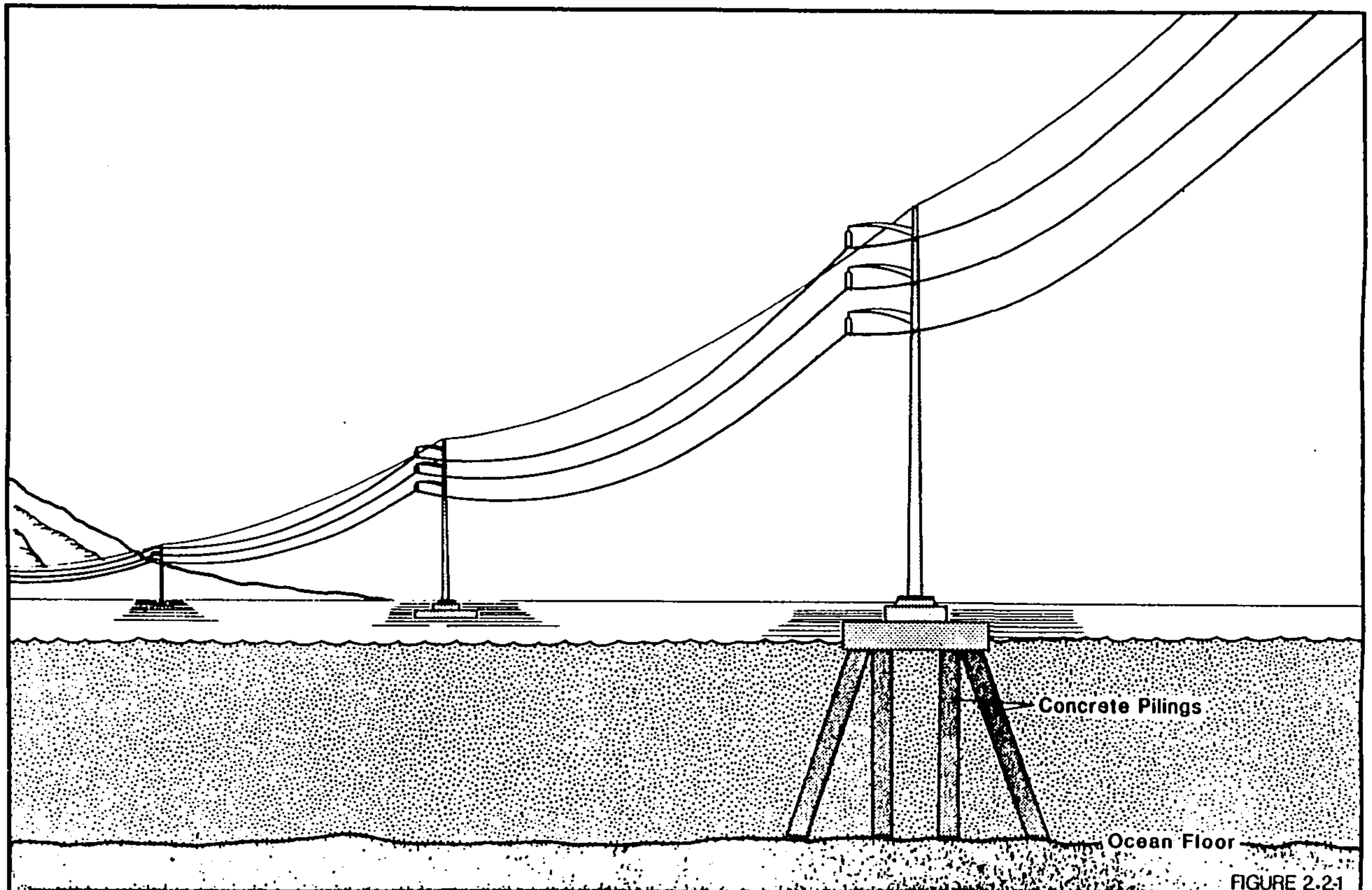

FIGURE 2.2-1

POSSIBLE CONFIGURATION
138kV TRANSMISSION LINE
SITED OVER WATER

(Not to scale)

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

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and School to Archer 138 kV lines and will be proposed for the Waiau-Makalapa No. 2 138 kV Transmission Line.

An HPFF 138 kV underground system consists of three paper-insulated cables installed in a fluid-filled pipe (see Figure 2.3-1). The pipe contains a low-viscosity dielectric fluid under nominal 200-psi pressure. The fluid and insulation on each of the cables provide the necessary dielectric or electrical strength to the transmission cable. The pipe diameter is usually about 8 inches, but varies according to cable conductor size and ampacity. The pipe provides mechanical and moisture protection, which is particularly important in the alluvial conditions of the soils on Oahu. The number of pipes installed depends on the power and reliability requirements of the system. For the Waiau-Makalapa No. 2 138 kV Transmission Line, two circuits would probably be installed for the 3.5-mile underground route.

The pipe system is buried in a special backfill with specified thermal characteristics if the native soil has poor thermal properties. A fluid return pipe is often installed adjacent to the cable pipe. Special terminations are used at the line terminals for the transition from the cable insulation system of the underground system to the typical porcelain and air insulation of the 138 kV outdoor substations.

Two types of cooling can be used for an HPFF system: natural and forced. If forced cooling is required, fluid handling equipment includes pumping, cooling, filtering, and recirculating components at the line terminals. The space occupied by cooling stations varies according to their capacities. For example, a 525,000-Btu/hour capacity station is 10 feet by 30 feet by 9 feet high. If forced cooling is not required, only fluid pressurization stations need to be installed at the terminals. Splice vaults (manholes) are required at varying intervals along the line with a the maximum interval of 2,000 to 4,000 feet.

2.4 SUBMARINE TRANSMISSION CABLE

A potential marine route would enter Pearl Harbor at the Waiau Power Plant and run parallel to the coastline in a southeasterly direction. It would come onshore in the vicinity of the U.S.S. Arizona Memorial Visitor Center and would continue overland to the proposed Makalapa Substation. If a submarine system were selected in part to minimize visual effects, it is likely that an underground cable would be used for the overland portion. The approximate length of the route would be 3.6 miles, with 2 miles of submarine cable and 1.6 miles of underground cable.

Submarine cables consist of a central conductor surrounded by insulating material, enclosed in hard armoring. There are four types of submarine cables: self-contained (low pressure) fluid-filled; high-pressure fluid-filled pipe; solid paper; and solid dielectric. A review of literature on submarine cables indicates that the self-contained fluid-filled cable (Figure 2.4-1) has a history of good performance in the transmission of power over long distances and would be proposed for this project. The pressurized dielectric fluid is very light, similar to mineral oil. Three cables per circuit would be required; an extra circuit is sometimes installed.

In addition to the cable itself, a submarine cable system requires transition stations to link the submarine and underground cables. These stations would be located close to the shoreline and would serve as a transition between the low-pressure, fluid-filled submarine cable and the high-pressure, fluid-filled underground cable.

2.5 COMPARISON OF TRANSMISSION ALTERNATIVES AND ENVIRONMENTAL CONSIDERATIONS

The four transmission alternatives described in this section differ in their potential environmental impacts, construction cost, and maintenance requirements. The following subsections and Table 2.5-1 compare the principal characteristics of each transmission alternative.

2.5.1 Geological Considerations

The construction, operation, and maintenance of each of the transmission alternatives could affect topography, soils, and geological features of the landscape. Shoreline considerations are also presented in this subsection.

Overhead Transmission Lines Over Land. Construction of an overhead line in the Makalapa study area would have minimal impact on topography and soils because only soils in and around the pole locations would be disturbed. At each pole, soils would be temporarily disturbed for augured excavations or pile-driving and backfilling. The soil not required for backfill would be trucked to a fill site. The land between the poles would remain undisturbed except where equipment used for conductor pulling and splicing would require access. Surface soils might be compacted by movement of

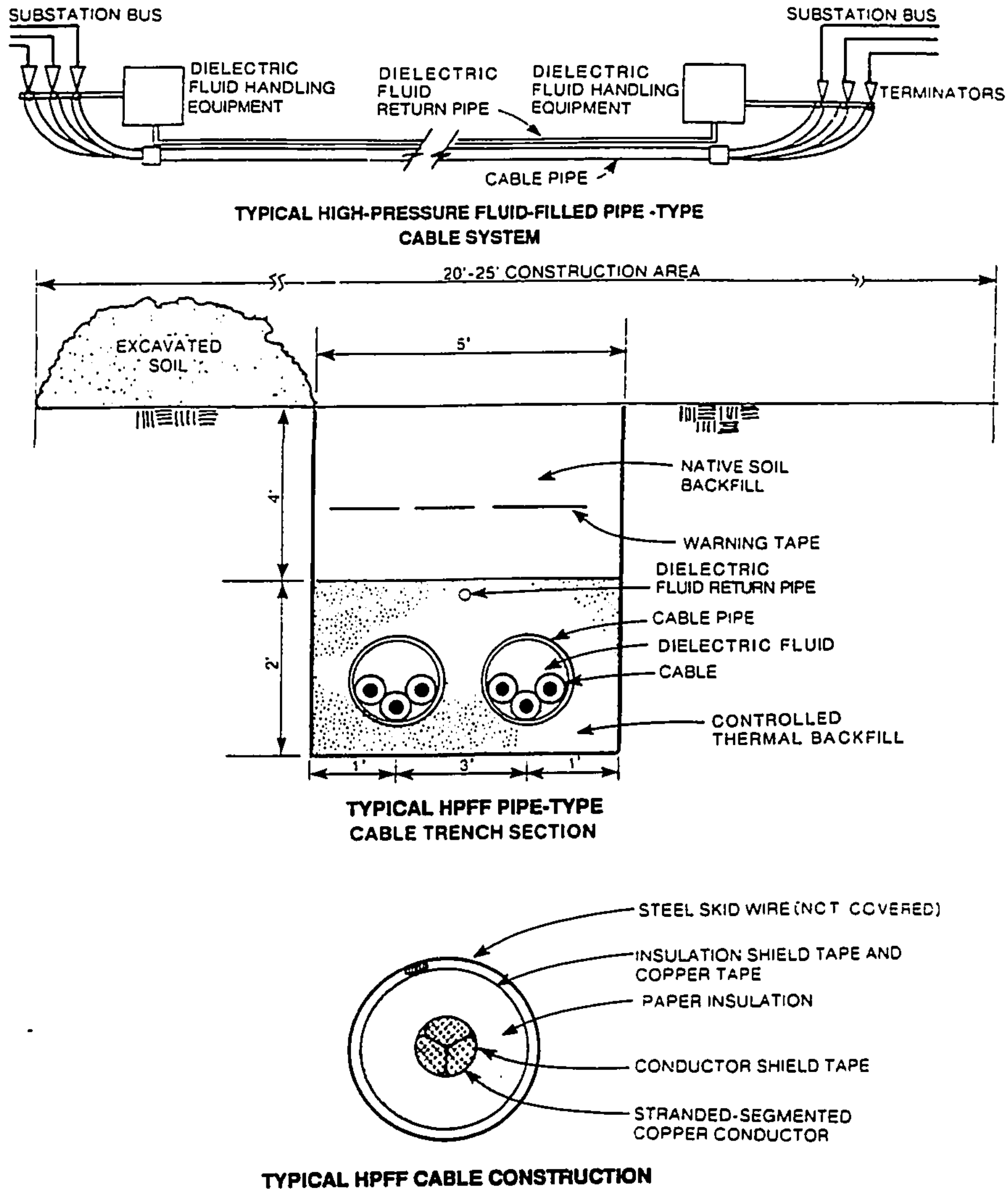

FIGURE 2.3-1

TYPICAL 138kV UNDERGROUND SYSTEM

Waiau – Makalapa No. 2 Transmission Line Project

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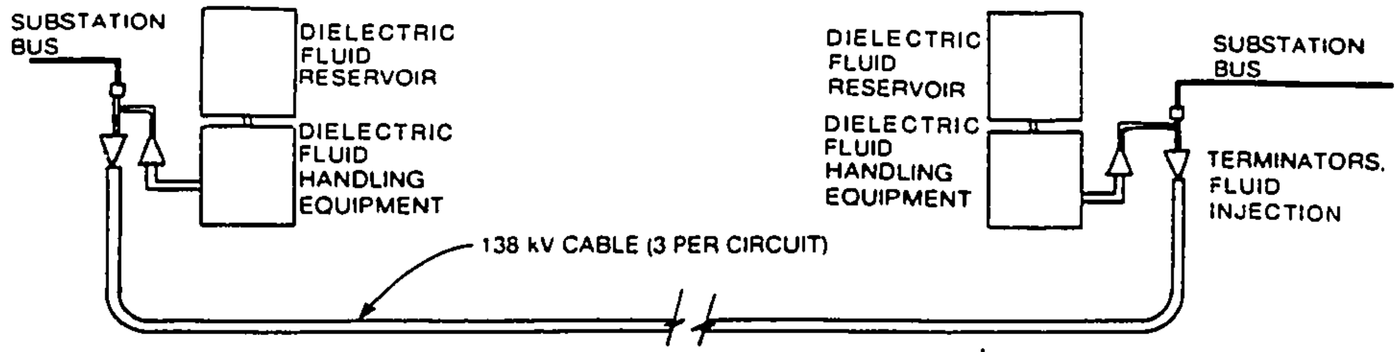
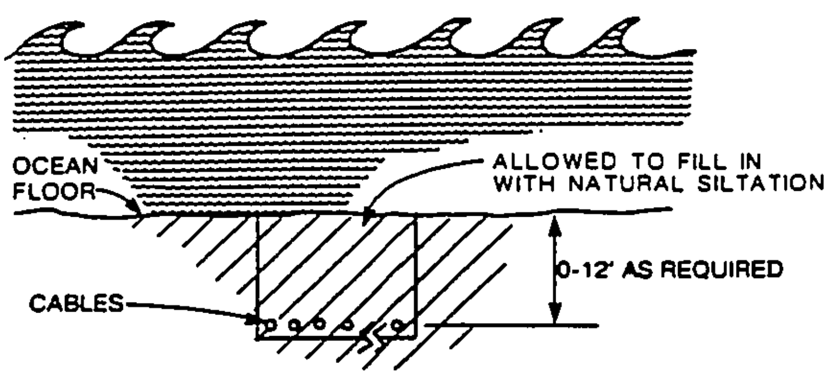
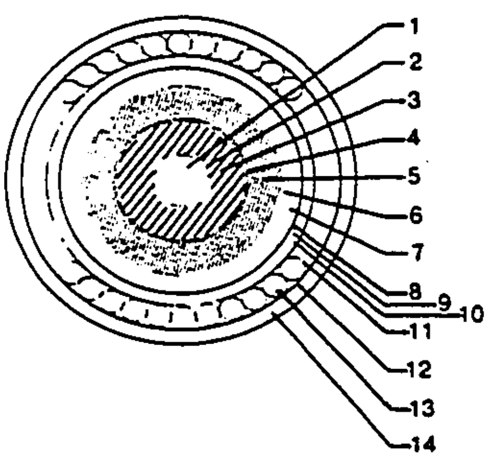


TYPICAL SUBMARINE CABLE SYSTEM



TYPICAL SUBMARINE CABLE TRENCH SECTION



1. DIELECTRIC FLUID CHANNEL
2. GALVANIZED STEEL SPIRAL
3. STRANDED COPPER CONDUCTOR
4. CARBON BLACK CONDUCTOR SHIELD TAPE
5. PAPER INSULATION
6. CARBON BLACK INSULATION SHIELD TAPE
7. LEAD ALLOY SHEATH
8. RUBBER COATED FABRIC TAPE
9. STAINLESS STEEL TAPE
10. RUBBER COATED FABRIC TAPE
11. EXTRUDED POLYETHLENE
12. RUBBER COATED FABRIC TAPE
13. GALVANIZED STEEL ARMOR WIRE
14. COMPOUNDED JUTE

TYPICAL CABLE CONSTRUCTION

FIGURE 2.4-1

TYPICAL 138kV SUBMARINE CABLE SYSTEM

Waiau – Makalapa No. 2 Transmission Line Project
Hawaiian Electric Company
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Table 2.5-1
TRANSMISSION SYSTEM ALTERNATIVES
SUMMARY OF CHARACTERISTICS AND ENVIRONMENTAL EFFECTS

Transmission Alternative	Basic System Components	Approx. Line Length (Mile)	Construction Cost ($M/Mile)	Construction and Operation Effects: Geological, Biological, and Cultural Resources	Construction and Operation Effects: Socioeconomics, EMF, and Visual Resources	Traffic Considerations	Maintenance Considerations
Conventional Overhead Across Land	Augered concrete pier foundations Pile foundations in wet soils; 6 to 12 piles per pole Tubular steel poles; 80 to 135 ft. high Three aluminum conductor bundles and one shield wire Some sections underbuilt with 46 kV lines	4.5	4.1	Clearing of surface vegetation at pole sites Excavation for pile foundations 14 ft. x 18 ft. x 4 ft. Trees near ROW trimmed within 10 ft. of conductor position in high wind Excavation required for all foundations; 70 to 100 poles Subsurface archaeological features may be disturbed in excavations; requires field archaeologist to survey pole sites	Assumes single circuit line with 46 kV underbuild Electric field at center of ROW approx. 0.5 kV/m or less Magnetic field at center of ROW approx. 21 mG or less Poles and conductors visible throughout	Construction: ROW near roadway--one lane of traffic obstructed for 4 to 6 weeks per mile during off-peak traffic periods Maintenance: Potential traffic disruption or delays depending on type of repair/maintenance practices	Locating and accessing faults relatively easy Repair time: hours "Live line" maintenance possible
Overhead Across Pearl Harbor	Pile foundations; 6 to 12 piles each pole across water and in wet soils Tubular steel poles; 100 to 120 ft. high Three aluminum conductor bundles and one shield wire Some sections underbuilt with 46 kV lines	4.5 (2.0 across water; 2.5 over land)	3.8	Temporary disruption of benthic ecosystems; loss of habitat as a result of pile foundation installation Potential conflict with known historic resources in Pearl Harbor; extensive mitigation may be required Effects for overland portion would be the same as those for conventional overhead	Field strengths similar to overhead line on land Poles and conductors visually intrusive from recreation areas, shorelines, and the Pearl Harbor National Landmark Recreational boaters and Navy ships may require safety markers on poles and lines Effects for overland portion would be the same as those for conventional overhead	Potential ship traffic disruption during construction, operation, and maintenance Effects for overland portion would be the same as those for conventional overhead	Difficult access for maintenance and repair Repair time: days Poles and foundations will require extensive maintenance due to harsh marine environment Effects for overland portion would be the same as those for conventional overhead

Table 2.5-1
(continued)

Transmission Alternative	Basic System Components	Approx. Line Length (Mile)	Construction Cost ($M/Mile)	Construction and Operation Effects: Geological, Biological, and Cultural Resources	Construction and Operation Effects: Socioeconomics, EMF, and Visual Resources	Construction and Operation Effects: Traffic Considerations	Maintenance Considerations
Underground (HPFF)	High-pressure fluid-filled pipe containing cable, plus smaller fluid return pipe Fluid handling stations at each terminal Splice vaults (manholes) every 2,000 to 4,000 feet Cooling stations, filtering, and recirculation equipment may be required	3.5	13	Construction: Trench excavation; 5 ft. wide by 6 ft. deep Temporary loss of surface vegetation along entire route Potential to disrupt subsurface cultural resources within ROW Operation: Potential need to excavate pipe for repair of line Potential for leaks resulting from line rupture	No electric field Magnetic field 1 to 44 mG at soil surface directly above pipe No visual impact from underground cable Fluid handling equipment would require screening unless placed in industrial area	Construction: Longer period of traffic disruption for trenching and laying pipe than for conventional overhead Potential traffic disruptions during maintenance	Potential for heavy traffic disruption during maintenance or repairs Difficult to locate faults: could take hours to days Repair time: weeks Daily maintenance of fluid-handling equipment necessary
Submarine Cable	Six fluid-filled cables with conductors laid in trench (three cables per circuit) Transition stations with fluid pumping equipment at shoreline Overland portion consists of high-pressure, fluid-filled underground cable	3.6 (2.0 submarine; 1.6 underground)	13	Temporary disruption of benthic habitat Submarine trench 0 to 12 ft. deep Potential for fluid leaks because of rupture by ship traffic Potential disruption of submarine historic artifacts within Pearl Harbor Effects for overland portion would be the same as those for underground cable	Field strengths low to negligible at surface, depending on depth of cable No visual impact under water Transition stations and other equipment visible on shoreline Effects for overland portion would be the same as those for underground cable	Construction: Potential ship traffic disruption during construction Maintenance: Frequent dive inspections that may affect ship traffic Effects for overland portion would be the same as those for underground cable	Periodic dive inspection required Difficult to locate faults: could take days or weeks Repair time: weeks Potential for heat buildup in cable Effects for overland portion would be the same as those for underground cable

equipment and there would be the possibility for soil loss through erosion until vegetation were reestablished.

Overhead Transmission Line Across Pearl Harbor. Constructing pole platforms for the over-water portions of this alternative would require driving 6 to 12 concrete piles for each tower into the soils underlying Pearl Harbor. Soil disturbance would be limited to the areas surrounding each of the piles. The overland portions of the line would be identical to the conventional overhead transmission line.

Underground Transmission Cable. The amount of excavation required for the installation of a 138 kV high-pressure, fluid-filled pipe (HPFF) system depends on the number and sizes of pipes to be installed which, in turn, depend on the ampacity of the line and the requirement for spare or emergency circuits. The area of excavation required determines the degree of disturbance of surface and subsurface soils or rock. The Waiau-Makalapa No. 2 138 kV Transmission Line would probably require two 8-inch-diameter pipes with an excavated trench 6 feet deep and 5 feet wide.

Soil compaction and mixing of soil layers may result from cable trenching and backfill. This, in turn, may affect soil particle sizes and chemical characteristics. The surface of the trench is vulnerable to soil erosion until the vegetation or concrete/asphalt surfaces are reestablished. Topography can be altered by cut-and-fill grading within the easement where required for construction equipment access.

Splice vault dimensions could be as large as 10 by 18 by 7 feet deep and require excavations of 12 by 20 by 12 feet deep. These vaults would be required at 2,000- to 4,000-foot intervals, depending on the topography and number of bends in the route. Approximately ten splice vault excavations would be required for the estimated 3.5-mile line length. Because the cable is filled with a dielectric fluid for insulation and cooling, a rupture in the pipe system could result in fluid leakage. The pipe system would normally be designed to reduce potential damage caused by seismic activity and subsequent soil movement.

Submarine Transmission Cable. During construction, dredging or trenching in the floor of Pearl Harbor could be necessary over the entire route. Other geophysical concerns include potential heat buildup in the cable if it is buried in the ocean bottom muds that act as insulation; potential chafing action and cable wear if the new line is placed in an exposed area where storms cause surge action; and potential damage to the shoreline and terminal facilities during storms.

2.5.2 Biological Considerations

Overhead Transmission Line Over Land. Construction in undeveloped open space usually requires selective clearing and/or removal of vegetation from construction pads and pole sites. Natural revegetation normally occurs on these sites within one to three growing years, except in areas occupied by poles.

Selective clearing or trimming of street trees and woody plants may be necessary if a line is constructed through dense shrubland or along roadways in order to provide room for construction equipment and proper conductor clearances. Trees that are not located within the right-of-way path but are tall enough to contact the line if they fall are either removed or trimmed.

HECO requires that vegetation be kept a minimum of 10 feet from the extreme position of all 138 kV conductors and 8 feet from 46 kV and 12 kV conductors.

Overhead Transmission Line Across Pearl Harbor. Driving piles to support the pole platforms would temporarily disrupt benthic ecosystems. The biological effects on the overland portion of the line would be comparable to those of conventional overhead lines.

Underground Transmission Cable. Trench excavation may adversely affect existing vegetation (both natural communities and landscaping), wetlands, and wildlife habitat. All surface vegetation along the route would have to be removed during construction; however, revegetation would take place naturally or could be expedited by planting a ground cover. Because of potential reexcavation for maintenance or repairs and to minimize damage to the cable caused by tree roots, trees and large shrubs should not be planted over the pipeline routes.

Underground pipe requires fluid-pressurizing equipment (and sometimes cooling stations) on land at the terminations of the underground portion. If these facilities were placed on undeveloped land or shoreline, they could remove natural habitat that might be used by wildlife.

If any sizable area of vegetation were removed for trenching or facilities, it is likely that food and cover resources for wildlife would be lost, particularly near streams and wetlands. The trenching activities near these types of habitats would require special permits from the Department of Land and Natural Resources and/or the U.S. Army Corps of Engineers.

Another consideration is the potential for pipe rupture and fluid leakage caused by seismic activity, mechanical flaws, or other causes, which could cause biological damage. The degree of impact would depend on the extent of the leak and the biological sensitivity of the affected area.

Submarine Transmission Cable. Dredging or trenching the ocean floor would temporarily disrupt benthic ecosystems during the exploration and laying of the submarine cable. Shoreline habitat would be affected during the lifetime of the project by the placement of the terminal facilities and the increased activity near these plants.

Because the submarine cable would be located within Pearl Harbor, the State Harbors Division would require that the cable be embedded in the harbor floor. As with underground systems, this practice would be costly. Additionally, it would exacerbate heat buildup in the cables.

Energy loss through the cable would be dissipated as heat and would be conducted to the surrounding harbor waters. This discharged heat is a potential impact to the benthic organisms in the immediate area of the cable. The temperature elevation would be confined primarily to the substrate because of the current flow and diluting effect of the surrounding water.

The cable shield would mitigate potential electric and magnetic field effects on marine animals. However, leakage of fluid from the submarine cable as a result of damage to the cable could also adversely affect marine organisms. It might be necessary, depending on the repair strategy, to continue to pump fluid through the cable to prevent the inflow of sea water. By the time the cable break could be located and repaired, a considerable volume of fluid could be discharged into the ocean. The degree of impact would depend on the extent of the leakage and sensitivity of the local marine environment. A survey would have to be conducted before construction to determine whether the marine route would cross any particularly valuable marine resource areas.

2.5.3 Electric and Magnetic Fields

An electric field is produced in the area surrounding a conductor (such as a transmission line or cable) when voltage is applied to the conductor. Magnetic fields occur when electric current flows through a conductor. Any electrical device, including household appliances and transmission lines, creates electric and magnetic fields (EMF).

In recent years, there has been growing interest in the potential health effect of exposure to EMF. Concern was initially raised (and studies were conducted) in regard to the fields associated with much higher voltage lines (up to 765 kV) than the 138 kV lines planned for this project. Current research on EMF and field strengths along the proposed alignment are discussed in Section 3.9 of the Environmental Assessment and in Appendix C. The following subsections compare the likely fields near the four transmission alternatives.

Overhead Transmission Line Over Land. Overhead transmission line conductors are insulated from each other and the ground by porcelain insulators and the surrounding air. Electric and magnetic fields exist around each conductor. The strength of these fields diminishes in proportion to distance from the conductor. At the ground level, field strengths are highest almost directly under the conductors at the point where the conductors sag closest to the ground (usually at the mid-point between transmission poles). At that point, the electric field underneath a typical 138 kV transmission line with a 46 kV line strung on the same poles is about 0.5 per meter (kV/m) or less. The corresponding magnetic field would be about 21 milliGauss (mG) under normal average line loadings (HECO, May 1988). Because the 46 kV lines tend to cancel out some of the electric and magnetic fields, in locations where the 138 kV line does not share poles with a 46 kV line, field strengths directly under the 138 kV conductors would be somewhat higher--up to 1.8 kV/meter (electric field) and 48 mG (magnetic field). Field strengths would be lower at the edge of the right-of-way.

These field strengths are lower than field strengths associated with some of the higher-voltage transmission lines (such as 500 kV and 765 kV) that are typical of utility systems in other parts of the United States.

Overhead Transmission Line Across Pearl Harbor. An overhead transmission line sited across water would have the same electric and magnetic fields as conventional overhead lines.

Siting the lines across water would separate the line from residences and other areas frequented by humans by a greater distance than if it were sited on land. The field strengths of the sections of line sited across Pearl Harbor, as measured from the land, would probably be very low to negligible.

Underground Transmission Cable. The paper insulation, fluid, and pipe that encase the conductor in typical high-pressure fluid-filled underground cable systems effectively eliminate any measurable electric field outside the pipe. Magnetic fields could measure 1 to 44 mG at the surface of the soil directly above the pipe (Power Technologies, Inc., 1989).

Submarine Transmission Cable. The electric and magnetic fields at the surface of the water above a submarine transmission cable would vary according to the depth of the cable, but generally would be negligible.

2.5.4 Socioeconomic Factors

Some socioeconomic factors (e.g., land jurisdiction and use, transportation and utility easements) depend on the route selected rather than the type of transmission system selected. The major socioeconomic considerations related to the selection of a transmission technology include: potential visual impacts, television and radio interference, traffic disruption during construction and maintenance, and potential impacts to cultural resources.

Visual Quality

Overhead Transmission Line Across Land. An overhead transmission line is visible to the public. Assessing the visual effect requires considering the displacement and/or addition of visual elements in the landscape, the degree of change to existing visual resources, the configuration of the overhead line and its supporting structures, and the number and subjective preferences of people affected by these changes.

Overhead Transmission Line Across Pearl Harbor. The poles located in Pearl Harbor would be visible from several public vantage points along Pearl Harbor and could be considered to be highly intrusive into existing shoreline views. One existing park (Pearl Harbor [Blaisdell]) and one planned park (Aiea Bay State Recreation Area) are situated along the shoreline and prominently feature harbor views. A transmission line sited just offshore would obstruct horizon views from both parks, given the low angle from which the line would be seen. The transmission line would also be visible from McGrew Point (Naval Housing) and from some locations along Kam Highway. The line could also be seen from the Navy's Richardson Recreation Center and the U.S.S. Arizona Memorial site and ferry. Land portions of this transmission alternative would have visual effects comparable with conventional overhead lines.

Underground Transmission Cable. After an underground cable is installed, there is no visual impact from the underground cable itself. Underground systems require fluid handling and ground-to-air transition stations at either end of the underground portion; although these stations would be fenced or screened, they might be considered visually intrusive in some locations.

Submarine Transmission Cable. The underwater portions of a submarine cable system would not be visible above the water surface. A submarine cable would require a transition station, including fluid-pumping equipment, at the shoreline. Given the visual sensitivity of many shoreline areas, the transition station could be viewed as objectionable by some, depending on its location and treatment.

Television and Radio Interference

Overhead Transmission Lines Over Land. Overhead transmission lines do not usually interfere with normal radio or television reception. There are two potential sources of interference: corona and gap discharges. Corona can affect AM radios, while gap discharge can affect both television and radio reception.

Corona activity is usually minimized through proper design of the line and is, therefore, almost never a source of interference. The design of the Waiau-Makalapa No. 2 138 kV Transmission Line is of a type that generally does not cause television interference; corona is lower than on many previous 138 kV lines on the mainland where television interference has not been a problem.

Gap discharges are a very different problem. They are caused by electrical discharges between damaged or poorly fitting hardware such as insulators, clamps, or brackets. Hardware is designed and installed to be problem-free, but gunshot damage, wind motion, corrosion damage, etc., sometimes can create gap discharges. The discharges act as small transmitters at frequencies that can be received on some radio and television receivers. Gap discharge sources can be located by HECO engineers and repaired.

HECO engineers design all transmission lines to be as free as possible from corona and other sources of interference and, generally, interference is not a problem. Radio and television interference complaints are recorded, evaluated, and investigated when necessary, and corrective measures are taken as required.

Overhead Transmission Line Across Pearl Harbor. Radio and television interference associated with this alternative would be comparable with interference associated with a conventional overhead line over land. Given that the line sections sited over water would be somewhat more distant from human activity than those sited over land, interference, if it occurred at all, would be perceived by fewer people.

Underground Transmission Cable. Radio and television interference would be virtually nonexistent from an underground cable system.

Submarine Transmission Cable. Radio and television interference would be virtually nonexistent from a submarine cable system.

Traffic Disruption During Construction and Maintenance

Because all of the potential routes of the Waiau-Makalapa No. 2 138 kV Transmission Line are in urban areas, the possible disruption of traffic during construction and maintenance is a major concern.

Overhead Transmission Line Over Land. For an overhead line, the major traffic disruption would occur during construction. All construction within and restoration of roadways would be performed in accordance with applicable standards set by federal, state, and county authorities (see Section 3.3).

Preparing foundations, setting poles, and stringing conductor could require closing a lane of traffic temporarily. HECO's construction crews might need to close a lane of traffic on multilane roads during off-peak traffic periods (8:30 a.m. to 3:00 p.m.). At any one spot along the 4.5-mile line, construction would occur in stages, separated by days or weeks.

The initial construction activity would be foundation installation. The construction of two or three pole foundations would begin at the same time and would require 2 to 3 weeks to complete for each group of two or three poles. A

1,000- to 1,500-foot section of road would be coned off to exclude traffic. This 1,000- to 1,500-foot section would move forward along the road as each set of two to three foundations is completed.

Installing poles would occur next. About three poles per day would be installed, requiring a 1,000- to 1,500-foot section of road to be coned off. Again, this coned-off section would move forward as pole installation was completed along the route.

Pulling conductor, tensioning, and dead-ending are usually done in segments about 1 mile long. Traffic would be coned off at the beginning of a segment to accommodate the reel-holding conductor and at the end of the segment to accommodate pulling equipment. A few bucket trucks located between the beginning and the end of the segment would also require traffic coning. Approximately 1 month is required to complete 1 mile of conductor installation.

After construction, traffic disruption for routine maintenance would be less frequent and for shorter durations. Because overhead lines are easily visible, HECO's biannual routine maintenance is essentially a "drive-by" inspection. A detailed climbing inspection is performed once every 5 years. This inspection requires about 1 day per pole. The road would be coned off for a few hundred feet on either side of the pole being inspected.

Overhead Transmission Line Across Pearl Harbor. Constructing the over-water portions of this alternative would probably require the use of barges and specialized pile-driving equipment. Navigating barges and equipment into the location and completing construction would substantially interfere with ship and submarine operations. The overland portions of this option would have the same traffic impacts as conventional overhead lines.

Underground Transmission Cable. Because an underground cable would require trenching along its entire route, traffic disruption during construction would be more extensive and for longer periods than for overhead lines. A traffic study would probably be required by the State Department of Transportation to determine during what hours and in what areas lanes of traffic could be coned off during construction.

When a fault occurs on underground lines, it could take days or weeks to locate and repair the problem. Traffic disruption during repair could be more prolonged than for overhead lines because excavation and backfilling would be required.

Submarine Transmission Cable. The undersea portion of a Waiau-Makalapa No. 2 submarine transmission system would run through Pearl Harbor. There could be substantial interference with Navy ship operations while each cable is being laid or while maintenance is performed. The underground portions would have the impacts described above for underground cables.

Cultural Resources

The construction activities associated with each of the four transmission alternatives have the potential to disrupt subsurface cultural resources.

Overhead Transmission Line Over Land. During the route selection process for an overhead line, a survey of the proposed alignment is prepared by a professional archaeologist. The survey identifies locations of cultural resources in or near the proposed route and areas where there is a significant probability of finding artifacts below the soil surface. Route selection takes into account the cultural resource survey to avoid areas with the potential for cultural resources. During design, careful pole siting can help avoid disrupting cultural resources.

Overhead Transmission Line Across Pearl Harbor. Driving piles into the floor of Pearl Harbor would have some potential to disrupt historical artifacts from the 1941 attack on Pearl Harbor within the Pearl Harbor National Register District/National Historic Landmark. Underwater investigations at each potential pole location would reveal any potential impact to historical artifacts. A specific Historic Preservation Plan should be in place and approved by the State Historic Preservation Office and Navy archaeologist prior to construction of the line.

Underground Transmission Cable. The potential for disrupting cultural resources (especially subsurface resources) is higher with an underground cable than for an overhead line because of the greater extent of excavation. A cultural resource survey could be used to screen surface features prior to selecting the cable alignment, but some potential to disrupt subsurface cultural resources during the trenching would remain.

Submarine Cable. The submarine cable from Waiau Power Plant to Makalapa Substation would pass through Pearl Harbor. On land, an underground cable system would probably be used. Laying cable through land and water areas of Pearl Harbor would potentially disrupt the underwater and on-land historical artifacts of the 1941 attack on Pearl Harbor within the Pearl Harbor National Register District/National Historic Landmark. All activities would require thorough State Historic Preservation Office review and compliance with the National Historic Preservation Act.

2.5.5 Maintenance and Repair Considerations

Maintenance techniques vary for each type of transmission system. Time for repair depends on maintenance techniques, degree of repair required, and location of the outage or area requiring repair.

Overhead Transmission Line Over Land. Operation and maintenance for overhead lines is routine and relatively inexpensive when compared with underground or marine options. New "live line" maintenance techniques are being implemented by HECO to increase the efficiency and economy of maintenance and repair. Although overhead lines are more vulnerable to vandalism and damage, repairs can usually be accomplished within hours.

Overhead Transmission Line Across Pearl Harbor. Maintenance would involve operations comparable with conventional overhead lines, except that access would probably require the use of barges with special bucket equipment to reach the lines. The necessity of using barges would increase the cost and time involved in maintenance and repairs.

Underground Transmission Cable. The dielectric fluid-handling equipment requires periodic maintenance and continual remote monitoring. The paper-insulated cables are quite reliable; however, trouble with fluid flow can cause overheating, which can shorten service life or cause a failure. The repair of this system requires skilled workers trained and experienced in cable splicing.

Splicing is a critical procedure, requiring absolute cleanliness in cable preparation, conductor welding, and application of paper-tape insulation to a specific tension, overlap, and thickness. The insulation shield tape and copper tape must also be replaced and the pipe must be repaired and refilled with dielectric fluid. HECO would need to organize special crews, develop procedures, and acquire equipment for maintaining and repairing the cable. In addition, a contingency arrangement with mainland utilities who routinely do such work may be required to provide emergency assistance and equipment in the event of an underground cable failure.

Because of the difficulty of locating faults in an underground cable and getting access for repair crews and equipment, repair of outages would take far longer than for an overhead line (i.e., days or weeks rather than hours).

Submarine Transmission Cable. Marine cables are similar to underground high-pressure, fluid-filled cables in that they require fluid handling equipment and frequent monitoring and maintenance. Other considerations include potential heat buildup in the cable if it is buried in ocean bottom muds that act as insulation, and potential damage to shoreline facilities or cables caused by storms or ships' anchors.

Most reported damage to existing submarine cables is attributed to external damage caused by fishing and trawling gear or by anchors. Damage from fishing would not be a factor along this route because there is no fishing industry in Pearl Harbor. However, vessels waiting to dock could drop anchor, damaging the cable from the direct impact of an anchor or by snagging the cable as the anchor is dragged.

The cost of operating and maintaining a submarine cable system is minimal because there are no manholes to open or splices to inspect. Emergency repairs to the cable, however, represent a significant cost and the outage duration would be longer than for an underground or overhead system because the repair vessel would not be permanently moored in Hawaii. Adverse weather and sea conditions can seriously impede access to the cable. In 1977, for example, a crew from the Long Island Lighting Company had to abandon its repair barges because of a storm.

Repairing a damaged or failed marine cable requires locating the fault, uncovering the faulted section of cable, raising it to a barge, and splicing in a length of new cable. The repair excavation would be extensive to accommodate a longer repaired cable. The cable repair technique is even more demanding than repairs on underground cables because the cable must be retrieved from the ocean bottom before repairs can be made. In addition, the lead sheath and steel armor must be replaced. The time required to complete repairs can be lengthy and could affect service to customers. Any cable repair work at Pearl Harbor could involve some risk to existing utilities in the harbor. The on-land (underground) portions of this alternative would be subject to the same maintenance and repair considerations described above for underground cable systems.

2.5.6 Cost

The costs of the three transmission alternatives differ significantly, as described below.

Overhead Transmission Lines Over Land. Engineering and construction for the Waiau-Makalapa No. 2 overhead line are projected to cost approximately $18.5 million (excluding the costs of acquiring right-of-way easements and conversion of 12 kV overhead lines along portions of Kam Highway to underground lines).

Overhead Transmission Line Across Pearl Harbor. Engineering and construction for this alternative are projected to cost $17.3 million (excluding the cost of acquiring right-of-way easements).

Underground Transmission Cable. The capital cost of a 138 kV underground system would range from two to six times the cost of a comparable overhead system. The need for excavation, pipe, and fluid-insulated conductor all increase costs greatly. Cost is also influenced by the degree of difficulty encountered in excavation. If the underground route is located next to other underground utilities such as sewer, water, telephone, oil, and gas pipelines, the costs of relocating or moving these facilities would increase the overall cost of the project. The current HECO estimate for the underground option is approximately $45 million, excluding the cost of easements.

Submarine Transmission Cable. HECO currently estimates the submarine option to cost on the order of $46 million, including the underground portions and transition station, but not including the costs of easements.

For comparison, a similar submarine cable project between Yonkers and Long Island is currently under design by the New York Power Authority. This project is a 345 kV, 600 MW line and is expected to cost $12 million/mile, or $317 million total for the 23-mile length.

2.5.7 Permit Considerations

Several permit requirements are shared by all four transmission alternatives. These include requirements for approval by the Public Utilities Commission and a Conditional Use Permit issued by the Department of Land Utilization. In addition, because the Waiau Power Plant is located within the Special Management Area (SMA), all alternatives would need an SMA use permit, which requires review and approval by City Council.

A preliminary analysis of permit requirements suggests that the overhead and underground alternatives (and the on-land portion of the submarine cable alternative) would have similar permit requirements, determined by the locations of the right-of-way. If the route passes through the Conservation Land Use District, the overhead and underground alternatives would need a Conservation District Use Permit, which requires review and approval by the State Department of Land and Natural Resources.

Agencies' consideration and review might differ somewhat between these two options. Permitting agencies could be expected to give more attention to the visual effects of overhead lines and perhaps more attention to possible impacts on biological and cultural resources and existing underground structures (such as pipelines and water mains) for underground lines.

The submarine cable and overhead line across Pearl Harbor alternatives would require an additional set of permits and reviews. The U.S. Army Corps of Engineers is the federal agency with permitting authority for all dredge and fill activities in wetlands and navigable waters of the United States. The Corps would grant a permit for a cable or overhead line to cross Pearl Harbor only after reviewing project environmental and economic impacts and determining the project to be in the public interest. One concern of the Corps of Engineers would be the potential for disturbing the Pearl Harbor National Historic Site.

Permission to cross Pearl Harbor would need to be granted by the U.S. Navy, and the Navy would consider environmental concerns as well as Naval operations. The Navy and other permitting agencies would probably grant permission only if it could be demonstrated that no other feasible alternative existed and that there would be only minimal disruption to naval operations and the Pearl Harbor historic sites.

2.6 CONCLUSION

After reviewing the alternatives to an overhead transmission line, HECO has selected the conventional overhead line technology as the only feasible alternative for the Waiau-Makalapa No. 2 138 kV Transmission Line.

The overhead line sited across Pearl Harbor is not a feasible alternative for several reasons. This alternative would probably be the most visually intrusive of all the alternatives because it would be prominently visible from park sites and residences. The construction of over-water sections could disrupt ship traffic in the harbor and might damage marine biological resources. Maintenance costs would be higher because specialized barges would have to be used as work platforms.

Several considerations make the submarine cable alternative unfeasible. The marine technology is fairly rare in the United States and has never been used by HECO; therefore, the potential for costly delays and unnecessary construction costs is higher than for the other alternatives. Additionally, the location and repair of faults in the underwater cable, although likely to be rare, would be costly and time-consuming to accomplish. The construction costs of a submarine cable would be comparable with the costs of the underground alternative, or close to $46 million.

The underground cable alternative has both advantages and significant disadvantages. The principal advantage is the low level of visual impact. The disadvantages include significantly higher construction and maintenance costs and much longer time required for construction and repair than for a conventional overhead line. In addition, the extensive excavation required for construction of an underground cable would pose a greater risk to biological and cultural resources. Locating and repairing faults would be costly and time-consuming, with greater disruption to traffic. The costs of an underground cable would be higher (around $45 million) with the potential to increase the cost of electricity to customers.

For the reasons explained above, HECO believes that the overhead transmission line technology is the only feasible alternative for the Waiau-Makalapa No. 2 138 kV Transmission Line Project.

Chapter 3
Project Description

Chapter 3
PROJECT DESCRIPTION

The Waiau-Makalapa No. 2 138 kV Transmission Line Project includes the following facilities and activities:

- Construction of approximately 4.5 miles of 138 kV, single-circuit, alternating current (AC) transmission line between Waiau Power Plant and Makalapa Substation

- Realignment of the existing Makalapa No. 1 line in the vicinity of Aloha Stadium from the makai to mauka side of Kam Highway

- Modification of the Waiau and Makalapa Substations to accommodate new electrical equipment

- Undergrounding of existing 12 kV distribution lines and service connections from Waiau Power Plant to McGrew Point along Kam Highway (subject to Hawaii Public Utilities Commission [PUC] approval)

The Waiau-Makalapa No. 2 138 kV Transmission Line is scheduled to be operational in September 1992.

3.1 ENGINEERING DESCRIPTION

3.1.1 General Configuration

Design, construction, operation, and maintenance of the Waiau-Makalapa No. 2 Transmission Line will be in accordance with HECO's standards for safety and protection of the public, landowners, and property. Requirements of PUC General Order No. 6 (Rules for Overhead Electric Line Construction); the National Electric Safety Code (NESC), and the U.S. Department of Labor, Occupational Safety and Health Standards (USDL OSHA) govern the transmission design.

The proposed Waiau-Makalapa No. 2 Transmission Line will consist of a single-circuit 138 kV transmission line with a single-circuit 46 kV underbuild on tubular steel poles. In Chapter 2, Figure 2.1-1 illustrates the typical single-circuit pole, conductor, and insulator configuration. Table 3.1-1 summarizes the design characteristics of the project. The new poles will generally be placed along existing public rights-of-way and will use the alignment of existing 46 kV poles. Along the makai side of Kam Highway

Table 3.1-1
WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE
DESIGN CHARACTERISTICS

	Units
Line length	4.5 miles (approximate)
Type of structure	Tubular steel, single-pole
Structure height	80 to 135 feet
Structure weight	6,000 to 24,000 pounds
Structure foundation type	Augered/reinforced concrete, piers or piles
Structure foundation dimensions	Piers: 15 to 25 feet deep; 4 to 6 feet in diameter
	Piles: 50 to 150 feet deep
Average span length	300 to 600 feet (longer if needed because of terrain)
Number of structures per mile	9 to 18
Right-of-way width	25 to 100 feet
Land temporarily disturbed	
• Foundation	40 ft by 40 ft, or 1,600 ft^2 (approximately)
• Conductor pulling site	50 ft by 100 ft, or 5,000 ft^2 (approximately)
138 kV conductor configuration	
• Bundle description	Two conductors per phase (three phases per circuit); 12-inch vertical spacing
• Conductor size and type	795 kcmil[1]; AAC "ARBUTUS"[2]
• Conductor ground clearance	30 ft minimum at 212°F, final sag
• Shield wire	Optical ground wire (OPGW)
Normal operating voltage	138,000 volts AC (138 kV) ±5%
138 kV subconductor thermal limit	215 MVA normal (900 amps) 247 MVA emergency (1,035 amps)
138 kV conductor bundle capacity	430 MVA normal (1,800 amps) 480 MVA emergency (2,000 amps)

[1]Cross-sectional measure of the conductor area in thousands of circular mils.
[2]Aluminum industry standard code for the conductor and size of strands.

between Waiau Power Plant and McGrew Point, existing 12 kV lines will be placed underground, if approved by PUC.

3.1.2 Poles

HECO's standard practice in developed areas is to use single-shaft tapered tubular steel poles. The poles are strong, resistant to damage and deterioration, and present a clean design with uniform materials, tapers, and curves. In addition, the gray galvanized poles can be painted to conform to local conditions or easement requirements. These tubular steel poles are custom-designed and manufactured by several mainland firms.

The steel poles are bolted to steel-reinforced concrete foundations. The foundations are designed to resist overturning forces and usually are constructed with either an augured shaft of 4 to 6 feet in diameter and 15 to 25 feet in depth or, in wet soils, 6 to 12 concrete piles (each 50 to 150 feet long) beneath a concrete pile cap.

Pole heights, locations, and span lengths vary and are determined by the following factors: natural terrain and topography, structural limitations, costs, visual considerations, existing and proposed land uses, crossings of man-made features such as roads and telephone lines, and other criteria that may be unique to the project.

The poles, which weigh from 3 to 12 tons, will vary in height from 80 to 135 feet and will average 110 feet. The poles will be similar in height and appearance to those used for the existing Waiau-Makalapa No. 1 138 kV Transmission Line, which consist of tubular steel poles along Moanalua Road from the Waiau Power Plant to Pearlridge Shopping Center and along Salt Lake Boulevard from aloha Stadium to Bougainville Drive.

The poles will be spaced approximately 300 to 600 feet apart, with some longer or shorter spans, depending on final detailed transmission line design. The distances between poles will vary according to the terrain (e.g., the need to span streams or roads), the number of curves and angles in the route, and opportunities to minimize visual impacts by careful pole location. There will be an average of 9 to 18 poles per mile.

In many cases in urban areas, 12 kV distribution lines are located along the same alignment as 46 kV lines. Generally, 12 kV wooden poles are 45 to 55 feet high and are spaced 150 to 300 feet apart, while 46 kV lines are 55 to 65 feet high and are spaced 300 to 600 feet apart. Where existing 46 kV will be strung on the new 138 kV poles, pole heights may be up to 135 feet. In this case, the 138 kV poles will replace the 46 kV poles, but 12 kV poles will remain between the taller poles. The exception will be along Kam Highway between the Waiau Power Plant and McGrew Point, where HECO proposes (subject to PUC approval) to place existing 12 kV distribution lines underground.

3.1.3 Conductors and Insulators

138 kV Conductors

The Waiau-Makalapa No. 2 project will consist of a single-circuit 138 kV transmission line with bundled 795-kcmil, all-aluminum conductors (AAC) "ARBUTUS," arranged in a vertical configuration. The three-phase, bundled transmission line will have two subconductors per phase, electrically connected to share the current. They will be arranged with a vertical separation of 12 inches.

Shield Wires

At the top of each pole and attached at the end of a short crossarm is a shield wire. The shield wire is optical ground wire (OPGW) positioned to shield the 138 kV and 46 kV circuits from direct lightning strikes. Lightning striking the shield wire is conducted to earth (grounded) through the structure. The shield wire will also serve as a communication link between the Waiau Power Plant and the Makalapa Substation.

46 kV Conductors

The single 46 kV circuits will use one 556.6-kcmil AAC "Dahlia" conductor per phase. These conductors are of the same type as the 138 kV conductors but are smaller in diameter.

138 kV Insulators

Post insulators, which are typically used on short or moderate span lengths, are proposed for most poles. Post insulators are rigid, made of glazed porcelain, and mounted on a short bracket. A malleable iron fitting permits the connection of the conductor attachment hardware. Poles that anchor dead-ends or angles in the line will be fitted with suspension insulators, which consist of a string of nine or ten pole insulators for each phase of the line.

46 kV Insulators

In most cases, each 46 kV conductor will be attached to the pole on a horizontally mounted post-type insulator, which is in turn bolted to the end of a short davit arm. Suspension insulators will be used at angle and dead-end poles.

3.1.4 Foundations

A range of geologic conditions exists in the study area (see Subsection 6.3.4, Figure 6.3-4, and Appendix B). Soils along the preferred alignment between the Waiau Power Plant and Aloha Stadium makai of Kam Highway consist primarily of recent alluvium. These soils are generally poorly suited for foundation loads. It is anticipated that a deep pile foundation system will be required to support the transmission line poles in portions of these areas.

Soil types along the preferred alignment between Aloha Stadium and Radford Drive, including the area surrounding Makalapa Substation, consist of volcanic tuff. This formation can support heavy foundation loads. It is anticipated that conventional pier foundations will be used to support the proposed transmission line poles in these areas.

The types of foundations to be used at each pole location will be determined following further geotechnical investigations (including borings and field and laboratory testing) prior to the final design stage of the project. Foundation installation is described in more detail in Subsection 3.3.5.

3.1.5 Underground Installation of Distribution Lines and Service Connections

In conjunction with the Waiau-Makalapa No. 2 138 kV Transmission Line Project, HECO proposes (subject to PUC approval) underground placement of the existing overhead 12 kV distribution lines and service connections on the makai side of Kam Highway between Waiau Power Plant and McGrew Point.

The 12 kV underground lines will be installed in ductlines buried approximately 3 feet beneath the roadway along Kam Highway. The main cable will be a solid dielectric polyethylene-insulated cable approximately 2 inches in diameter. Manholes will be installed every 200 to 300 feet to facilitate cable splicing, service connections and inspections. Four to five switch vaults (pad-mounted metal-clad structures each 4 feet high and 6 by 6 feet square) will be installed along the 2-mile route. HECO will work with customers to identify appropriate locations for the switch vaults on customer property. Each switch vault will service a number of distribution pad-mounted transformers with 12 kV fused/switched feeders.

The existing overhead pole-mounted transformers will be replaced with pad-mounted transformers, ranging in sizes from 3 by 3 feet by 2-1/2 feet high to 5 by 5 feet by 6 feet high (depending on the size of the customer's load). Most commercial and apartment buildings will each require a transformer; in some locations (depending on the size of the load and the distances involved), a single transformer can serve several single-family houses. HECO will work with each customer to identify an appropriate location for the pad-mounted transformer within each customer's property. Transformers may also be installed underground beneath sidewalks; however, due to high initial construction costs and high recurring maintenance costs, this is not usually a viable alternative.

Each customer will be connected to a transformer by an underground secondary line (service connection). Service ductlines and cables will be buried approximately 2 feet deep.

HECO has informed the City and County of Honolulu, GTE Hawaiian Tel, and Oceanic Cable Vision about HECO's plan to underground the distribution line along Kam Highway. If these entities agree to participate, street light feeders, telephone lines, and television cables may also be placed underground. If they decide not to participate, poles that carry cables for these services will remain; however, many of the wooden poles will be shortened after the electric distribution lines are removed.

3.2 RIGHT-OF-WAY ACQUISITION

Right-of-way easements are the land rights acquired for the construction, operation, and maintenance of the transmission line within private property. The right-of-way for the transmission line is established only when all easement rights have been documented.

It is currently proposed that the Waiau-Makalapa No. 2 138 kV Transmission Line route follow, completely or in large part, existing 46 kV subtransmission lines between the Waiau Power Plant and the Makalapa Substation. Assuming the 138 kV line is an overbuild of the existing 46 kV line, few new right-of-way easements need be acquired. If new easements or widening of existing easements are required, they will be negotiated with the individual landowners.

The typical single-circuit 138 kV right-of-way easement varies in width between 25 and 100 feet. In places where the pole is adjacent to a roadway, every attempt is made to site the line within the roadway right-of-way and thus eliminate the need to acquire easements from private landowners. Where the line will be located parallel and adjacent to a state highway in an urban area, the pole must be set back at least 2 feet from the curb. Where curbs do not exist, the pole must be located at least 20 feet from the edge of the traveled roadway, except where protective barriers are installed.

In areas where easements are required, a right of access to the right-of-way will be required during construction and maintenance of the transmission line. Access will be established at a location mutually convenient for both landowner and HECO. If the right-of-way is adjacent to a public road, HECO's franchise rights provide access from the roadway to the line for construction and maintenance.

Typically, several steps are involved in obtaining a transmission line right-of-way. Initially, a land agent contacts each owner (and other parties of interest) to negotiate a perpetual easement to accommodate the proposed transmission line. Following surveying and mapping of the land to be crossed, an appraisal is prepared to provide a basis for determining the market value of the land rights to be acquired. The appraisal is prepared by an independent real estate appraiser and the report is the basis for determining a value payable for the easement.

The owner of each affected parcel is then contacted by HECO's land agent and a price for the easement is negotiated. Adjustments to the appraisal value may be necessary. When a price has been agreed upon with the owners, the formal easement document is prepared and executed, the landowner is paid, and the document is recorded.

A "right to entry" (i.e., a temporary right of access) may also be negotiated if entry is necessary for surveys or preconstruction work before the perpetual easement has been recorded and takes effect.

The landowner grants HECO an easement for its facilities, but retains title to the land and full use of the easement area, subject only to safety limitations such as building heights.

Where easement negotiations are unsuccessful and adjustment to construction or routing requirements are impractical, HECO may invoke a legal option. The state constitution grants certain public bodies and utilities the right of eminent domain. This right gives utilities the power to acquire, through the courts, property rights for facilities to be built in the public interest. Eminent domain (sometimes called condemnation) is used as a last resort if an agreement cannot be reached between a landowner and HECO and an owner refuses to grant an acceptable easement. The court provides for fair compensation to be paid for the easements acquired in condemnations.

HECO attempts to minimize the impact of construction activity on the right-of-way. Claims for damages to land and crops are generally resolved through repair or compensation after construction is completed.

3.3 CONSTRUCTION PRACTICES

During the construction of a typical HECO transmission line, most or all of the following phases of work must be accomplished: surveying, determining access requirements, establishing construction facilities or base yards, installing foundations, erecting poles, installing conductors, and cleaning up and removing construction equipment. In the case of the Waiau-Makalapa No. 2 138 kV Transmission Line, an additional step is proposed, contingent on PUC approval: the placement underground of existing 12 kV distribution lines and service connections between Waiau Power Plant and McGrew Point along Kam Highway. Table 3.3-1 lists typical equipment expected to be used during construction.

3.3.1 Surveying Phase

Surveying for construction of a transmission line includes property, right-of-way, ground profile, access road, and construction surveys. A typical survey crew includes three people. Additionally, geotechnical investigations at selected locations will determine the types of foundations required at each pole site. This activity may require coning off a lane of traffic for a few hours at each test location.

3.3.2 Clearing Requirements

Right-of-way clearing is done when required to prepare for efficient installation of poles and conductors and to provide for required electrical clearances. Because the study area is urban, with little high-growing vegetation, and

Table 3.3-1
TYPICAL EQUIPMENT USED DURING CONSTRUCTION

This table lists equipment that may be used for each major task in the construction of the transmission line. This is an inclusive list; in many cases, not all of the equipment listed here is required.

Construction Category	Purpose
1. Access, Clearing, and Cleanup	
1/2-ton pickup truck	Transport personnel and hand tools
Crew-cab truck	Transport personnel and hand tools
2-ton truck	Haul materials, debris
Chipper	Dispose of cleared trees and limbs
2. Steel Pole Construction	
A. Pier foundations	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
Mechanic's service trucks	Make field repairs
Truck-mounted auger	Excavate foundations
Compressors	Drive pneumatic tools
5-ton trucks	Haul materials
10-ton trucks	Haul materials
20-ton trucks	Haul materials
Tilted trailer	Haul equipment
Concrete mixer trucks	Haul concrete
Tool van	Tool storage
Mobile office trailer	Supervision and clerical office
Front-end loader	Load excavated material
Concrete pump truck	Pump concrete
B. Pile foundations	
(Same as pier foundations, plus the following)	
Pile-driving rig	Drive piles
30-ton cranes (mobile)	Unload and stack piles
15-ton cranes (mobile	Unload and stack piles
C. Pole erection	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
5-ton trucks	Haul materials
10-ton trucks	Haul materials
20-ton trailer	Haul materials
30-ton cranes (mobile)	Erect structures
15-ton cranes (mobile)	Erect structures
80-ton or larger crane, depending on need (mobile)	Erect structures

Table 3.3-1
(continued)

Construction Category	Purpose
3. Conductor Installation	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
Tensioners (truck-mounted)	Install conductor
Pullers (truck-mounted)	Install conductor
Reel trailer with reel stands (semi-trailer type)	Haul conductor
Tractors (semi-type)	Haul conductor
Low-bed trailer	Haul materials
5-ton trucks	Haul materials
10-ton trucks	Haul materials
Take-up trailers (sock line)	Install conductor
Reel winders	Install conductor
Crawl tractors	Install conductor
Auger (truck-mounted)	Excavate pole holes
Line truck	Install clearance structures
Tool vans	Tool storage
Mobile office trailer	Supervision and clerical office
4. Underground Installation of 12 kV Distribution Ducting, Cables, and Service Connections	
Pavement saws	Cut pavement
Jackhammer	Loosen and remove pavement
Backhoe	Dig ditch
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
5-ton trucks	Haul materials
Low-bed trailer	Haul materials
Cable puller and trailer	Haul and install cables
Boom truck	Haul and install cables
Line vans	Haul tools, splicing materials, and personnel

because most construction will occur adjacent to existing roadways, very little, if any, right-of-way clearing will be required.

3.3.3 Access Requirements and Traffic Management Practices

Surface access to each pole location is required during construction. Existing roads are used wherever possible and, in fact, access from existing roads appears to be available for the preferred alignment.

When poles are installed adjacent to roads, part of the road must sometimes be occupied by equipment used in installing foundations, poles and conductor. Work on public roads must follow traffic control procedures prescribed by the Federal Highway Administration, the State Department of Transportation Highways Division, and the City and County of Honolulu Department of Transportation Services. Work adjacent to a state road or highway requires a Permit to Perform Work on State Highways, which must incorporate a Traffic Control Plan approved by the Highways Division. The City and County of Honolulu requires observation of state and federal traffic control regulations for any work on county roads.

According to state procedures, only one lane at a time may be closed on a multilane highway and, on a two-lane highway, wherever possible, lanes of adequate width in both directions must be provided. All lanes must be open to traffic during morning peak hours (6:00 a.m. to 8:30 a.m.) and afternoon peak hours (3:00 p.m. to 6:00 p.m.). HECO and its construction contractors follow state guidelines for the types of signs, lights, markers, position of traffic cones, areas coned off, and the use of flaggers and/or police officers (State of Hawaii Department of Transportation; U.S. Federal Highway Administration, 1978).

Coning off a lane of traffic is usually required during foundation, pole, and conductor installation phases of line construction, and will also be required when existing 12 kV lines are placed underground. At any one point along the new route, traffic might have to be interrupted for several relatively brief periods over the course of a few months. The time required to complete each phase of construction is described in Subsections 3.3.5 to 3.3.7.

3.3.4 Construction of Support Facilities

Construction Yards

A construction yard headquarters will be identified in a location near the new line's route. The construction yard headquarters is the base station where employees report at the start and end of each day's activities. These facilities are used for other activities including field office; pole and davit arm laydown areas; storage of materials, equipment, and vehicles; and security.

One material storage yard, or staging area, will probably be used during construction of the Waiau-Makalapa No. 2 138 kV Transmission Line; it will probably be located on HECO property at or adjacent to the Waiau Power Plant.

3.3.5 Foundation Installation

The next phase in the construction of the transmission line is foundation installation. Foundations for the Waiau-Makalapa No. 2 138 kV Transmission Line will be of the conventional pier or pile type.

Pier Foundations

Foundation installation requires boring a large-diameter hole in the ground and placing a reinforcing steel and anchor bolt cage in the hole. Each hole is then filled with concrete to a depth of 2 feet below finished grade (Figure 3.1-1). While the concrete is curing, backfill is placed and compacted, as necessary, around the foundations. Where holes fill with water during auguring or hole walls are unstable, a corrugated steel culvert pipe is lowered or driven as a form. Concrete is then tremied into the hole, allowing water to be pumped out for conventional completion of the work. Concrete is allowed to cure for a period of 2 to 4 weeks before the poles are placed on the foundations. After the poles are erected, a 6-inch grout is packed under the steel pole.

Typically, two to three foundations at a time are excavated, formed, and poured, requiring 2 to 3 weeks to complete. If the poles are located adjacent to a roadway, foundation installation requires coning off a single lane of traffic for approximately 1,000 to 1,500 feet. This coned area is moved forward as the foundations are completed.

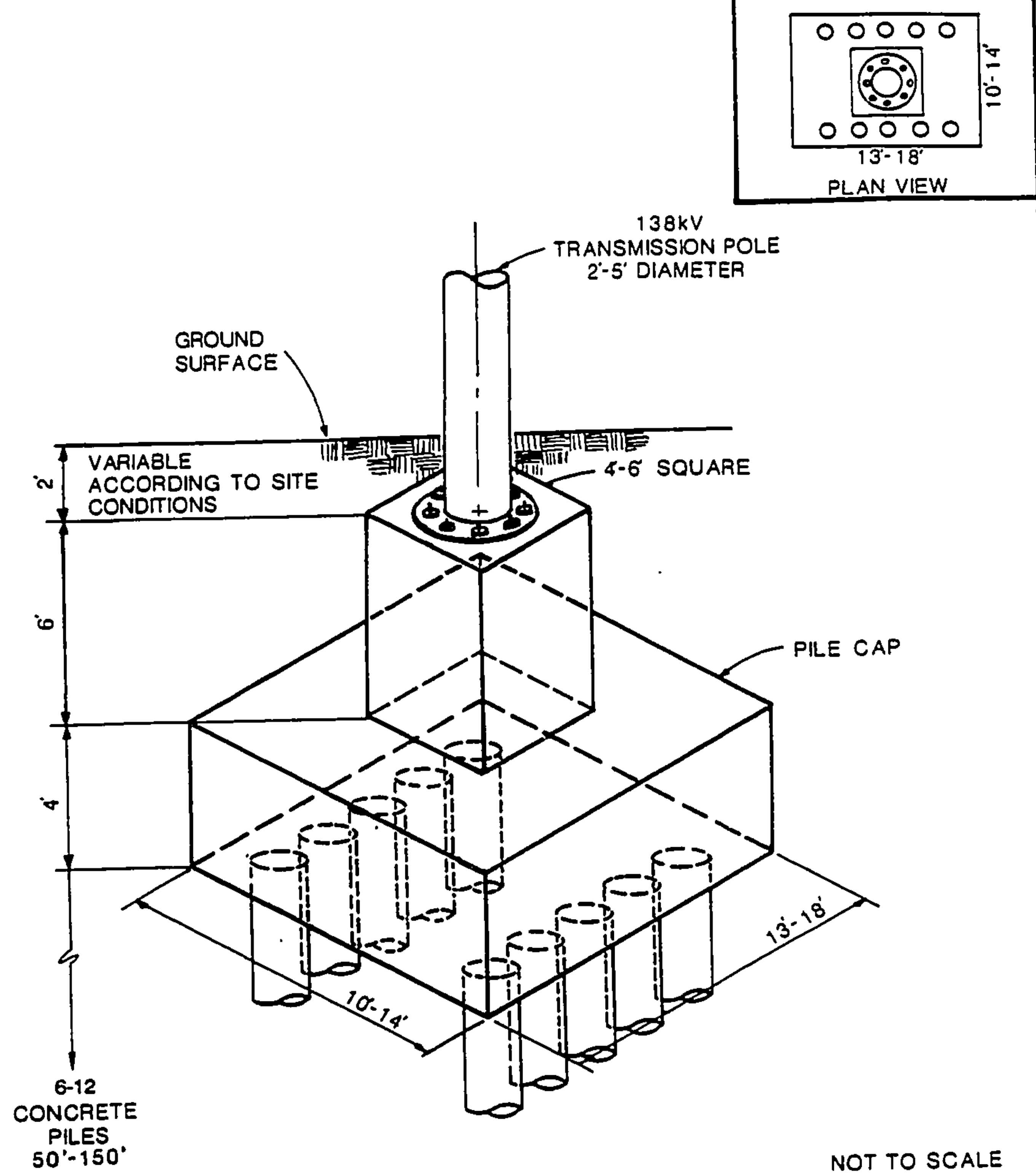

FIGURE 3.3-1

TYPICAL PILE FOUNDATION
(USED IN SOFT, SATURATED SOILS)

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
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Pile Foundations

Pile foundations consist of a square reinforced concrete pile cap (10 to 14 feet by 13 to 18 feet by 4 feet deep) mounted above 6 to 12 concrete piles, each about 50 to 150 feet long (Figure 3.3-1). The steel transmission pole is mounted with steel bolts to a square pedestal (4 to 6 feet square and 6 feet high) attached to the top of the pile cap.

Precast concrete piles are fabricated offsite and are transported to the pole locations by truck. A crane will be used to unload the piles from the tractor-trailer and will be used to place the concrete piles in the "leads" at the front end of the pile-driver, which then moves piles into place to be driven.

A hole is excavated large enough to accommodate the pile cap (at least 15 feet deep by 10 to 14 feet by 13 to 18 feet). If the hole must be excavated in a wet area, sheet piles (12-inch-wide steel sheets) may be driven side to side to exclude water. The piles are then driven to the proper depth.

A diesel, steam, or compressed-air pile-driver is used to drive each pile into the soil. A heavy hammer within a lattice scaffolding drops onto the head of the concrete pile, which is topped by a plywood cushion. In the case of a diesel hammer, diesel fuel within the head of the pile-driver is compressed by the falling hammer and explodes, driving the pile into the ground and the hammer back to its raised position to repeat the cycle. Other pile-driver types use steam or compressed air to raise the hammer after each blow.

The piles are linked into the pile cap by chipping away the concrete from the top 2 to 3 feet of pile, leaving the steel reinforcing or steel cables exposed. The pile reinforcement is woven into the reinforcement of the concrete pile cap and the anchor bolt cage is used to reinforce the pile cap. Concrete is poured into forms surrounding the reinforcement cage and is allowed to cure for a period of 2 to 4 weeks before poles are mounted on the foundation (C. Mimura, 1988; S. Ashord, 1988).

3.3.6 Pole Assembly and Installation

After the foundation concrete is cured, the poles are transported to the pole locations and are assembled and erected. In congested areas, the poles are partially or completely assembled, then transported to the pole locations and erected. A mobile crane is used to lift each assembled pole or section into place.

The base section of each steel pole is fitted with a base-plate with an array of anchor bolt holes that match the anchor bolt pattern installed in the foundation. Anchor bolt leveling nuts are tightened in accordance with the manufacturer's recommendations before the pile is erected. Insulator hardware is assembled and installed on each pole after it is erected.

Approximately two to four poles per day can be erected by four to seven workers.

3.3.7 Conductor Installation

Before conductor installation begins, temporary clearance structures may be installed at road crossings and at locations where the conductors might inadvertently contact existing electrical or communication facilities and vehicular traffic during installation.

"Tension-stringing" is used to install the conductors. This method prevents the conductors from touching the ground or other objects by maintaining a certain tension and sag during the stringing operation. The conductors, the tensioner, the puller, and other related equipment and material are assembled at sites located along the route at 1- to 2-mile intervals. A pulling line (or sock line), which is usually a dacron or nylon rope, is pulled from pole to pole through pulleys (sheaves) attached to the insulators. The conductor is then pulled through the sheaves behind the sock line, brought to a specified ground clearance (sag), and clipped in to dead-end or suspension insulator clamps.

In pole locations adjacent to roadways, one lane would be closed to traffic during pulling and sagging operations. Approximately 1 month is required to complete 1 mile of conductor installation.

3.3.8 Underground Installation of Distribution Lines and Service Connectors

Underground installation of distribution lines and service connections will be completed after the transmission line has been constructed and energized.

First, HECO will work with each customer to establish the customer's demand (load) and the location of pad-mounted transformers required to serve the customer's load. Easements for concrete pads (either 5 by 5 feet or 10 by 10 feet) will be acquired, and transformers ordered.

Next, the primary 12 kV distribution ductline and manholes will be constructed underground within the roadway. Pavement saws, jackhammers and backhoes will be used to cut through the asphalt of Kam Highway and dig a trench approximately 2 to 4 feet wide and 5 to 10 feet deep. Manholes or hand holes of various sizes will be established every 200 to 300 feet, as needed. Concrete pads for switch vaults and transformer vaults will be constructed as needed within the sidewalk area for customers whose properties do not have space for pad-mounted transformers. The main distribution cables will then be pulled into the ductline, spliced in the manholes (or hand holes), and connected to the pad-mounted switch vaults. After the main cables have been installed, 12 kV fused and switched feeders will be installed from the switch vaults to customers' transformers and connected.

Next, the underground distribution lines will be tested and energized and work will begin on converting service connections from overhead to underground. Service connections (between the transformer and the customer) typically require trenches about 2 feet deep and 6 inches to 1 foot wide, depending on the number of ducts required to serve the customer's load. A backhoe will be used to dig the trench. When the new service ductline has been installed, the soil will be replaced and any asphalt or concrete surfaces will be patched. Converting from overhead to underground service connections requires a brief outage for each customer (1 to 3 hours). HECO will work with each customer to schedule the cable installation and conversion at a time that is mutually acceptable to the customer and the construction crews.

After distribution lines and service connections are installed and energized, the old overhead line and any superfluous poles will be removed. In those places where the overhead line shared poles with overhead telephone, television cable, or streetlight feeder lines, these poles will be "topped" (shortened) above the remaining lines.

The entire underground installation of 12 kV distribution lines and feeders is predicted to take 6 to 8 months.

3.3.9 Quality Control, Cleanup, and Removal of Construction Materials

As sections of the transmission line are completed, HECO makes thorough inspections of the work to verify that it is built according to specifications and standards. Anything that does not comply is corrected.

Cleanup work generally includes:

- Removing all temporary crossing and clearance structures and backfilling any remaining holes used for temporary poles
- Disposing of packing crates, reels, shipping material, and debris
- Dressing roads, work sites, and pole sites to remove ruts and leveling and preparing areas for seeding, if required
- Repairing gates and fences to their original condition or better
- Grounding fences and trellises, as needed
- Repairing any damage that occurred during construction

3.3.10 Substation Improvements

To accommodate the Waiau-Makalapa No. 2 138 kV Transmission Line, new equipment must be installed at the substations that terminate the line. At the Waiau Power Plant, three 138 kV circuit breakers and associated steel and concrete support and foundation structures will be installed, along with line protection and control equipment. At the Makalapa Substation, two 138 kV circuit breakers and associated line protection and control equipment, and steel and concrete support and foundation structures will be installed. All substation work will take place within existing HECO property.

3.4 PROJECT SCHEDULE, COST, AND WORK FORCE

Figure 3.4-1 illustrates the project schedule and shows the duration of government approvals, surveying, soil testing, engineering and design, pole manufacturing and delivery, and construction. Construction of the transmission line will take about 16 months, from May 1991 to September 1992.

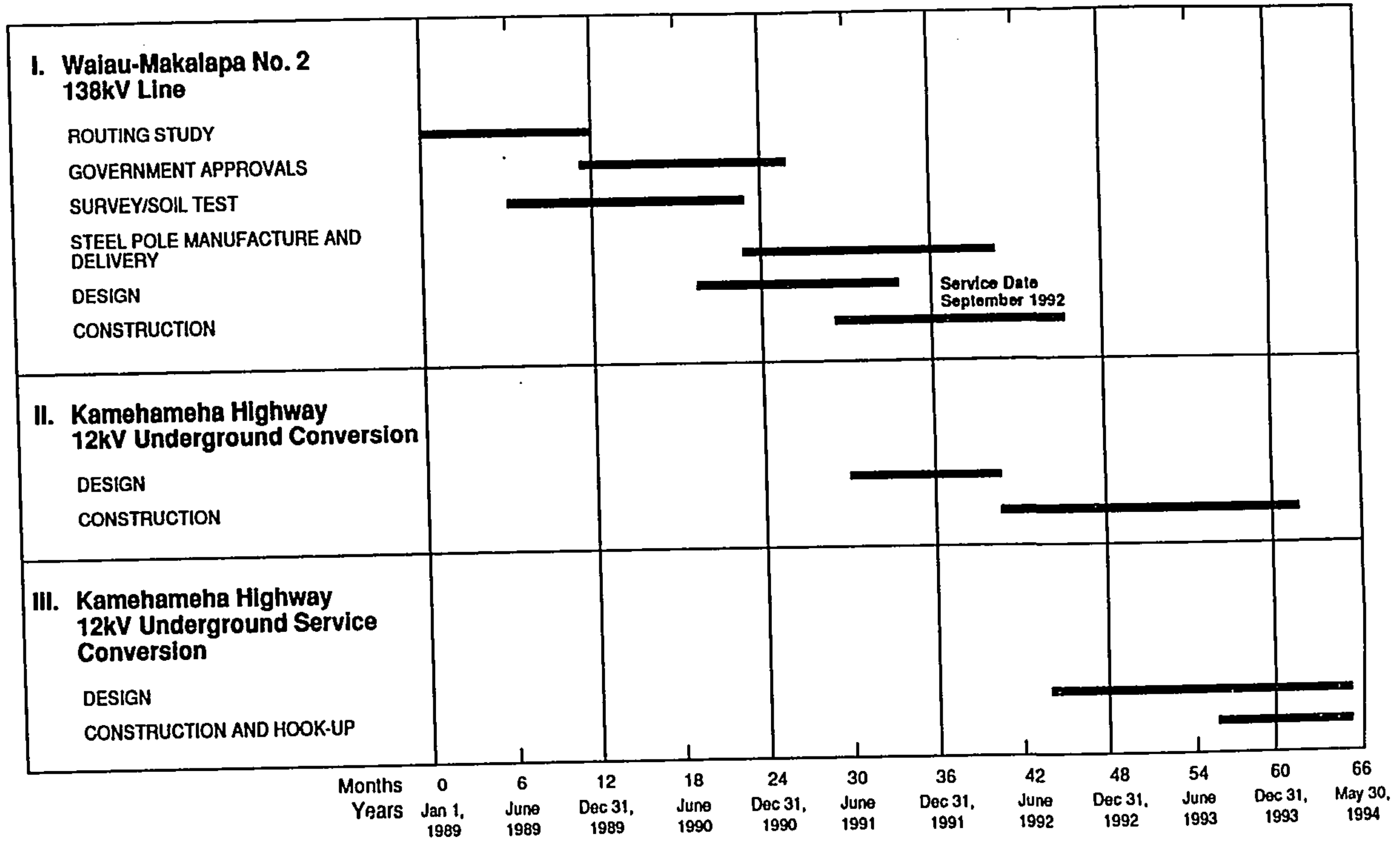


FIGURE 3.4-1

PROJECT SCHEDULE

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

Operation of the line is scheduled for 1992. Placing existing 12 kV distribution lines underground along Kam Highway would occur after the 138 kV line is constructed and the line has been energized. Underground placement of the 12 kV lines is scheduled to occur between mid-1992 and mid-1993.

The estimated capital cost for the Waiau-Makalapa No. 2 138 kV Transmission Line Project is $27.7 million (in 1991 dollars). This amount includes $21.0 million for the overhead 138 kV line and substation improvements and $6.7 million to place existing overhead 12 kV lines and service connections along portions of Kam Highway underground.

The construction work force for the Waiau-Makalapa No. 2 138 kV Transmission Line Project will be made up of 30 to 40 workers. There will be two separate work forces, one for substation improvements and another for transmission line construction.

Foundation construction will probably be performed by contractors. HECO construction crews will erect the poles and string the conductors with a work force of approximately 20 workers. HECO construction crews will also make necessary substation improvements. The substation work force will be smaller--approximately 10 to 20 workers.

3.5 OPERATION AND MAINTENANCE

3.5.1 Operational Characteristics and Procedures

The proposed transmission line will be energized and operated at a nominal voltage of 138 kV, plus or minus 5 percent. Changes in load flow will cause minor fluctuations in the actual operating voltage. With HECO's supervisory control system, dispatchers in a power control center direct the day-to-day power scheduling and operate switchgear and other devices, as required, to maintain and protect the system. Circuit breakers operate automatically in an emergency to help ensure the security and stability of the system.

3.5.2 Right-of-Way Use

Land use activities within and adjacent to the transmission line right-of-way would be permitted within the terms of the easement. Incompatible activities within the right-of-way include constructing buildings, drilling wells, growing trees that may interfere with line operation, or other activities that may compromise safety. If necessary, appropriate techniques would be used within the right-of-way to control vegetation that might interfere with reliable service. HECO's standard vegetation control practice is to trim or remove all vegetation within 10 feet of the extreme position (defined as the lowest position of the conductor at rest or the farthest position in high winds) of 138 kV conductors and within 8 feet of the extreme position of 46 kV conductors. Low-growing vegetation may be left in the right-of-way.

3.5.3 Maintenance Practices

The proposed transmission line structures and rights-of-way would be regularly inspected on foot or vehicle two times per year. A detailed climbing inspection of the line would be conducted every 5 years.

Emergency repair would be made if the transmission line were damaged and required immediate attention. Maintenance crews use tools, trucks, assist trucks, aerial lift trucks, cranes, and other equipment necessary for repairing and maintaining insulators, conductors, and structures.

HECO Engineering and Distribution Departments are developing a program for live line maintenance, which enables personnel to approach and work on transmission lines without de-energizing them. Although specialized equipment and insulation are needed, live line maintenance procedures can be used to complete certain repairs with the line energized to minimize outage requirements.

The underground 12 kV distribution line will be inspected yearly through manholes in the street. Switching equipment and transformers will be visually inspected during the same inspection.

Chapter 4
Transmission Line Routing Methodology

Chapter 4
TRANSMISSION LINE ROUTING METHODOLOGY

4.1 OVERVIEW OF ROUTING STUDY PROCESS

The methodology used for selecting the route for a transmission line is a sequence of analytical tasks that are organized in two phases, as outlined below.

<u>Phase I--Regional Study</u>

Task 1--Project Definition
Task 2--Regional Study and Corridor Identification

<u>Phase II--Corridor Evaluation and Alignment Selection</u>

Task 3--Corridor Evaluation
Task 4--Alternative Alignment Identification
Task 5--Preferred Alignment Selection

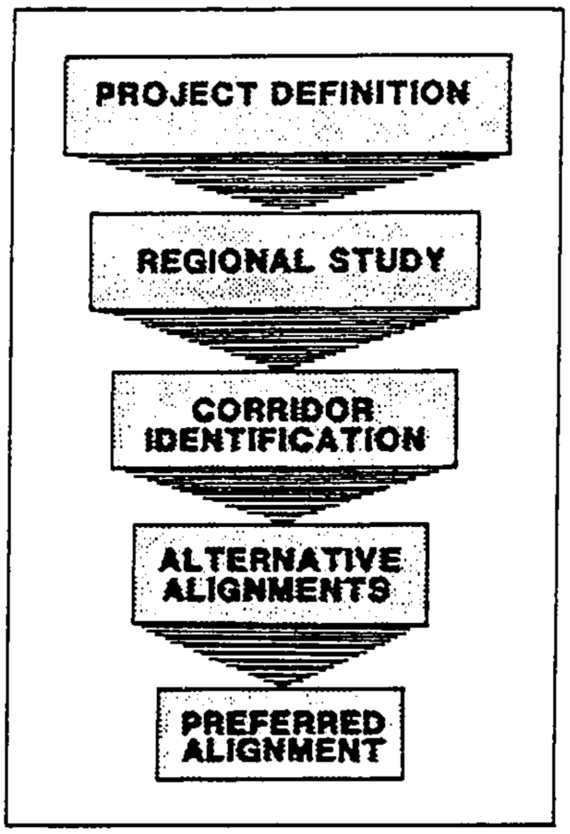
The route selection process considers many factors simultaneously, including:

- Public concerns
- Government agency concerns
- HECO's system reliability and existing transmission system
- Potential environmental and land use impacts
- Economic impacts for both HECO and its customers

The objective of the siting process is systematically to reduce a relatively large geographic study area to alternative corridors through the evaluation of opportunities and constraints. The width of the alternative corridors may vary (one-quarter to one-half mile wide) depending on the number of constraining factors in any particular area, but corridors are wide enough to permit the location of several alternative alignments.

More detailed study of the corridors results in the selection of a preferred corridor, which is followed by the identification of alternative alignments. Alignments are strips of land within the corridor (100 feet wide) on which the transmission line could be sited and constructed. The alternative alignments are subject to further detailed evaluation that results in the selection of a preferred alignment.

Throughout the process, as the study area narrows to a defined route, environmental data are collected and analyzed, the public and agencies are consulted, and field work is conducted. The information and results gathered from these efforts are continually refined and reevaluated. A conceptual illustration of the siting process is shown below, followed by a brief description of each task in the two phases of the process.



Task 1--Project Definition

HECO conducts engineering studies to determine the need for the project and specifies the required transmission line characteristics.

Task 2--Regional Study and Corridor Identification

A study area that contains the lines' end points and areas that could be affected by the location of the line is established. Following identification of the study area, environmental and land use information is collected and mapped and used to identify opportunities and constraints for line location. This information is then used to delineate alternative transmission corridors.

Task 3--Corridor Evaluation

Community meetings or workshops are held to review the alternative corridors with interested groups and individuals. Based on the input received at the workshops, along with a more detailed evaluation of environmental and engineering factors, a preferred corridor is selected for more detailed study.

Task 4--Alternative Alignment Identification

Additional information on conditions within the preferred corridor is gathered through detailed field studies. The information is mapped and analyzed. Transmission engineers, assisted by environmental and land use specialists, then select alternative alignments within the corridor. The alignments are selected to reflect a balance among public concerns, environmental factors, engineering requirements, and economic considerations. Because not all impacts can be avoided, measures to mitigate for potential negative impacts are evaluated.

Task 5--Preferred Alignment Selection

Input from the community workshops and information gathered in consultation with city, county, state, and federal agencies are used to make adjustments to the potential alignments. With this input and further technical analyses, a preferred alignment is selected.

4.2 STEP-BY-STEP PROCEDURE

This section describes the step-by-step procedure that was used to select the preferred alignment for the Waiau-Makalapa No. 2 138 kV Transmission Line Project. The procedure is illustrated in Figure 4.2-1.

PHASE I--Regional Study and Corridor Identification

Step 1. Evaluate System Requirements and Define Project Needs

The system requirements and needs for the Waiau-Makalapa No. 2 138 kV Transmission Line were established by HECO and are described in Chapter 1 of this report.

Step 2. Describe and Evaluate Transmission Line Alternatives

Alternatives to a conventional overhead transmission line were identified and a comparative evaluation was conducted of their limitations, advantages, and potential environmental effects relative to an overhead line. Transmission alternatives evaluated were:

- Conventional overhead transmission line--over land
- Overhead transmission line across Pearl Harbor
- Underground transmission cable
- Submarine transmission cable

Each of the transmission alternatives was evaluated based on:

- Geological considerations
- Biological considerations
- Electromagnetic fields
- Socioeconomic factors
- Maintenance and repair considerations
- Cost
- Permit considerations

The comparative evaluation of transmission alternatives is presented in Chapter 2.

Step 3. Determine Study Area

A study area was established to include--but to the extent possible, minimize--the distance required to connect the Waiau Power Plant and the Makalapa Substation. Other criteria used in establishing the study area were designed to:

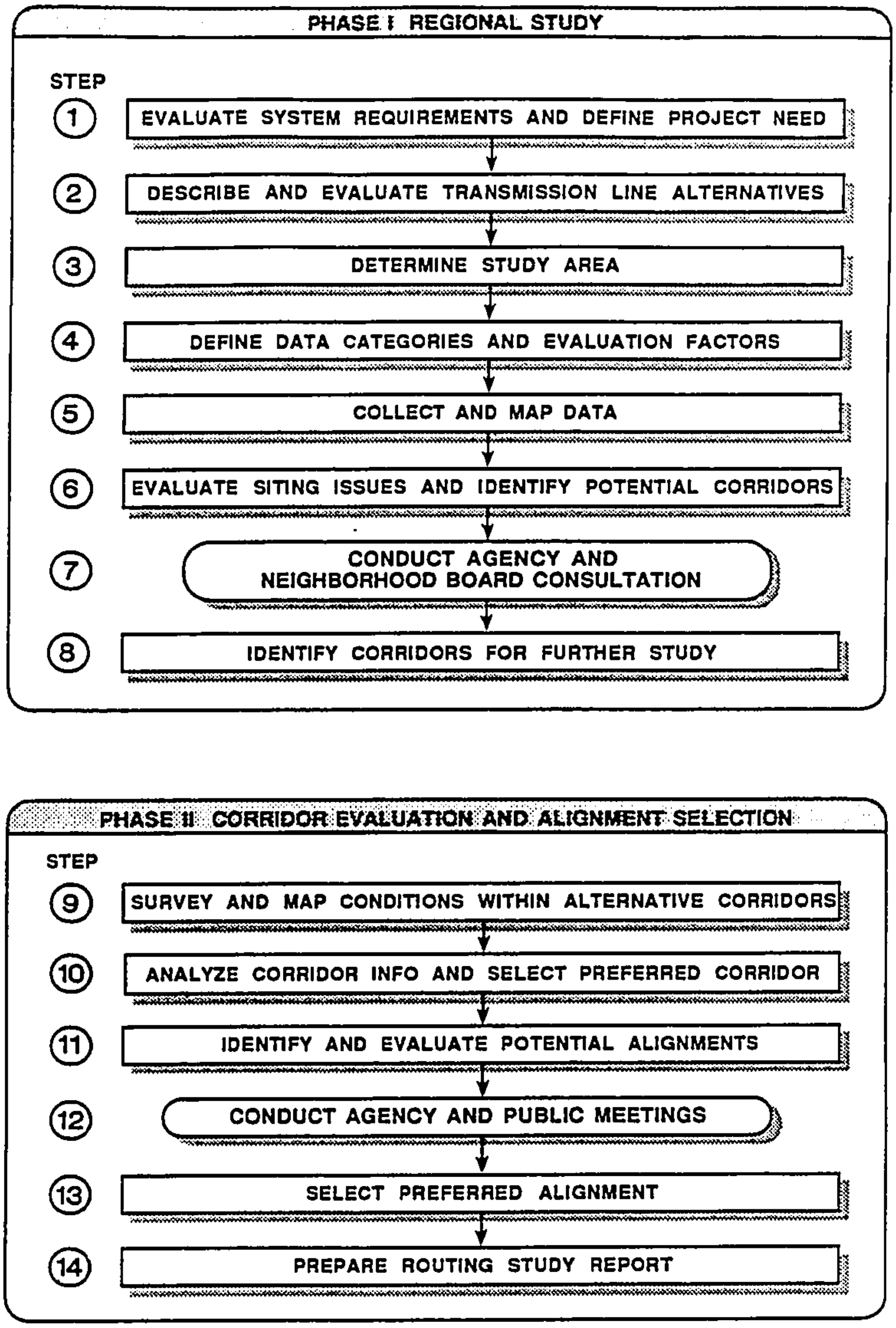
- Include sufficient area to allow flexibility in the siting of the new line

- Include major transportation and utility corridors

FIGURE 4.2-1

Waiau-Makalapa No. 2 Transmission Line Project

Routing Study Process



- To the extent possible, minimize the inclusion of residential areas

- Include all shoreline areas, but minimize open water areas

Step 4. Define Data Categories and Evaluation Factors

To structure the analysis and provide a means to focus the study area on alternative corridors, a comprehensive range of resource categories and, within them, sets of evaluation factors were established. These categories span the considerations that are appropriate to the data gathering needs for thoroughly evaluating a linear construction project.

Table 4.2-1 is a list of the specific information collected, mapped, and analyzed based on the data categories and data evaluation factors used in Phase I--Regional Study and Corridor Identification (see Chapter 5).

Step 5. Collect and Map Data

A reproducible base map of the study area was prepared at a scale of 1:24,000 (1 inch equals 2,000 feet). U.S. Geological Survey 7.5 minute quadrangle maps were the basis for a pin-registered overlay mapping system.

A comprehensive database representing the data categories and evaluation factors shown in Table 4.2-1 was compiled from published sources, agency files and maps, EISs, project area planning documents, and black and white aerial photographs taken specifically for this project.

Step 6. Evaluate Siting Issues and Identify Potential Corridors

Information collected and mapped at the regional study level was evaluated to identify the siting issues that influence the identification of potential corridors. This evaluation revealed that the study area is highly urbanized, with a complex mix of land jurisdiction and uses. Because of the diversity and extensive development, transmission line siting could not avoid affecting a mix of uses. The study area was further examined for major constraints that could be avoided and opportunities for siting the line. Principal guidelines used to identify potential corridors were:

- Avoid conservation areas

- Avoid major residential areas

Table 4.2-1
PHASE I--REGIONAL STUDY AND CORRIDOR IDENTIFICATION
DATA CATEGORIES AND FACTORS

Data Categories	Data Factors
Land Jurisdiction	Military lands State of Hawaii City/County Private
Land Regulation	State land use districts Special management areas
Existing Land Use	Civilian lands • Residential • Commercial • Industrial • Agricultural • Public/semipublic • Schools • Hospitals • Parks/recreation • Preservation • Utilities Military lands • Housing • Supply, training, operations, and maintenance • Administration and community facilities • Recreation
Proposed Land Use	Planned Approved Under construction
Biological and Water Resources	Vegetation types Flood-prone areas Streams/channels
Cultural Resources	Good resource potential Moderate resource potential Poor resource potential Fill areas National Historic District
Utility Systems	Power plant Substation 138 kV lines 46 kV lines
Roads and Pipelines	Roads Pipelines

- Make maximum use of existing transmission line rights-of-way and transportation corridors

- Avoid crossing existing 138 kV transmission lines and maintain separation from existing 138 kV lines for maximum reliability

Applying these guidelines resulted in the narrowing of the study area and the identification of potential corridors (see Section 5.3).

Step 7. **Conduct Agency and Neighborhood Board Consultation**

Government agencies, residents, and neighborhood boards in or near the study area were kept informed about the progress of this study from the outset and were consulted for their opinions and concerns on the potential corridors at several informational meetings (see Chapter 8).

Presentations were given to the following neighborhood boards:

• Pearl City Neighborhood Board Development Plan and Zoning Committee	March 17, 1988
• Aiea Neighborhood Board	April 11, 1988
• Aliamanu/Salt Lake/Foster Village Neighborhood Board	May 12, 1988

Agency consultation (both formal and informal) was conducted. Federal, state, city, and county agencies were contacted during the data collection process. A formal consultation meeting of representatives from 18 agencies was held February 5, 1988, in which the project purpose and need and potential corridors were presented. Input on specific issues, concerns, and corridor preferences was solicited.

Through newsletter, phone calls, and in-person briefings, key elected officials and other interested individuals were consulted and informed about the project. Chapter 8 discusses the public and agency consultation program.

Step 8. **Identify Alternative Corridors for Further Study**

A workshop was held at HECO offices on February 18, 1988, to consider the input received from the agency and public consultation; to review land use, environmental, and electrical issues that would be considered to adjust the potential corridors; and to select alternative corridors for further study. The potential corridors were more closely evaluated in this task. In advance of the workshop at HECO, existing maps, data, and field notes were reviewed; brief site visits were conducted; and an evaluations summary was prepared. Two alternative corridors were identified for further study.

One corridor runs between Kam Highway and the shoreline from the Waiau Power Plant to North Road. It then follows Bougainville Drive to Makalapa Substation. This corridor includes opportunities to consolidate the new line with existing 46 kV lines along the shoreline and Kam Highway and largely avoids residential areas.

The second corridor follows Salt Lake Boulevard crossing makai to Aloha Stadium to Makalapa Substation. This corridor offers opportunities to consolidate the new line with an existing 46 kV line along Salt Lake Boulevard.

PHASE II--Corridor Evaluation and Alignment Selection

Step 9. Survey and Map Conditions Within Alternative Corridors

Conditions in the alternative corridors that influence the identification and selection of a transmission line alignment were defined and mapped. The types of information and conditions largely correspond to the data factors for the Phase I Regional Study, but these data were analyzed and mapped at a finer scale than in the regional study. Some additional data were identified and mapped for evaluation of the alternative corridors; Table 4.2-2 shows these additional data factors.

The first step in this effort was to adjust the map scale. Reproducible base maps at a scale of 1 inch equals 500 feet were prepared.

Meetings were held with each technical investigator to establish the data collection and documentation requirements.

Field surveys were conducted for biology, archaeology, soils, geology, and visual resources. Land use interpretations based on aerial photographs were confirmed through field verification surveys. Land ownership and jurisdiction details were determined from tax key maps. Agencies and developers were consulted about the status of proposed projects.

Table 4.2-2
PHASE II--CORRIDOR EVALUATION AND ALIGNMENT SELECTION
ADDITIONAL DATA FACTORS

Data Categories	Data Factors
Land Jurisdiction and Regulation	Hawaiian Electric Co. Bishop estate Other private parcels greater than 5 acres Other private parcels less than 5 acres Energy corridor
Land Use	Residential (single-family) Residential (multifamily)
Geological	Geological type/formation
Visual	Key viewpoints for visual stimulations

Color aerial photography of the alternative corridors was done during this task at a scale of 1 inch equals 1,000 feet to provide a reliable data source for refinement of existing land use identification and to support the biological investigation and public presentations.

Step 10. Analyze Corridor Information and Select Preferred Corridor

After the corridor resource information was mapped and quantified, an alternative corridor evaluation was conducted. This evaluation involved comparing all the mapped data factors and determining which corridor had the best opportunity of accommodating alignments that met the following criteria:

- Avoid existing residential areas and schools
- Maximize separation from existing 138 kV lines
- Avoid proposed projects

In addition, potential permit requirements for the corridors were compared. Following the evaluation, the Salt Lake Boulevard Corridor alternative (SL) was eliminated from further consideration and the Kam Highway/Shoreline alternative (KS) was selected as the preferred corridor (see Chapter 6 for discussion).

Step 11. Identify and Evaluate Potential Alignments

The preferred corridor was then analyzed in further detail and alternative alignments approximately 100 feet wide were identified. Additional criteria used to identify and evaluate alignment alternatives included:

- Use suitable 46 kV overbuild opportunities
- Use public roads and highways
- Avoid areas with soil conditions that could require special foundation requirements
- Avoid siting adjacent to pipelines

Step 12. Conduct Agency and Public Meetings

Additional public information meetings were held on the following dates and locations:

• Pearl City Alignment Public Meeting	November 16, 1988
• Aiea/Foster/Village/ Aliamanu Alignment Public Meeting	November 17, 1988
• Pearl City Neighborhood Board	August 31, 1989
• Aiea Neighborhood Board	September 11, 1989
• Aliamanu/Salt Lake/Foster Village Neighborhood Board	September 14, 1989

These meetings provided a forum for review and comment on the alternative alignments. During the meetings, attendees examined detailed maps; compared alternatives; and shared comments, suggestions, and ideas with each other and the project representatives. Information gathered at these meetings was used in selection of the preferred alignment.

On September 11, 1989, the Aiea Board unanimously approved a motion that the Board go on record as supporting the undergrounding of 12 kV distribution lines along Kam Highway and supporting the 138 kV line construction.

On September 14, 1989, the Aliamanu/Salt Lake/Foster Village Board also approved a motion to support the preferred alignment for the Waiau-Makalapa No. 2 Transmission Line.

A second consolidated agency meeting was held on November 29, 1988 to review, discuss, and receive agency input about the alternative alignments. This information was also used in selecting the preferred alignment.

Step 13. Select Preferred Alternative

Based on the input received from the public and agency meetings, the alignments were adjusted and a preferred alignment, which balanced engineering, environmental, and economic considerations, was selected by HECO. The preferred alignment is described in Chapter 7.

Step 14 Prepare Routing Report and Environmental Assessment

The findings of the Waiau-Makalapa No. 2 138 kV Transmission Line Project routing studies were documented in this Routing Report and the Environmental Assessment that accompanies it.

Chapter 5
Regional Study and Corridor Identification

Chapter 5
REGIONAL STUDY AND CORRIDOR IDENTIFICATION

5.1 STUDY AREA DEFINITION

The Waiau-Makalapa No. 2 138 kV Transmission Line Study Area (Figure 5.1-1) occupies approximately 5 square miles (3,200 acres) along the shoreline of the East and Southeast Lochs of Pearl Harbor. The total study area includes water within Pearl Harbor (approximately 650 surface acres, or 20 percent of the study area) and approximately 2,650 acres of land (80 percent of the study area). The Waiau Power Plant marks the northern boundary of the study area, and the Pearl Harbor intersection (i.e., Kam Highway, H-1, and Pearl Harbor Boulevard) marks the southern boundary. The land area extends from the East Loch shoreline near Waiau Power Plant on the west through Foster Village to the U.S. Coast Guard Red Hill reservation on the east.

The following guidelines were used to define the study area:

- Include sufficient area to allow flexibility in locating a new 138 kV transmission line right-of-way
- Include all shoreline areas, but minimize the open water areas
- Minimize the inclusion of major residential communities
- Include existing major linear facilities, including transportation rights-of-way and utility corridors
- Minimize the length of the route connecting the power plant and the substation

5.2 RESOURCE INVENTORY AND CORRIDOR IDENTIFICATION

5.2.1 Data Evaluation Factors

To structure the regional analysis and provide a means for narrowing the study area to alternative corridors, a comprehensive range of resource categories was identified and, within these categories, sets of data factors were established. The data factors were selected because they are relevant to siting a linear construction project such as a transmission line. They include those environmental and land use data that would influence the location of a corridor one-quarter to one-half mile wide and, when considered in total, form a comprehensive database that characterizes environmental conditions and uses within the study area. During the process of identifying alternative corridors, each data factor was evaluated separately. The objective was to analyze the opportunities and constraints relative to each data factor as if all other factors were equal. No single factor determined corridor location.

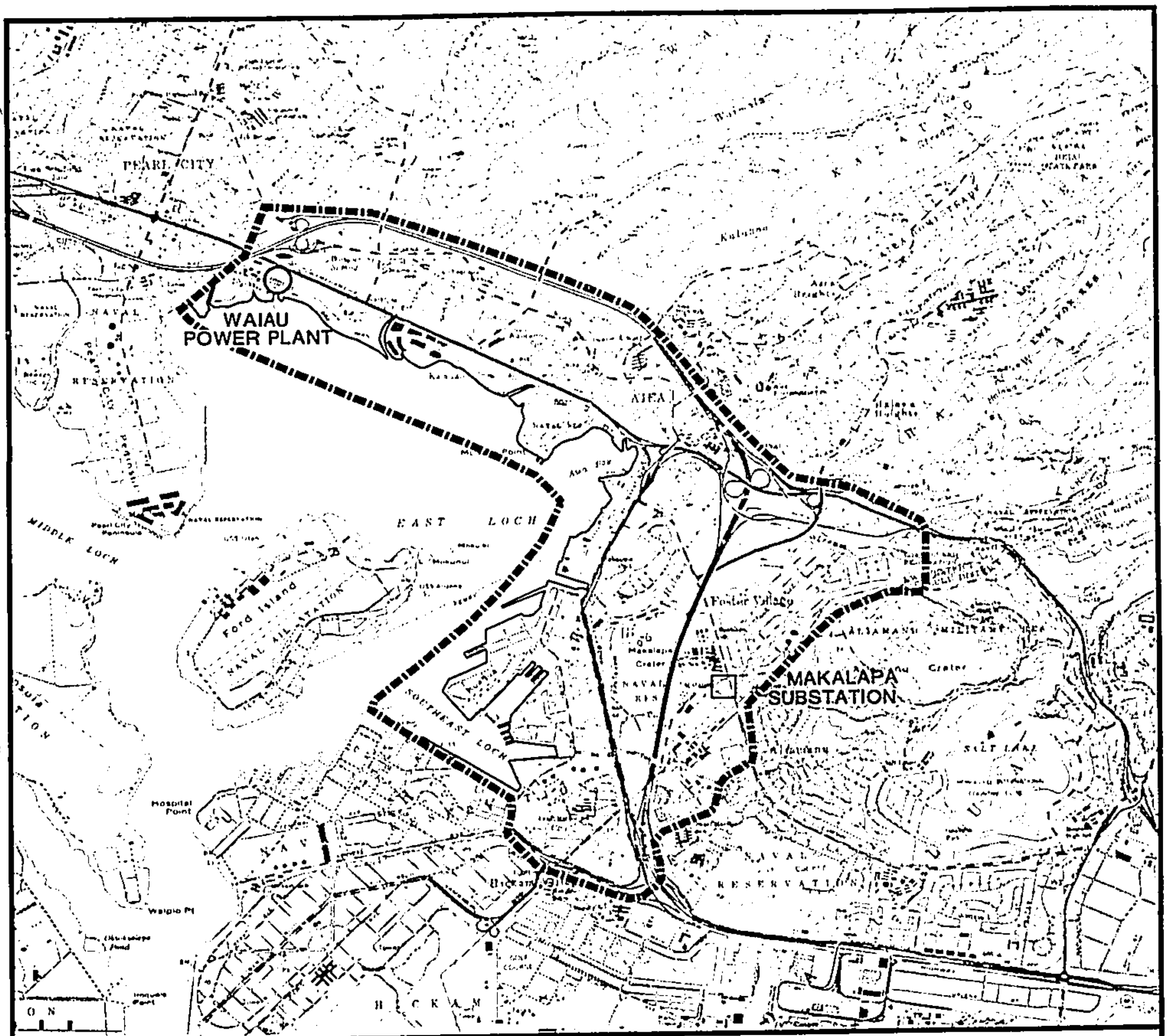
Resource categories were identified and data factors defined for the entire study region. The parameters of each data factor were defined with respect to Oahu's unique characteristics. Data were collected from available information, supplemented with field verification.

Several means were used to characterize the study area. Acreage was calculated as a percent of the total study area and land area, where feasible, for each data factor (Table 5.2-1). An inventory of the resources within the study area was conducted and is provided in Subsections 5.2.2 through 5.2.8. Definitions used for the data factors are provided in Appendix A, Data Factor Definitions.

5.2.2 Land Jurisdiction

Overview

Land jurisdiction does not in itself constrain corridor location; however, parcel size and ownership can affect right-of-way location and acquisition. The acquisition of a right-of-way (usually 25 to 100 feet wide) would have a more significant impact on the potential use of small parcels than it would on large ones. Landowners are primarily concerned that transmission line rights-of-way do not divide their landholdings into small irregular-shaped parcels that could reduce the value of their property. In addition, the negotiations involved in acquiring the right-of-way easements through an area with numerous small parcels, each with different owners, could take substantially longer than through areas with a single owner. Other factors that influence corridor location are the permits, policies, and guidelines that act to regulate development within certain jurisdictions. These requirements vary with the type of owner: federal, state, city/county, or private landholding. Therefore, identifying and mapping major jurisdictional boundaries within the study region determines ownership patterns and helps to establish the broad guidelines that can influence corridor location.



STUDY AREA LOCATION

Study Area Boundary

FIGURE 5.1-1

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

Waiau - Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

CH2M HILL

Table 5.2-1
DATA FACTORS AND LAND AREA COMPARISON

Category	Acres	% Total Study Area	% Total Land Area
Study area	3,300	100.00	N/A
Open water	647	19.61	0.00
Land area	2,653	80.39	100.00
Resource Category/Data Factor			
Land Jurisdiction			
Military lands			
U.S. Navy	909	27.55	34.26
U.S. Army	14	0.42	0.53
U.S. Coast Guard	28	0.85	1.06
Total Military	951	28.82	35.85
State of Hawaii	154	4.67	5.80
City/County of Honolulu	81	2.45	3.05
Private	1,467	44.45	55.30
Land Regulation			
State land use districts			
Conservation	103	3.13	3.90
General subzone	90	2.73	3.39
Resource subzone	13	0.39	0.49
Agriculture	17	0.52	0.64
Urban	2,533	76.75	95.46
Special Management Area	520	15.76	19.60
Existing Land Use			
Civilian lands			
Residential	652	19.76	24.58
Commercial	259	7.85	9.76
Industrial	438	13.27	16.51
Agricultural	17	0.52	0.64
Public and semipublic facilities	270	8.18	10.18
Schools			
Hospitals			
Parks and recreations areas	129	3.91	4.86
Preservation	30	0.91	1.13
Utilities	49	1.48	1.85
Highway rights-of-way interchanges	441	13.36	16.62
Stationary views	N/A	N/A	N/A
Military lands			
Housing	121	3.67	4.56
Supply, training, operations, and maintenance	60	1.82	2.26
Administrative and community facilities	64	1.94	2.41
Recreation and conservation buffer	123	3.73	4.64

Table 5.2-1
(continued)

Category	Acres	% Total Study Area	% Total Land Area
Biological and Water Resources			
Vegetative types			
Koa-haole scrub	24.67	0.74	0.92
Wetlands	83.49	2.53	3.15
Urban complex	2,545.04	77.12	95.93
Flood-prone areas	28.14	0.85	1.06
Open lined channel	31.31	0.95	1.18
Cultural Resources			
Unsurveyed areas			
With good resource potential	661.85	20.06	24.95
With moderate resource potential	372.2	11.28	14.03
With poor resource potential	1,365.6	41.38	51.47
Fill areas (poor resource potential)	253.35	7.68	9.55
Utility Systems			
Power plant	32.7	0.99	1.23
Substations (three)	4.76	0.14	0.18
138 kV lines	51.2	1.55	1.92
46 kV lines	119.7	3.63	4.51
Roads and Pipelines			
Roads and highways			
Interstate H-1	119.3	3.62	45.0
Interstate H-3 (proposed)	7.3	0.22	0.27
State Rt. 99 (Kam Hwy)	60.7	1.84	2.29
State Rt. 78 (Moanalua Fwy)	15.2	0.46	0.57
Moanalua Road (balance)	17.9	0.54	0.67
Salt Lake Boulevard	8.9	0.27	0.33
Kaahumanu Road	1.4	0.04	0.05
Kaonohi Road	1.5	0.05	0.06
Kaamilo Road	0.5	0.00	0.00
Kahaupaani Road	2.8	0.08	0.11
Radford Road	1.1	0.03	0.04
Halawa & H-1/Kam Hwy Interchange	135.00	4.09	5.09
Pipelines			
HIRI pipelines (10" & 12")	16.2	0.49	0.61
GASCO pipeline (16")	16.2	0.49	0.61
Chevron USA pipelines (8")	1.9	0.05	0.07

Note: The following assumptions were used in calculating the area of linear facilities:

Feature	Average Width of Right-of-Way (feet)
138 kV transmission lines	50
46 kV transmission lines	50
Interstate highways	200
State routes	110
Major local roads	60
Minor local roads	30
Pipelines (HIRI and Gasco)	30
Pipelines (Chevron)	15

Source: State of Hawaii, Department of Transportation, Right-of-Way Map.

The State of Hawaii Tax Key Maps (Real Estate Atlas of Hawaii, 1987 edition) were used to determine land ownership.

Inventory

The study area includes property under the jurisdiction of the United States, the State of Hawaii, the City and County of Honolulu, and private landowners (Figure 5.2-1).

Military Lands

Lands owned by the United States and administered by the Department of Defense and Department of Transportation consist of a total of approximately 950 acres, or nearly 36 percent of the study area.

The U.S. Navy lands are part of the Pearl Harbor Naval Base Complex. Among the Navy facilities are the McGrew Point housing area, the headquarters of the Pacific Division (PACDIV), and Public Works Center Main Compound, the Richardson Recreation Center, NAVSTA Pearl Harbor, SUBASE Pearl Harbor, Naval Supply Center (NSC), and military troop and officer housing. U.S. Army activities are limited to a small area of housing in the vicinity of Aliamanu. In addition, the Coast Guard (Department of Transportation) holdings consist of a small section (28 acres) of the Red Hill housing area.

State of Hawaii

The State of Hawaii owns and, through various state agencies, administers approximately 154 acres of land (6 percent of the study area) plus additional land (approximately 441 acres, or 17 percent of the land area) in the form of freeway and major highway rights-of-way and interchanges. Major state-owned properties include the Aloha Stadium, several schools, and small parcels near the shoreline that have been proposed for the Aiea Bay State Recreation Area.

City/County of Honolulu

The City and County of Honolulu owns and, through various city/county departments, administers 81 acres (3 percent of the land area) in the form of school properties and stream channel protection and improvements.

Private

Private holdings amount to 1,467 acres, or 55 percent of the land area.

5.2.3 Land Regulation

Overview

Land regulation identifies areas that are subject to regulatory controls of state, city, and county governmental agencies in order to protect resources and to guide future development.

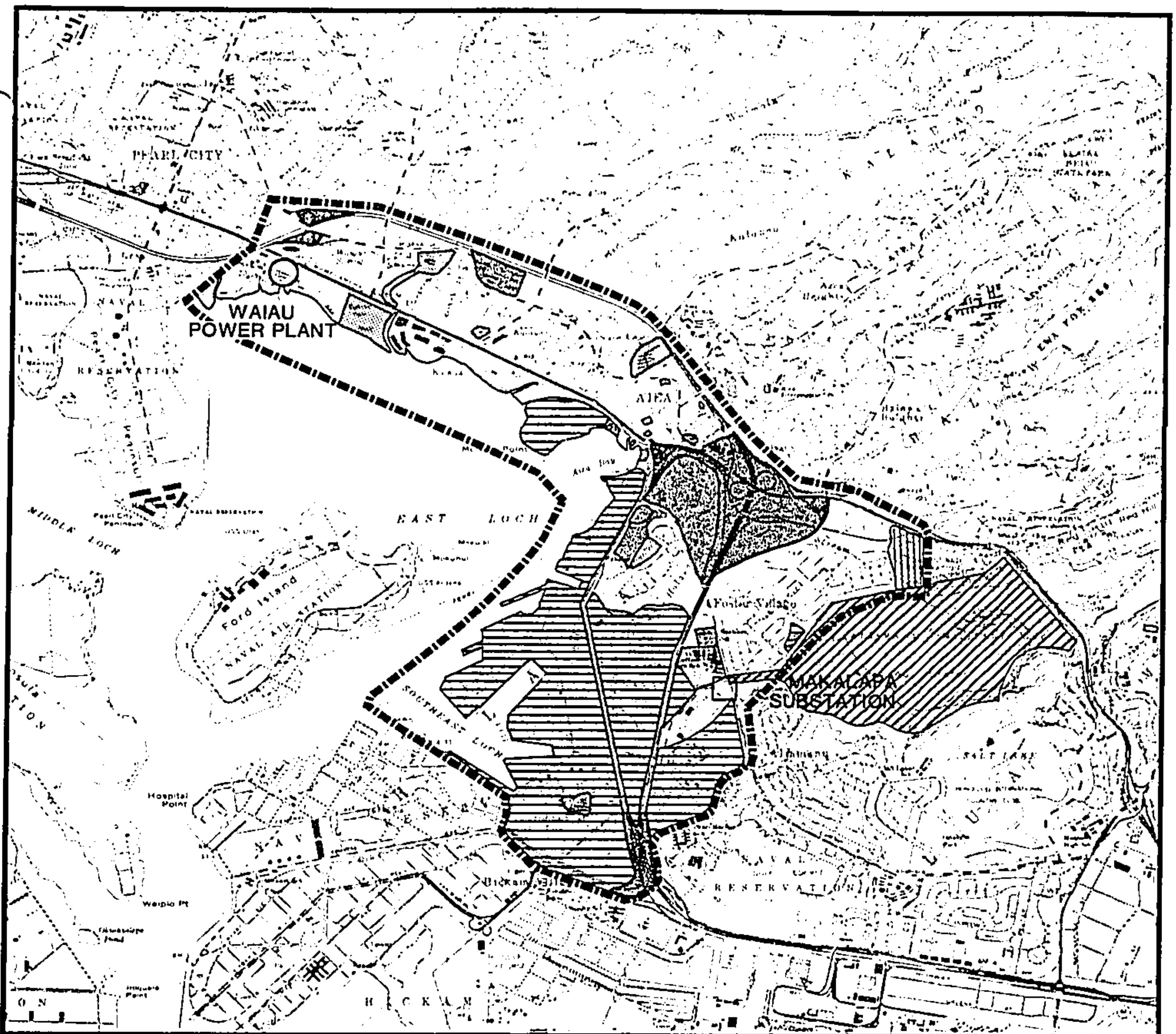
There are no areas within the study area where government regulation expressly prohibits the construction and operation of a transmission line (i.e., exclusion areas such as Conservation District Protective Subzones). There are, however, several areas where the siting of a transmission line would be discouraged by regulatory controls designed to protect special resource values. Siting a transmission line through these areas would be subject to regulatory review and permits.

It is important to know the location of areas with substantial regulatory controls at the corridor identification phase and, if possible, these areas should be avoided. However, in a highly urbanized setting, this is not always possible.

The data factors mapped are State Land Use Districts (LUD) as designated by the State of Hawaii Land Use Commission, and the Special Management Area (SMA) as defined by the City and County of Honolulu, Department of Land Utilization. LUD boundaries were mapped from the Land Use District maps prepared by the State Department of Land and Natural Resources. While city and county zoning is a land regulation factor, transmission lines are a permitted use within all zones, provided that a conditional use permit is obtained from the city (City and County of Honolulu, Department of Land Utilization, Land Use Ordinance, 1986). Therefore, local zoning designations were not mapped.

Inventory

State Land Use Districts. The State of Hawaii Land Use Commission, pursuant to Hawaii Revised Statutes Chapter 183, has established land use districts throughout the state. Three LUD designations (agricultural, conservation, and urban) apply to lands within the Makalapa study area. Overhead transmission lines are a permitted use within urban and agricultural LUDs, but siting a new line in a conservation LUD requires a Conservation District Use Permit and review and approval by the Board of Land and Natural Resources.



LAND JURISDICTION

Study Area Boundary

MILITARY LANDS

Navy

Army

OTHER FEDERAL LANDS

Coast Guard

STATE, CITY/COUNTY, AND PRIVATE LANDS

State of Hawaii

City/County of Honolulu

Private

FIGURE 5.2-1

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

The State Conservation District contains several subzones and special districts varying in their degree of restrictiveness. The most restrictive is the Protective Subzone, which prohibits the construction of a transmission line. Next in the hierarchy of restrictiveness are Limited and Resource subzones. While regulations governing these subzones would not preclude a transmission line, their stated objectives and the narrow range of permitted uses for these areas suggest a high regulatory constraint. The General subzone is more permissive in the types of uses and would permit a transmission line subject to approval of a conditional use permit.

Within the Makalapa study area, the urban LUD comprises the largest area, representing approximately 95 percent of the study area, or 2,533 acres (Figure 5.2-2). There are two conservation LUD areas within the Makalapa study area. The largest parcel of Conservation District land is within the Makalapa Crater and is designated General subzone. In addition, two small pockets of Conservation District land, Resource Subzone, exist along the shoreline just ewa of the McGrew Point Naval housing. These small parcels are former fish ponds.

The agricultural LUD occupies about 17 acres (0.6 percent of the study area) in the form of a watercress farm within the Pearlridge Shopping Center mauka of Kam Highway in the vicinity of Kalauao Springs.

Special Management Area. The State of Hawaii established the Special Management Area (SMA) primarily along shorelines of the state as part of the state's Coastal Zone Management policies. The SMA was created to place special controls on development within shoreline areas. Development includes "construction, reconstruction, demolition or alteration of the size of any structure." "Structure" includes both transmission and distribution lines. Permits for construction and use of land within the SMA boundary require review by the City and County Department of Land Utilization (DLU), a public hearing, and approval by the City Council.

Approximately 20 percent of the study area land (or 520 acres) is within the SMA boundary. The SMA includes the area makai of Kam Highway from the power plant to Halawa Stream. South of the stream, the SMA is defined as the area makai of a line created by extending Kam Highway to North Road, and continuing along North Road to South Road beyond the study area (Figure 5.2-2).

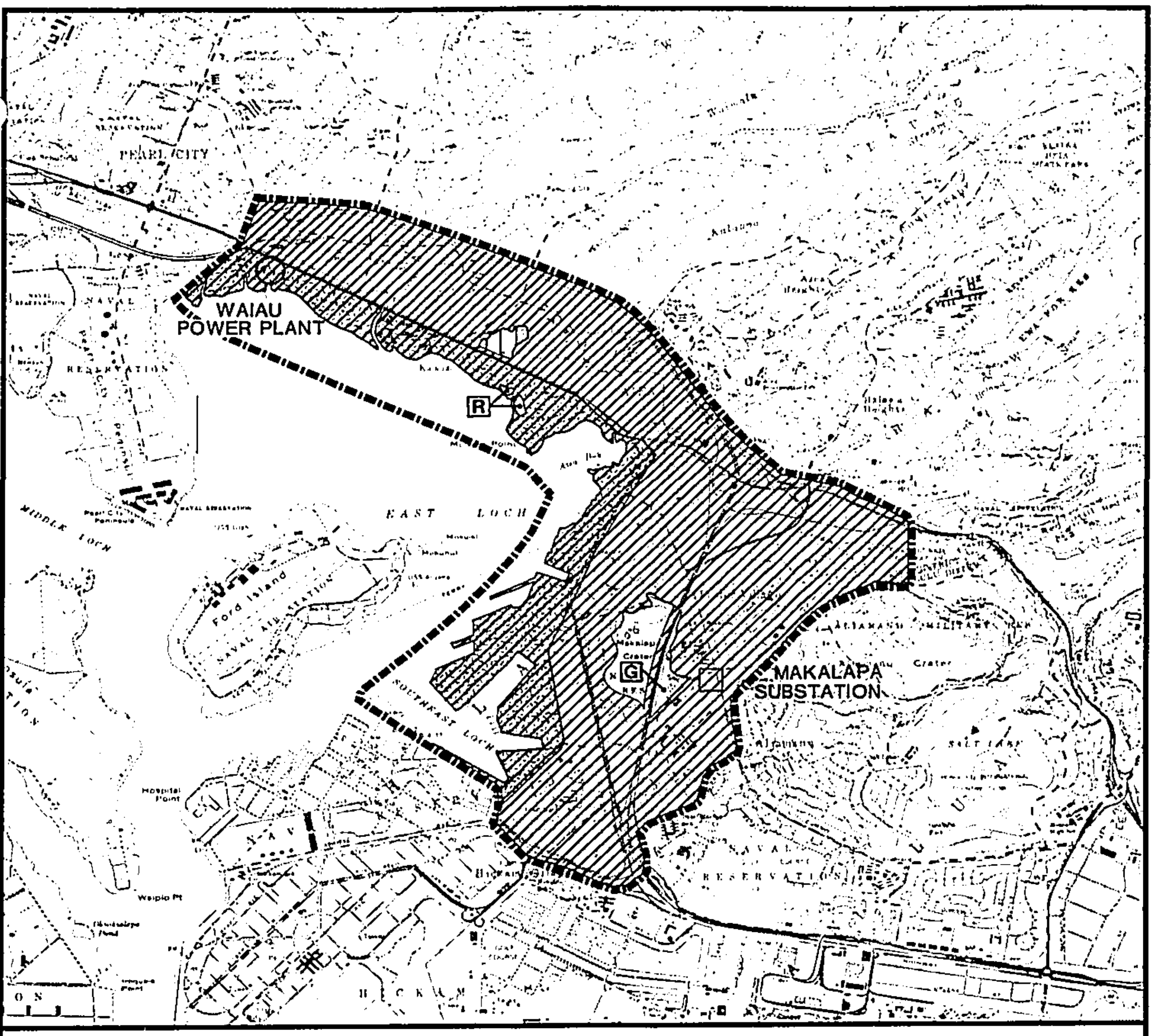
5.2.4 Existing Land Use and Visual Resources

Overview

Within an urban setting containing numerous existing utility lines, no single land use can be interpreted to preclude corridor location. Each land use does, however, have a unique relationship to the potential siting of a new line. For example, areas where no utility lines exist would be more affected by the presence of a new right-of-way than would areas where there are existing transmission and telephone lines. The relative sensitivity of different land use types at the corridor identification level depends primarily on the number of people, the land use restrictions, the scenic qualities, and the types of activities that occur in any one area. For example, recreation areas are considered more sensitive than industrial areas because of the concentration of human use and the relatively high impact to visual quality in these areas. The types of land uses that have a somewhat greater influence on corridor selection and have a major influence on the selection of alignments within those corridors include:

- Residential areas, both military and nonmilitary
- Hospital, schools, and school yards
- High-profile landmarks of the federal government, the State of Hawaii, and the U.S. Navy, including the U.S.S. Arizona Memorial Visitor Center, the Aloha Stadium, and the headquarters of the Commander-in-Chief Pacific Fleet (CINCPACFLT), respectively
- The Makalapa Crater, a large conservation area near the Makalapa Substation, which is permanently preserved as open space
- Large commercial districts, such as the Pearlridge Shopping Center

The City and County of Honolulu Development Plan Maps (scale 1:24,000) were used to delineate land use boundaries within the project area. The Pearl Harbor Naval Complex Master Plan (U.S. Navy, Pacific Division, 1984), and Capital Improvement Plans (U.S. Navy, Pacific Division, 1986 and 1987) were used to identify the existing land uses within the U.S. Navy lands and to distinguish military from nonmilitary uses as displayed on the City's Development Plan Maps.



LAND REGULATION

Study Area Boundary

COASTAL ZONE MANAGEMENT

Special Management Area

STATE LAND USE DISTRICTS

Urban

Agricultural

[G] Conservation [General (G) Subzone]

[R] Conservation [Resource (R) Subzone]

FIGURE 5.2-2

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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Visual elements, mapped as stationary views, were derived from the Department of Land Utilization Coastal View Study (1987).

All mapped elements were crosschecked with the Real Estate Atlas for Oahu (tax key maps) and 1987 black and white aerial photographs of the project area (1:24,000 scale).

A field reconnaissance was conducted to check aerial photographs and the draft environmental data maps. Facility names and current uses were noted in the field and actual use was recorded where it differed from the Development Plan Maps.

Inventory

Each of the land use data factors that could have a bearing on transmission line siting are shown in Figure 5.2-3.

Residential Uses

More than 24 percent of the study area serves as residential neighborhoods (either military or civilian). In Waiau, Pearlridge, and Aiea, there are five large residential complexes surrounding commercial centers between H-1 and Kam Highway. There are two civilian communities and one large Navy housing area (McGrew Point) makai of Kam Highway.

Two other civilian residential developments, Foster Village and Halawa, are on either side of the H-1 freeway in the center of the study area. The remaining residential areas are within the Pearl Harbor Naval Complex and are described below under Areas Within Military Lands--Housing.

Commercial Uses

Commercial shopping centers and restaurants are scattered throughout the study area near the major residential areas and along Kam Highway. The Pearlridge Shopping Center, Aiea Shopping Center, and Waimalu Shopping Center are in the strip of land between Kam Highway and H-1 freeway. The Pearlridge Shopping Center is the largest of the malls, spanning Pali Momi Road and surrounding a watercress farm. Most of the other shopping areas are single-story commercial strips or developed commercial parks near roadway intersections.

Industrial Uses

Industrial areas are scattered along the shoreline and near the H-1 interchange at the Waiau Power Plant. The major use is light industry warehousing for storage, processing, construction, and manufacturing.

Agricultural

There is one 17-acre watercress farm, surrounded by Pearlridge Shopping Center. This farm is the largest supplier of watercress in the State of Hawaii and is designated as Preservation in the City and County Development Plan Maps.

Public and Semipublic Facilities

Schools, hospitals, churches, fire stations, police stations, and other public use facilities are included in this category. There are ten schools, two hospitals, and numerous churches in the study area. The public facility covering the largest area (72 acres) is Aloha Stadium in the center of the study area. Another landmark public facility is the U.S.S. Arizona Memorial ferry dock entrance, visitor center, and parking lot on the East Loch shoreline within the Pearl Harbor NAVSTA.

Parks and Recreation

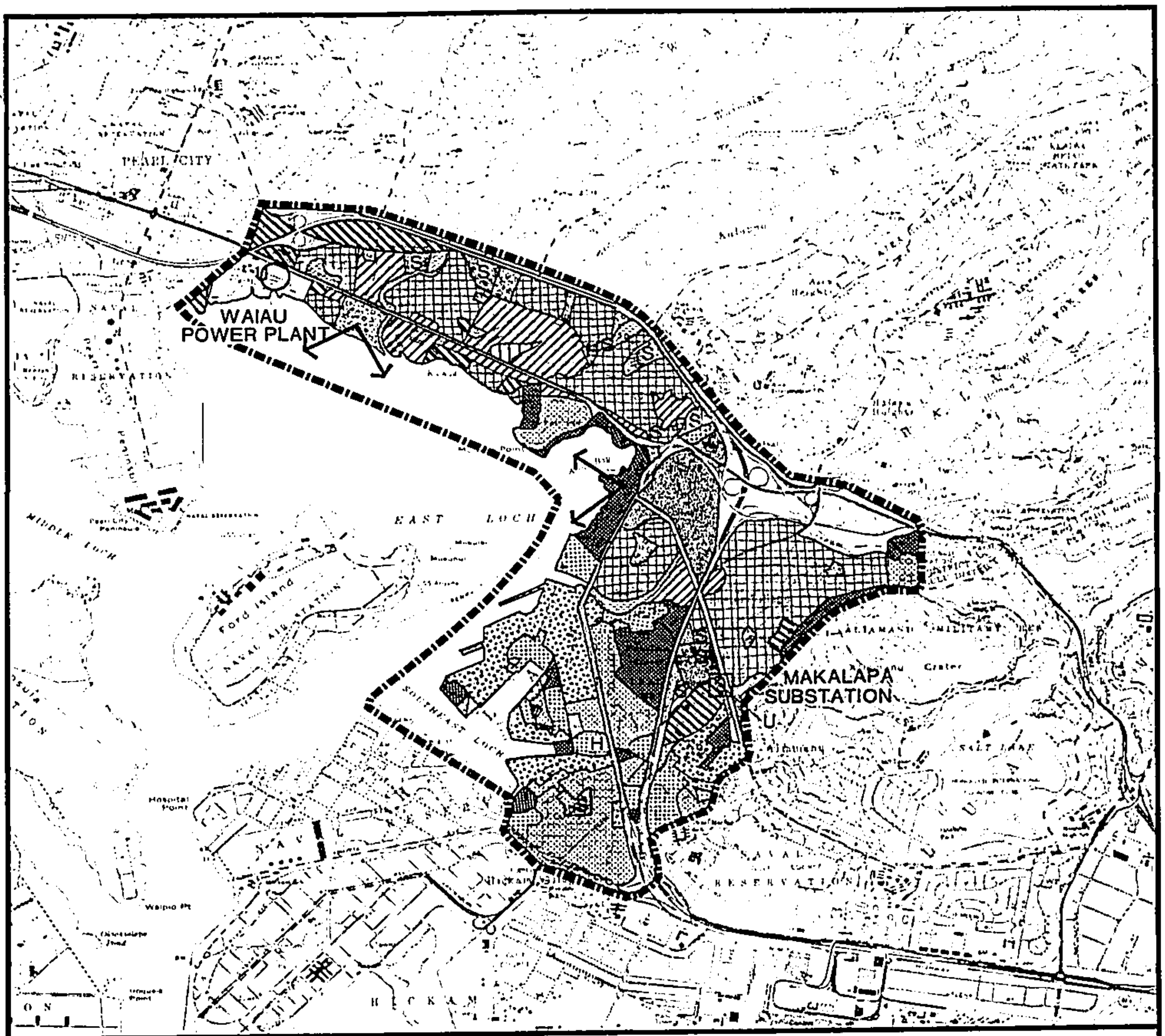
Several city and county parks are located near the residential neighborhoods and along the shoreline in the study area. Pearl Harbor (Blaisdell) Park is the largest civilian park and is located near the Waiau Power Plant and Kam Highway. Public parks and recreation areas cover approximately 129 acres, or about 5 percent of the total land area.

Preservation

There are three major streams that flow through the study area: Waimalu, Kalauoa, and Halawa Streams. The stream corridors are designated Preservation by the City and County of Honolulu. Preservation comprises about 30 acres of the study area land. This designation indicates that these lands should remain undeveloped for purposes of protecting watersheds, water resources, and water supplies (City and County of Honolulu, October 1986).

Utilities

The Waiau Power Plant and the Makalapa Substation mark the two ends of the proposed transmission line. In addition to



EXISTING LAND USE

- Study Area Boundary
- Residential
- Commercial
- Industrial
- Agricultural
- Parks & Recreation
- Preservation
- S School
- H Hospital
- U Utilities
- Highway Interchange
- Stationary View
- Public & Semi-Public Facilities

USES WITHIN MILITARY LANDS

- Housing
- Supply, Training, Operations, & Maintenance
- Administration, Community, & Medical Facilities
- Recreation and Conservation Buffer

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

FIGURE 5.2-3

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

these major (138 kV) facilities, HECO owns three 46 kV substations within the study area. Including the rights-of-way of 46 kV subtransmission and 138 kV transmission lines, utilities occupy approximately 6.3 percent of the study area.

Areas Within Military Lands

The following categories inventory the military uses in the study area:

Housing. Housing in U.S. Navy property is a mix of officers' family housing and bachelor quarters. Approximately 121 acres (or 4.6 percent of the study area) is military housing. Two of the housing developments are on the makai side of the Makalapa Crater (Little Makalapa and Flag Hill) within the Pearl Harbor Naval Complex. McGrew Point, an officers' family housing area, is separated from the Pearl Harbor Complex proper; it extends makai of Kam Highway north of Aiea Bay.

Supply, Training, Operations, and Maintenance Facilities. The Pearl Harbor Naval Base has developed approximately 1 mile of the shoreline for a Naval Supply Center (NSC). The supply/storage area extends inland from dock facilities through a complex of tank storage, warehousing, community/ administration facilities, and training facilities. This land use comprises 60 acres, or 2.3 percent of the study area.

Administration, Community, and Medical Facilities. The CINCPACFLT headquarters and the Pacific Division (PACDIV) administrative office are located in the center of the study area north of the Makalapa Crater. This large complex is one of several administration, community support, and medical facility complexes in the study area south of the Halawa Stream. Administrative and community facilities comprise about 64 acres, or 2.4 percent of the total land area.

Recreation and Conservation Buffer. The outdoor recreation facilities along the shoreline at Aiea Bay are some of the finest in Pearl Harbor. They comprise the CINCPACFLT boat pool and Richardson Recreation Center, a small marina, and ballfields for team sports. The State of Hawaii has proposed to develop part of this area as the Aiea Bay State Recreation Area. There are several other small parks and ballfields scattered throughout the housing and community support facilities.

A prominent feature of the landscape is the Makalapa Crater. Designated as a Conservation Land Use District by the state and owned by the Navy, most of the open space has been permanently set aside as a preserve.

Stationary Views and Visual Resources. Visual quality throughout the study area is dominated by the area's urban character, with the largest single structure being Aloha Stadium. Views toward the coast are limited and, within the context of the built environment, the flat terrain, and the military complex, coastal views have relatively limited visual distinction. The available stationary coastal views identified in the Coastal View Study include shoreline views at Pearl Harbor (Blaisdell Park) and the Navy's Richardson Recreation Center near Aloha Stadium (City and County of Honolulu, Department of Land Utilization, 1987). The study identifies a significant roadway view at Pearl Harbor (Blaisdell Park) and Kam Highway as well. These stationary views are shown in Figure 5.2-3.

Intermittent coastal views are also possible from Kam Highway in the vicinity of both Pearl Harbor (Blaisdell Park) and Richardson Recreation Area. Viewing opportunities are also available from less publicly accessible areas. Within the McGrew Point Naval housing area, views are possible to the Aiea Bay area, as well as toward the U.S.S Arizona Memorial. The ferry loading area for the memorial also offers a shoreline viewing opportunity. Outside the study area, the upper elevation residential areas of Pearl City, Aiea Heights, Halawa Heights, and Foster Village have views across the harbor.

5.2.5 Proposed Land Use

Overview

In a highly urbanized setting such as the Makalapa study area, projects proposed for development may influence corridor selection. Where possible, these areas should be avoided to prevent siting conflicts. Because many of the proposed projects are in the planning stage, potential conflicts between transmission line siting and the new development can be minimized through early consultation with the project proponents.

An investigation was made of all proposed developments that were listed in the Development Plan Status Review for 1986 (City and County, Department of Land Utilization, 1987). Each project proponent was contacted to determine size, location, and current status of the project.

Inventory

Twelve nonresidential transportation, recreation, commercial, and utilities projects are proposed within the study area (Figure 5.2-4). Two are under construction and ten are either in the planning stages or proposed. All but one of the projects fall under the jurisdiction of state or local governmental departments. The other is a commercial enterprise. Table 5.2-2 is a list of proposed projects within the study area.

The City and County, Board of Water Supply, Department of Transportation Services, and Department of Parks and Recreation projects are profiled below.

Board of Water Supply. Several proposals exist for new water facilities to be constructed in the study area within the next 5 to 10 years. Thirty-six-inch water lines are proposed for both Salt Lake Boulevard and Moanalua Road. These lines will supply fresh water for domestic use within these residential neighborhoods.

The Waiau HECO conversion project is under way at this time. Three wells located on HECO's Waiau Power Plant property are being converted to Board of Water Supply wells to supplement the water supply for the Honolulu area. The well conversion is accompanied by a new water distribution line that will feed into the Board of Water Supply system. The water line has been completed and one well is converted; the project is planned for completion by 1992.

A nonpotable water supply system is under construction for the Kalauao Springs area. The new pumping station is completed and the distribution line will extend along Kam Highway toward Aloha Stadium. This system will be used for irrigation throughout the vicinity of Aiea.

Department of Transportation Services. Moanalua Road improvements are planned for the portion of the right-of-way between Aiea Interchange and Pali Momi Road. The funds to complete this improvement have been budgeted.

Improvements are planned for the right-of-way on Salt Lake Boulevard between Kalaeloa and Ala Lilikoi to be constructed by the early 1990s.

Rapid Transit System (RTS) alternative alignments within the study area include an alignment along the median of Kam Highway and another along the median of Salt Lake Boulevard (joining the Kam Highway alignment at Aloha Stadium).

Table 5.2-2
PROPOSED PROJECTS WITHIN WAIAU-MAKALAPA TRANSMISSION PROJECT STUDY AREA

Map Code[g]	Project Name	Status[g]	Proponent	Description	Estimated Completion	Approx. Width (feet)	Length (feet)	Acres Within Study Area
P	Moanalua Rd. improvements[a]	P&E funds budgeted	C&C/Dept. of Transportation Services	Moanalua Rd. right-of-way improvements Aiea Interchange to Pali Momi	Unknown	65	3,700	5.52
P	Salt Lake Boulevard improvements[a]	No action	C&C Dept. of Transportation Services	Right-of-way improvements between Kalaeloa and Ala Lilikoi	Unknown	150	11,100	23.07
P	Rapid transit system Alt.[b]	None in 1987 document	C&C/Dept. of Transportation Services	Development of an automated rapid transit system between Moiliili and Waiau	Unknown	35	71,100	49.66
P	Blaisdell Park improvements[c]	None in 1987 document	C&C/Dept. of Parks and Recreation	Construct new parking area	Unknown	N/A	N/A	21.35
P	Pearlridge Community Park[c]	No action	C&C/Dept. of Parks and Recreation	Construct new recreation building and ground improvements	Unknown	N/A	N/A	7.32
P	Salt Lake Blvd. water line[d]	P&E funds budgeted	C&C/Board of Water Supply	Construct new 36-inch water line along Salt Lake Blvd. between Aliamanu School and Makalapa Elementary School	Unknown	15	8,000	1.23
P	Moanalua Road water line[d]	P&E funds budgeted	C&C/Board of Water Supply	Construct new 36-inch water line along Moanalua Road between Waimalu School and Kalauao Stream	Unknown	15	6,600	2.27
U	Waiau-HECO wells conversion[d]	Under construction	C&C/Board of Water Supply	Convert three Waiau HECO wells for general use by Honolulu residents	1992	15	3,310	8.26
U	Kalauao Springs nonpotable system[d]	Under construction	C&C/Board of Water Supply	Irrigation water supply system comprised of one pumping station and a water line along Kam Highway	1990	15	14,000	10.51
P	Aiea Bay State Recreation Area[e]	Land/construction funds budgeted	DLNR/Dept. of Parks and Recreation	Development of shoreline park for passive recreation (i.e., landscaping, comfort stations, picnicking)	Start date 1990	N/A	N/A	16.61
P	H-1 right-of-way improvements[a]	Unknown	State Department of Transportation	Improvements to the H-1 right-of-way in Aiea/Pearl City area	Unknown	200	14,4[illegible]0	66.35
P	Halawa Associates Shopping Center[f]	Pending zoning amendment approval	Private	Shopping center, Castle Park Center	1992	N/A	N/A	16.09

[a]City and County of Honolulu, Development Plan Status Review Volume II: Fiscal Year 1986.
[b]Marvin Char and Nadine Myeda, Department of Transportation Services, Rapid Transit Development Division.
[c]Steve Salis, City and County Department of Parks and Recreation.
[d]Susan Uyesugi, City and County Board of Water Supply.
[e]Daniel Quinn, State Department of Parks and Recreation.
[f]Kevin Carney, Halawa Associates.
[g]Status obtained from City and County Development Plan (1987) or private developer.

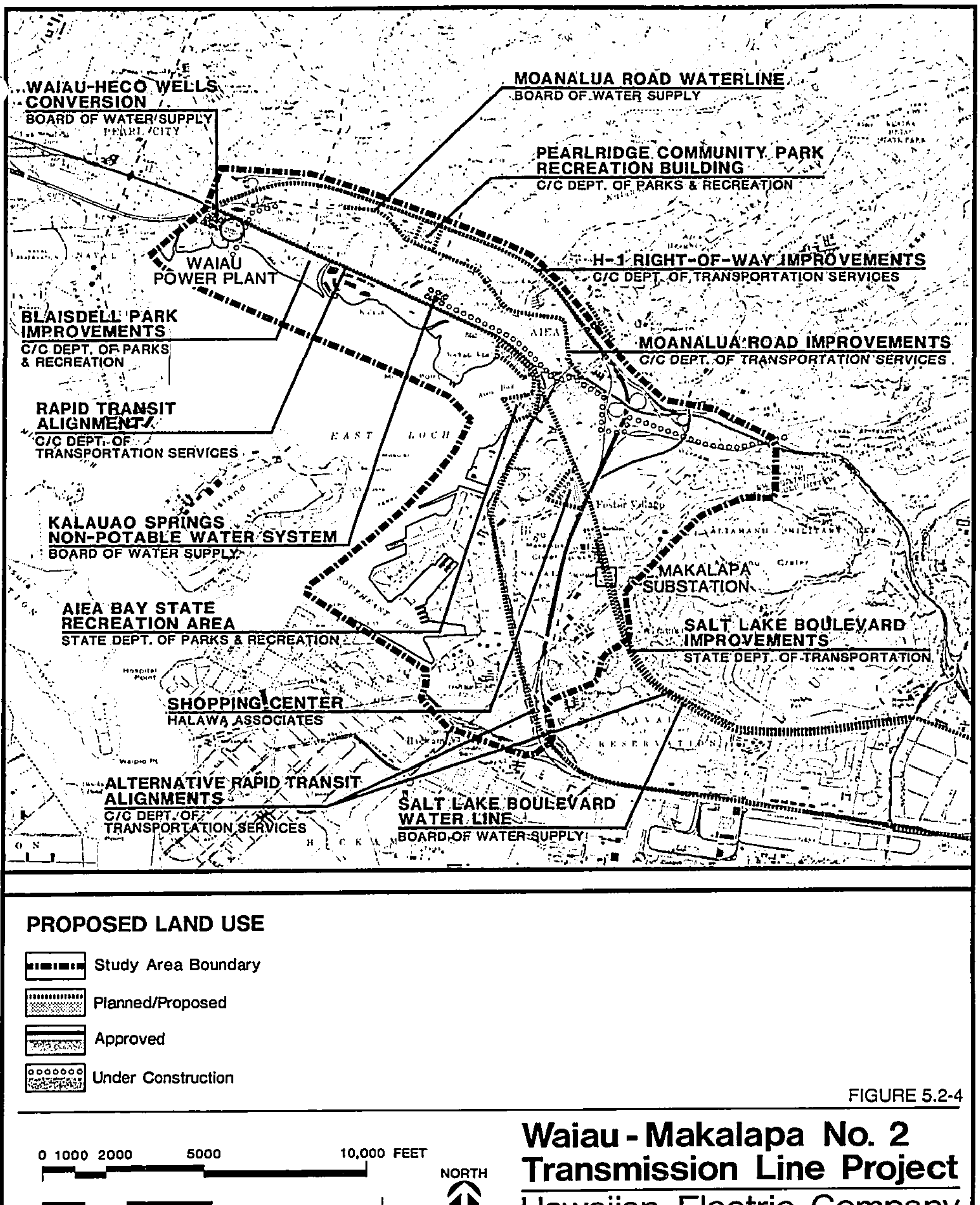


FIGURE 5.2-4

Waiau - Makalapa No. 2 Transmission Line Project

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Stations are planned near Pearlridge Shopping Center, Aloha Stadium, the U.S.S. Arizona Memorial, and near the Makalapa Substation. Construction of the RTS will begin no earlier than 1993.

Department of Parks and Recreation. The existing parking area within Blaisdell Park will be upgraded during 1989. No action outside of the park will be taken.

Pearlridge Community Park has been identified as needing a new recreation building to support the large number of recreationists using the playing fields. No action has been taken on this proposal by the City and County of Honolulu.

The following are profiles of the projects proposed by the state within the study area.

State Department of Transportation. Improvements are planned for the H-1 freeway right-of-way between Aiea and Waiau.

State Department of Land and Natural Resources--Parks and Recreation. The State Department of Land and Natural Resources, Parks, and Recreation, in collaboration with the U.S. Navy, proposes to develop the shoreline along Aiea Bay for recreational use. An Aiea Bay State Recreation Area (sometimes referred to as the Rainbow Bay State Recreation Park) Conceptual Master Plan and Draft EIS has been developed for the project (State of Hawaii, DLNR, 1986). All plans and documents are being reviewed by agencies and the U.S. Navy. No decision or approval has been made on the plans at this time; approval is pending a resolution of public access to the proposed park that would not conflict with security requirements of the Navy.

The major private project proposed in the Makalapa study area is the Halawa Associates shopping center. Halawa Associates has proposed a shopping center development on the existing site of the Castle Park Amusement Center adjacent to Salt Lake Boulevard and the Halawa Stream. The site occupies about 16 acres. Proposed development includes seven buildings with a total of 212,800 square feet of retail space and 701 parking spaces. Tenants would begin occupying space in mid-1990 after the City and County of Honolulu approves a zoning change from residential to commercial.

5.2.6 Utilities and Transportation Systems

The existing network of roads, pipelines, and utility lines within the study area represent opportunities for the siting of a transmission line. The major advantage in conforming with pre-existing linear facilities (i.e., siting within or adjacent to an existing right-of-way) is that doing so avoids the disruption that new transmission lines might create in areas where lines do not now exist. An additional advantage is that the construction and maintenance costs associated with access and easement acquisition would be, in most instances, less than with new easements.

Because these features present such important siting opportunities, all major roadways, pipelines, and existing electric transmission and subtransmission lines (138 kV and 46 kV) were mapped.

Within the Makalapa study area, the widths of existing rights-of-way for linear facilities range from approximately 30 feet for pipelines to approximately 200 feet for the interstate highway. The desired right-of-way width for a study corridor is one-quarter to one-half mile. Because some of these existing corridors provide opportunities for siting, the corridors selected for further study should be selected to include all major roads and utility rights-of-way between the two end points.

The opportunities for siting a new line along roads and highways may vary according to the road classification. For example, State Department of Transportation regulations discourage utilities from siting transmission lines parallel to interstate freeways within the freeway right-of-way (State of Hawaii Department of Transportation, 1981). The State of Hawaii allows utility lines to parallel roadways, but certain setback restrictions apply (State of Hawaii Department of Transportation, 1987). HECO's franchise agreement with the state permits construction of electric lines adjacent to state and county roads (State of Hawaii, 1925).

Existing utility lines can both constrain and provide opportunities for siting new transmission lines. An important criterion in siting a 138 kV transmission line is to attempt to provide adequate separation from other 138 kV lines and thereby reduce the possibility that a single emergency (such as a fire, aircraft accident, or windstorm) could simultaneously damage two or more of the principal transmission lines. Existing 46 kV lines provide overbuild opportunities where the new 138 kV line and the 46 kV lines can both occupy the same pole and right-of-way.

Several sources were used to map the existing petroleum product pipelines in the study area: photo maps of oil and gas pipelines (Chevron USA, Inc.; HIRI, 1987), maps of the pipeline routes (GASCO, Inc., 1987), and the Pearl City Force Main plans (City and County of Honolulu). These routes were verified through personal communications with pipeline engineers familiar with the study area pipelines.

Interstate, state, and major local roads were identified from Federal Aid Highway System Maps, highway, and city maps (Figure 5.2-5).

Transmission lines and substations were mapped from HECO transmission system maps and checked in the field.

Pipeline Inventory

Three private companies own and operate pipelines in the study area: Chevron USA, GASCO, and Hawaiian Independent Refinery (HIRI). An additional pipeline is owned by the U.S. Navy.

HIRI maintains both 10-inch and 12-inch petroleum pipelines within the study area (Figure 5.2-5). Chevron USA maintains two 8-inch oil lines (one black oil and one white oil) and a 4-inch heater oil line within the study area. The HIRI lines share the Kam Highway right-of-way from the study area's ewa boundary near the Waiau Power Plant to the intersection with Salt Lake Boulevard at Aloha Stadium. The pipeline parallels Salt Lake Boulevard to its intersection with H-1 and continues in the H-1 right-of-way to its intersection with Kam Highway near the study area's southern boundary.

Chevron USA Inc., has two 8-inch lines and a 4-inch line that connect the tank farm located in the Naval Supply Center to the HIRI lines at a point makai of the Aloha Stadium.

The U.S. Navy owns and operates a jet fuel line (8-inch) that runs along the shoreline of the study area between the Pearl City Peninsula and the Navy shipyard. This pipeline was not mapped in Figure 5.2-5 because the Navy could not provide drawings locating the pipeline route.

Transportation Route Inventory

Interstate Routes. The only route designated as interstate by the Federal Highway Administration currently in use within the study area is the H-1 freeway. The H-1 freeway generally defines the northern boundary of the study area to the Aloha Stadium area where it turns south and continues through the study area. The proposed alignment for the new

H-3 freeway originates at the H-1 interchange near Aloha Stadium.

State Routes. Two state routes exist within the study area: Kam Highway (Route 99) and the Moanalua Freeway (Route 78). These routes are shown in the Roads and Pipelines Map (Figure 5.2-5).

Major Local Roads. Other major local roads under the jurisdiction of the City and County of Honolulu are identified in Figure 5.2-5.

Utility System Inventory

The Waiau Power Plant and the Makalapa Substation define the western and southern ends, respectively, of the project study area. Three other substations are located within the study area: Kaonohi, Aiea, and Kuahua.

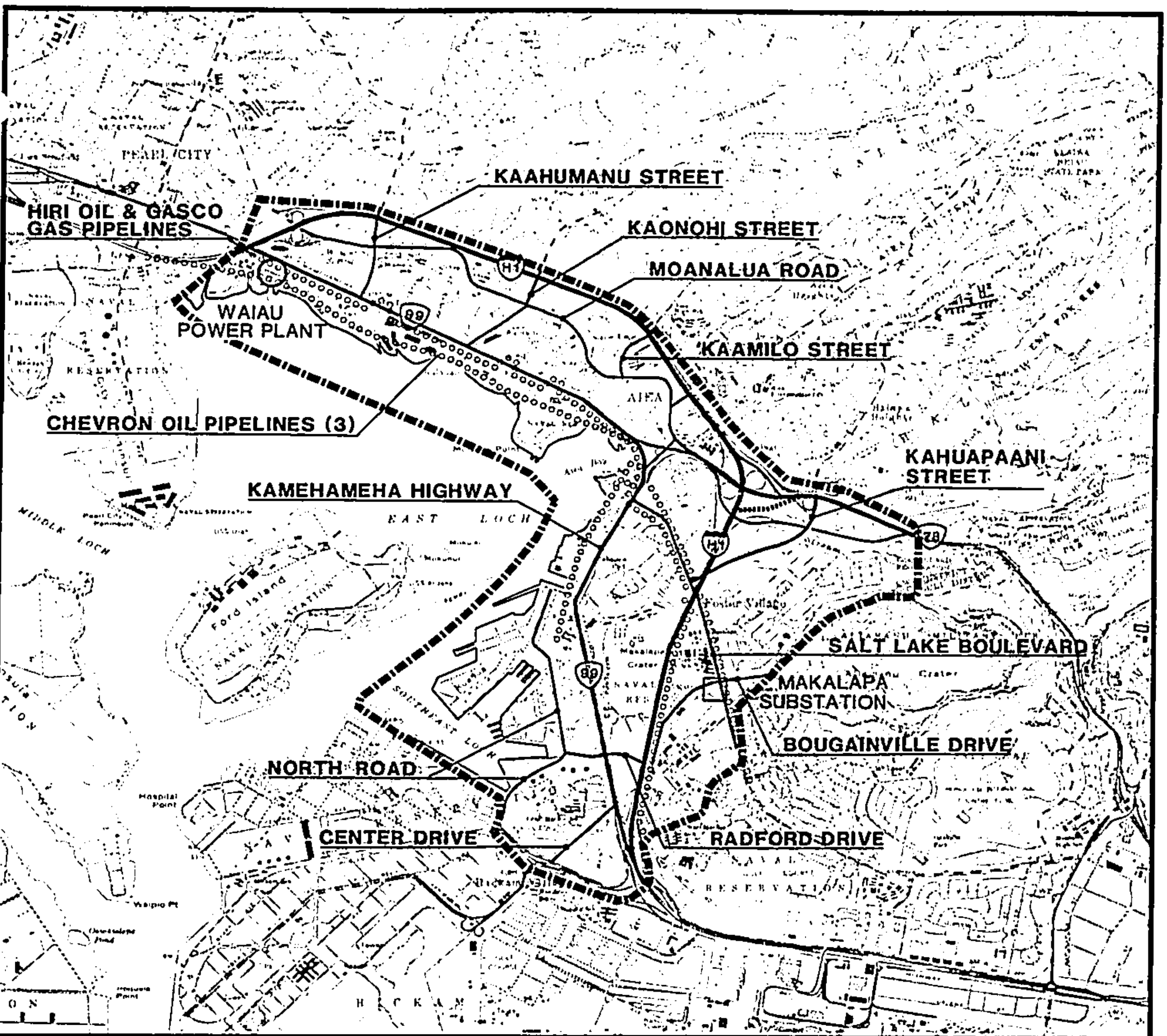
All, or sections of, three 138 kV lines are located in the study area (see the Utility Systems Map, Figure 5.2-6). The Waiau-Makalapa No. 1 line exits the Waiau Power Plant toward the northeast and then follows Moanalua Freeway to Aloha Stadium. It passes makai of Aloha Stadium and then follows Salt Lake Boulevard to Makalapa Substation. The Makalapa-Iwilei 138 kV line leaves the Makalapa Substation to the southwest and follows the mauka side of Bougainville Drive south out of the study area. Another line, the Halawa-Makalapa 138 kV line, leaves the Makalapa Substation toward the northeast, threading between Foster Village and Aliamanu Crater before continuing northeast toward the Halawa Substation.

The study area also includes all, or sections of, more than a dozen 46 kV lines. The most important of these for the current routing study include lines paralleling Kam Highway, a line following the bicycle path along the shoreline of Pearl Harbor to the Naval base, and a line following Salt Lake Boulevard to Makalapa Substation.

5.2.7 Biological and Water Resources

Overview

Transmission lines can pose a potential threat to highly sensitive avifauna in areas of high use and to vegetation in areas where there are high concentrations of sensitive plants or there is dense vegetative cover in a potential fire zone. Because none of these conditions exists within the Makalapa study area, the biological resources do not



ROADS AND PIPELINES

- Study Area Boundary
- Power Plant
- Interstate Routes
- State Routes
- Proposed Interstate Routes
- Major Local Routes
- Oil/Gas Pipelines

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

FIGURE 5.2-5

Waiau - Makalapa No. 2 Transmission Line Project

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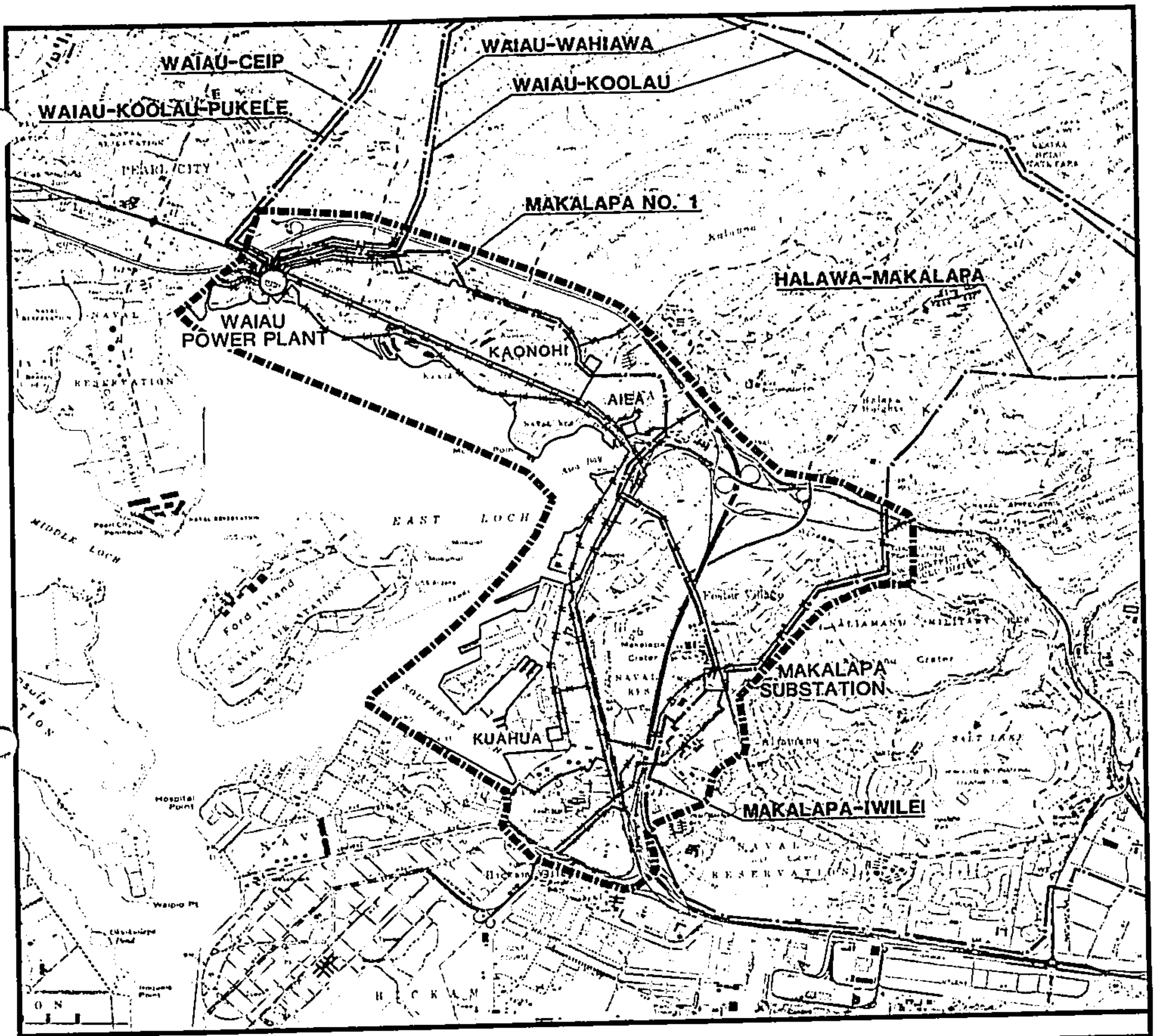

UTILITY SYSTEM

- Study Area Boundary
- Power Plant
- Substation
- 138 kV Transmission Lines
- 46 kV Transmission Lines

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

FIGURE 5.2-6

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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constrain transmission line corridor locations. The few biological resources that do exist in the Makalapa study area should, however, be considered during the alignment selection phase and should be avoided, if possible, during selection of pole sites.

Two areas of ecological importance are wetlands, both woody and nonwoody, and potential wildlife habitat near streams and open water channels. Transmission lines do not necessarily conflict with these resources; however, the permit requirements of both federal and state agencies for dredge and fill activities in or near these habitats may be substantial and should be considered in siting decisions.

Areas of biological concern are mostly located near water areas within the study area. The hydrologic features include: open lined channels, springs, and flood inundation zones.

The transmission line route should generally avoid surface waters because construction in water is technically more difficult (and, therefore, more expensive) and is subject to a variety of regulatory controls of state and federal agencies. Because flood waters may cause erosion and scouring of the soils surrounding the transmission poles, large flood-prone areas should be avoided, if possible. Transmission lines can be located within flood-prone areas with proper design of pole foundations.

Surface water features were mapped from USGS 7.5 minute quadrangle maps. Federal Emergency Management Agency (FEMA) 1987 Flood Insurance Rate Maps were used to map areas susceptible to flooding. State of Hawaii Department of Land and Natural Resources Wells Maps were used to analyze groundwater issues. Surface water features and flood-prone areas are mapped in the Biological and Water Resources Map (Figure 5.2-7).

Existing botanical and wildlife literature pertinent to the area was reviewed. Black and white aerial photographs (1987) were used to delineate vegetation types and classifications were verified in the field in January 1988. Vegetation types, as presented in Figure 5.2-7 are generalized. A list of avian species observed on nearby wetland areas, including as the two National Wildlife Refuge units in the western part of Pearl Harbor, was used to establish or verify possible bird use in the study area wetlands (Bremen, 1987).

Biological Resources Inventory

Less than 5 percent of the study area contains natural vegetated habitat (see Figure 5.2-7). Undeveloped areas are few and small. No rare, threatened, or endangered plant species designated by federal and/or state governments or sensitive native plant communities are known to occur in the study area.

Vegetation Types

Wetlands. Wetlands along the shoreline consist of mangrove swamps (*Rhizophora mangle*) with bands of plants extending inland for some distance along the banks of streams. Two freshwater springs, Waiau and Kalauao, are found within the project area; however, both have been modified by watercress (*Nasturtium microphyllum*) and taro (*Colocasia esculenta*) cultivation.

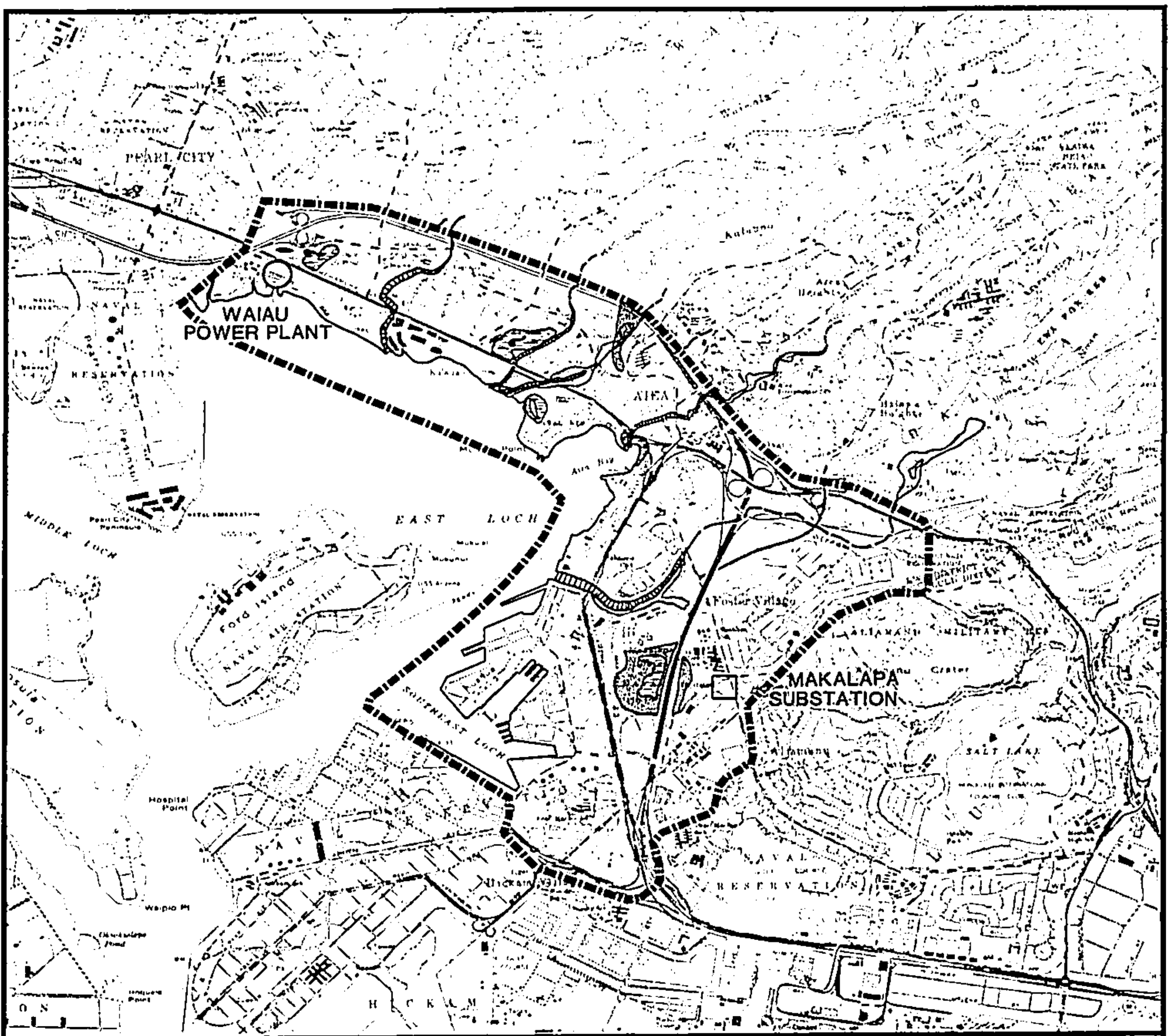
A low-lying area in Makalapa Crater, vegetated primarily with pluchea (*Pluchea symphytifolia, Pluchea indica*), Christmas berry (*Schinus terebinthifolius*), and scattered trees of kiawe (*Prosopis pallida*) and 'opiuma (*Pithecellobium dulce*). The area is designated Conservation Land Use District (Pearl Harbor Naval Base Complex Master Plan, 1984). It is frequently flooded during the rainy season and is in a flood-prone area. A thin layer of salt and other mineral deposits accumulates on the surface soil in some areas as the water evaporates; therefore, it supports vegetation typical of brackish water conditions.

Koa-Haole Scrub. Koa-Haole (*Leucaena leucocephala*) forms an open to closed scrub on more or less steeply sloping areas of the study area. Scattered trees of kiawe and 'opiuma may occasionally be observed. Groundcover consists of various grass species and herbs.

Urban Complex. The urban complex covers roughly 97 percent of the project area. U.S. Navy facilities and housing cover large areas on the lower portion of the study area and shoreline. A major shopping center, the Aloha Stadium, industrial areas, residential housing developments, and highways cover the remaining portion.

The few undisturbed habitats comprise less that 5 percent of the study area and the vegetation is composed of introduced forbs and shrub species.

Wildlife. No wildlife resource field survey was conducted because the study area does not contain any wildlife



BIOLOGICAL AND WATER RESOURCES

- Study Area Boundary
- Koa-Haole Scrub
- Wetlands
- Urban Complex
- Flood-Prone Areas (Subject to inundation by 100-year flood)
- Open-Lined Channel
- Springs

FIGURE 5.2-7

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

Waiau - Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

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habitat, refuges, or areas used intensively by endangered Hawaiian waterbirds. No sites within the study area have been identified as "Primary Habitat Areas" for endangered Hawaiian waterbirds by the U.S. Fish and Wildlife Service (1978).

Some waterbirds and migratory species may use the wetland acres along the shoreline, but their occurrence is sporadic. The other wetlands within the study area (i.e., Makalapa Crater and the springs) are few and small. These wetlands may provide marginal feeding and loafing areas for native waterbirds and migratory species.

Water Resources Inventory

Surface Water Resources. There are no large lakes or rivers in the study area. The Waimalu, Kalauao, Aiea, and Halawa streams are perennial in their lower reaches and are intermittent in their upper reaches. The Waimalu and Halawa streams have been modified for flood control with concrete-lined open channels in their lower reaches.

Flood-Prone Areas. Some areas of Oahu near the ocean shoreline have the potential for inundation in the event of a tsunami. However, the entire project study area is located adjacent to Pearl Harbor, inland from the ocean, and is not subject to tsunami inundation.

Flood-prone areas are defined as the areas subject to a 100-year flood as identified in FEMA flood hazard boundary and flood insurance rate maps. Three small areas subject to inundation by a 100-year flood exist within the study area: (1) land surrounding Kalauao Stream makai of the H-1 freeway, (2) Aiea Stream mauka of Moanalua Boulevard and makai of Kam Highway, and (3) Halawa Stream mauka of Route 78. The flood-prone areas within the Makalapa study area should not constrain siting a transmission line because of their small area.

Groundwater Resources. The entire Waiau-Makalapa No. 2 study area shares similar groundwater characteristics. Rainwater enters the ground in the high rainfall areas of the Koolau mountains. The water percolates into the soil where it exists as groundwater. In the study area, groundwater lies below an impervious layer of cap rock, which generally prevents the groundwater from rising to the surface and holds it under artesian pressure. When the cap rock is punctured by a well, however, the groundwater rises to several feet above sea level. Thus, the Department of Land and Natural Resources Well Maps generally show the groundwater level to be several feet above sea level throughout the study area. Where fractures exist in the cap rock, water may also leak out as springs.

In general within the study area, groundwater is a problem for construction only under two conditions. One is where springs release groundwater onto poorly drained, mucky soils. Two areas of springs exist in the study area and are identified in the Biological and Water Resources Map (Figure 5.2-7). The Waiau Spring is located northeast of Waiau Power Plant and the Kalauao Spring is located within the Pearlridge Shopping Center and supplies water to a watercress farm. Neither of these springs poses a significant constraint to siting a transmission line because their associated wetlands are relatively small and can be avoided during siting of individual poles.

Another situation where groundwater may be a concern is where the pole foundations (piles or piers) penetrate cap rock and reach the aquifer. Where that occurs, caution must be exercised in preparing foundations to provide sufficient support for the pole and to control water leakage from the aquifer. Groundwater and geologic formations and types are important in siting and selecting a transmission line alignment; however, groundwater resources do not constrain corridor location.

5.2.8 Cultural Resources

Overview

In general, a single archaeological or historic site is usually too small to influence corridor location. Furthermore, a single site can usually be avoided in locating a transmission line alignment. However, it is possible that national historic districts or areas containing large complexes of archaeological resources may have an effect on corridor location. At the regional study level, it is helpful to identify and map known archaeological and historic sites and districts and evaluate the study area in terms of the probability of occurrence of undiscovered archaeological resources.

The cultural resources potential within the Makalapa study area was evaluated through a predictive model that outlined cultural resource recovery potential as high, medium, or low, depending on a number of different criteria (see Appendix E). The evaluation was made by a project archaeologist in cooperation with the state archaeologist and the state historian. Mapping was done at a scale of 1:24,000 to show approximate boundaries among unsurveyed areas with good, moderate, and poor potential for discovery of cultural resources (Figure 5.2-8). Fill areas were distinguished from unsurveyed nonfill areas because the potential for recovery is even more remote in fill areas. The boundary for the National Historic Landmark of Pearl Harbor was mapped from the Pearl Harbor Naval Complex Master Plan (1984).

Cultural resources data were collected from the Department of Land and Natural Resources (DLNR) Historic Sites Section, Gilbert McAllister's Survey of Oahu (1931), and through interviews with the U.S. Navy archaeologist.

Inventory

National Register District/National Historic Landmarks. In 1964, the Pearl Harbor Naval Base was designated a National Historic Landmark by the Secretary of the Interior because of its crucial role in the nation's defense, and particularly for its role as the site of the dramatic World War II air attack on December 7, 1941. With the establishment of the National Register of Historic Places in 1966, Pearl Harbor was also included as a historic district.

The National Register designation provides for the protection of all facilities on the Naval base, including archaeological structures, fishponds, and subsurface materials. Any action taken within the boundary of the Pearl Harbor Naval Base must comply with the Pearl Harbor Historic Preservation Plan (1978). Historic preservation guidelines were established in a Memorandum of Agreement (MOA) drafted in 1979 by the U.S. Navy archaeologist, the State Historic Preservation Office, and the State Advisory Council on Historic Preservation.

Recorded National Historic Sites. All recorded historic sites within the study area are also part of the Pearl Harbor Naval Base National Historic Landmark. The structures in the landmark are classified into three categories: (1) structures that make a major contribution to the historic character of the Naval complex and should be preserved where possible; (2) those which make a lesser contribution to the complex and need to be recorded if altered; and (3) those which make no contribution to the historical character of the Naval landmark. Any procedures that affect the structures in the first two categories must be reviewed and potential mitigative actions may be required in accordance with the MOA and Pearl Harbor Historic Preservation Plan.

Fish Ponds in the Pearl Harbor Area. There is one recorded archaeological site, the Paaiau Fish Pond, within the Pearl Harbor National Register; it is protected under the MOA.

There are 27 other former fish ponds in the Pearl Harbor area but outside the Naval Base National Landmark. Most of these have been destroyed or filled in. Because fish ponds of aboriginal Hawaiian origin are significant to the archaeological record, they have been identified by name, status, and location in Appendix E.

Unsurveyed Area with High Potential for Cultural Resources. This category includes areas where there is a relatively high probability that archaeological remains could be found if subsurface investigations were conducted. These areas were determined by the following criteria:

- Similar environmental settings in Hawaii have contained a high number of sites and other types of archaeological data
- Known ethnographic and ethnohistoric data support the potential for locating subsurface archaeological remains
- Shorelines and river/stream beds often have a high frequency of archaeological sites

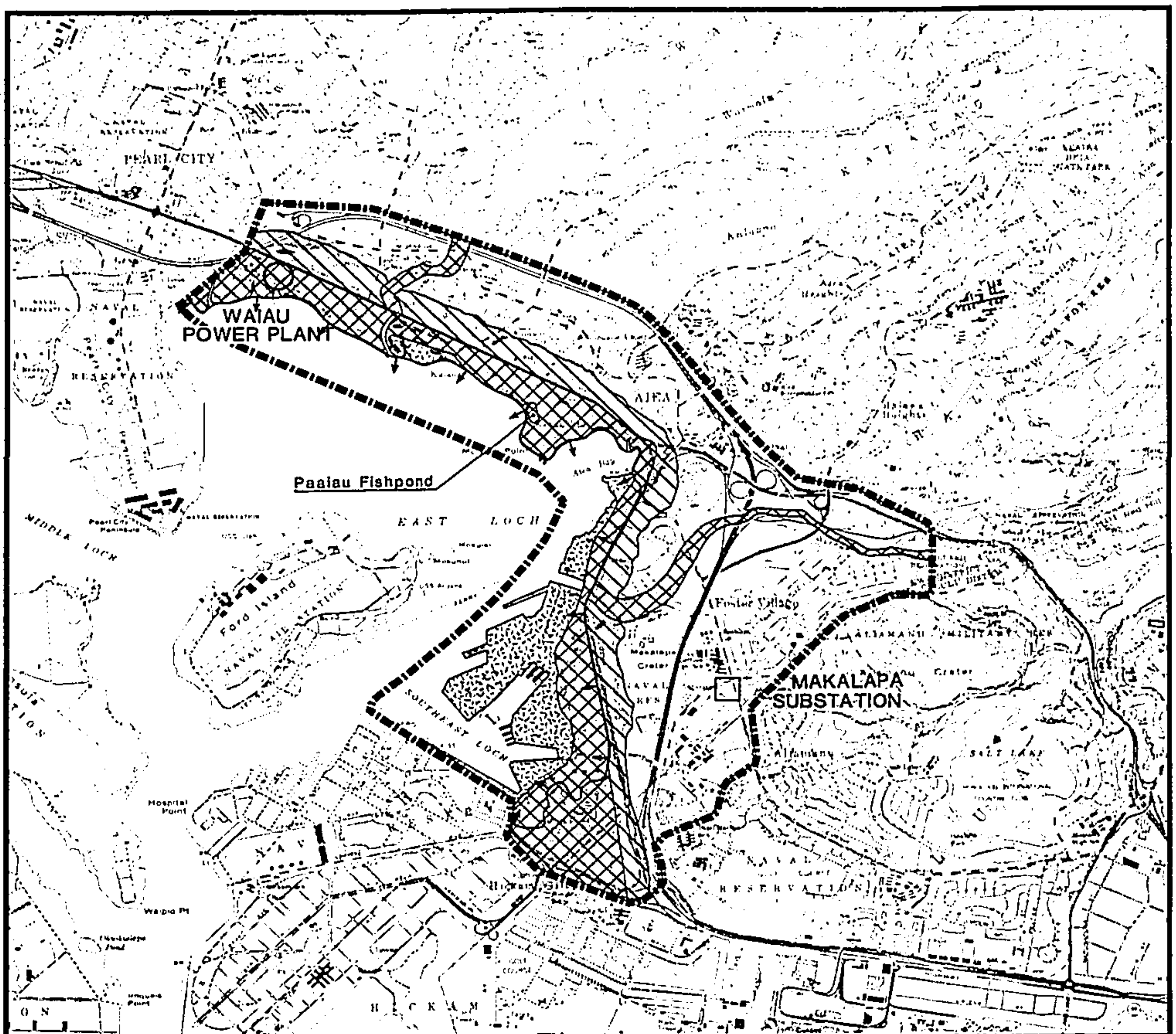
Unsurveyed Area with Medium Potential for Cultural Resources. This category includes areas that are similar to areas where previous surveys have resulted in a moderate to low frequency of archaeological recovery.

Unsurveyed Areas with Poor Cultural Resources Potential. This category includes areas with a poor likelihood of archaeological recovery. These are areas that have been previously disturbed or that resemble in pertinent characteristics surveyed areas in other parts of the state where little or no archaeological information has been recovered.

5.2.9 Corridor Identification

Corridor Identification Process

Resources within the Makalapa project area were examined to determine their influence on the location of a transmission line corridor one-quarter- to one-half-mile wide. The resource categories found to influence corridor location were:



CULTURAL RESOURCES

- Study Area Boundary
- Unsurveyed Areas with Good Cultural Resource Potential
- Unsurveyed Areas with Moderate Cultural Resource Potential
- Unsurveyed Areas with Poor Cultural Resource Potential
- Fill Area with Poor Cultural Resource Potential
- National Historic Landmark Boundary

FIGURE 5.2-8

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

Waiau - Makalapa No. 2 Transmission Line Project

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- Land regulation
- Existing land uses
- Roads and pipelines
- Utility systems

Table 5.2-3 outlines the guidelines used in determining general corridor boundaries. These potential corridor boundaries were mapped based on these general guidelines. Through further evaluation by site visits, discussions with HECO engineers, consideration of agency input, and review of electrical issues (e.g., overbuild potential and proximity to existing 138 kV lines), the potential corridors were refined to two alternative corridors, with one common section between Waiau Power Plant and Aloha Stadium.

Table 5.2-3
RESOURCE ISSUES INFLUENCING CORRIDOR LOCATION

Resource Category	Corridor Location Guideline
Land regulation	• Avoid Conservation Districts (i.e., Makalapa Crater)
Existing land use	• Avoid residential areas and schools where possible • Avoid crossing Aloha Stadium grounds • Avoid shoreline military operations (i.e., submarine docks, maintenance areas)
Roads, pipelines, and utility systems	• Avoid the interstate freeway because of regulatory restrictions • Transmission lines and state and local roads present siting opportunities

Alternative Corridor Description

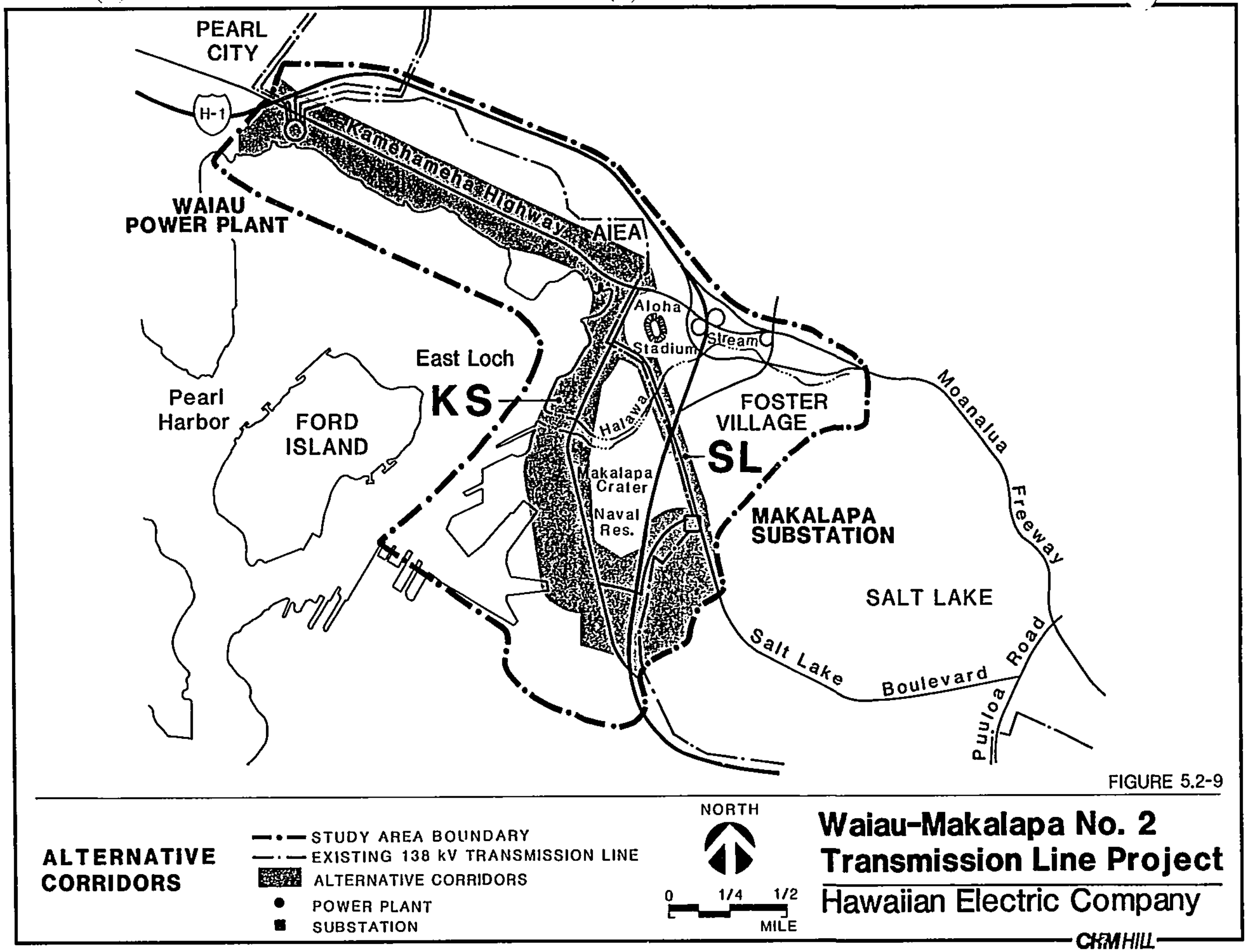
Through the inventory of resources within the study area and the analysis of factors that influence corridor location, two alternative corridors were identified. These were the Kam Highway-Shoreline (KS) alternative and Salt Lake Boulevard (SL) alternative. The portion of the corridor between Waiau Power Plant and Aloha Stadium is common for both alternative corridors (Figure 5.2-9).

(Common Segment) Waiau Power Plant to Aloha Stadium Corridor. This 2.25-mile section of the corridor is common to both the KS and SL alternatives. It ranges from 1,000 feet to 2,000 feet wide and occupies the land from the shoreline of Pearl Harbor to approximately 750 feet mauka of Kam Highway.

KS--Kam Highway-Shoreline Alternative Corridor. This 2.3-mile corridor runs between approximately 500 feet mauka of Kam Highway and the shoreline from Aloha Stadium to Makalapa Substation. The corridor surrounding the Kam Hay/H-1 interchange and Makalapa Substation was widened to allow for flexibility in siting the new line along roadways and existing 46 kV corridors.

SL--Salt Lake Boulevard Alternative Corridor. This corridor, approximately 0.8 mile long and 500 to 1,000 feet wide, runs from Aloha Stadium to Makalapa Substation along Salt Lake Boulevard. This corridor does not cross Aloha Stadium grounds and includes existing utility corridor opportunities.

The alternative corridors are evaluated in Chapter 6.


PEARL CITY
H-1
Kamehameha Highway
AIEA
WAIAU POWER PLANT
Aloha Stadium
Stream
East Loch
KS
Pearl Harbor
FORD ISLAND
Halawa
FOSTER VILLAGE
SL
Makalapa Crater
Naval Res.
MAKALAPA SUBSTATION
Moanalua Freeway
SALT LAKE
Salt Lake Boulevard
Road
Puuloa
FIGURE 5.2-9
ALTERNATIVE CORRIDORS
STUDY AREA BOUNDARY
EXISTING 138 kV TRANSMISSION LINE
ALTERNATIVE CORRIDORS
POWER PLANT
SUBSTATION
NORTH
0 1/4 1/2
MILE
Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
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Chapter 6
Alternative Corridor Evaluation

Chapter 6
ALTERNATIVE CORRIDOR EVALUATION

In order to compare alternative corridors, data were collected and mapped at a finer scale than for the regional study. This involved adjusting the map scale from 1 inch = 2,000 feet to 1 inch = 500 feet and conducting field surveys to characterize, in greater detail, the land use and environmental characteristics within the corridors. At the corridor evaluation stage, information about geophysical resources and site-specific detail about existing and proposed land uses were added. Data at this scale were used in the identification and evaluation of alternative alignments.

6.1 CORRIDOR COMPARISON

The primary objective of the alternative corridor evaluation was to compare the corridor alternatives from land use, environmental, and engineering perspectives and to select a preferred corridor using the detailed information collected and shown in the maps at the end of this chapter. The preferred corridor was selected as having the best potential to contain alignment alternatives that can balance environmental and engineering requirements and public concerns.

A primary objective in the corridor identification process was to minimize the potential impact of a new transmission line on residential areas. An effective way to achieve this objective was to consider the use of existing 46 kV transmission line rights-of-way and existing state and local roads. This resulted in the identification of only a single corridor alternative between the Waiau Power Plant and the intersection of Kam Highway and Salt Lake Boulevard. There is no corridor alternative for this segment.

The comparison instead focused on the two alternative corridor segments from Aloha Stadium to Makalapa Substation: the Kamehameha/Shoreline (KS) alternative and the Salt Lake Boulevard (SL) alternative (see Figure 5.2-9).

The KS and SL segments were compared to further distinguish which alternative corridor segment had the best opportunity of accommodating feasible alignments to meet the following criteria:

- Avoid major residential areas and schools
- Maximize separation from existing 138 kV lines for improved reliability

- Minimize conflict with proposed projects

In addition, the corridor segments were compared for potential permit requirements.

Avoid major residential areas and schools. During neighborhood board meetings and agency consultation, a major comment and recommendation was to avoid routing the line through residential areas or near schools.

Within the KS alternative the residential areas are primarily on the mauka side of Kam Highway. The alignment siting opportunities (adjacent to the roadway or overbuilding along existing 46 kV rights-of-way) are primarily on the makai side of Kam Highway. Residential areas can, therefore, be generally avoided in the KS alternative.

Within the SL alternative, the potential alignment options would involve overbuilding the existing 46 kV line along the mauka side of Salt Lake Boulevard immediately adjacent to Foster Village/Aliamanu neighborhoods. The new line would be routed adjacent to more residences in the SL corridor than in the KS corridor.

Maximize separation from existing 138 kV lines. An important HECO siting criterion for new 138 kV lines, and a recommendation of Stone and Webster's report on the 1983 outage (see Section 1.4), is to maximize the physical separation of new 138 kV lines from existing 138 kV lines. Separation can be accomplished by avoiding crossovers and by separating parallel transmission lines at a sufficient distance to reduce the probability that a single transmission emergency (such as a storm or accident) could damage two 138 kV lines at the same time. In highly urbanized areas with several 138 kV lines, upholding inflexible minimum separation distance criteria is difficult. Nonetheless, maximizing the distance between a new line and existing lines, to the extent possible, is an important evaluation criteria.

Because of the importance of maintaining separation from existing 138 kV lines, the KS corridor alternative is superior to the SL alternative.

The KS corridor includes no 138 kV lines throughout the area makai of Kam Highway and the H-1 freeway. Mauka of H-1, the Makalapa-Iwilei 138 kV line enters the Makalapa Substation from the south and might have to be relocated to accommodate the new line.

In the SL corridor, however, the Waiau-Makalapa No. 1 line runs along the makai side of Salt Lake Boulevard for the entire length of the corridor to Makalapa Substation. If the new line were sited on the mauka side of Salt Lake Boulevard there would be two 138 kV lines separated only by the width of the road right-of-way (approximately 60 feet) for a distance of about one mile. The average height of the poles would be about 100 feet. Minimum separation should be at least 60 percent of the height of one pole or, preferably, at least one pole length.

One additional factor made the SL corridor less desirable. Two 138 kV lines and three 46 kV lines already exit Makalapa Substation from the north side (versus one 138 kV line and two 46 kV lines on the south side). Locating another 138 kV line into the north side of the Makalapa Substation would be impossible unless major modifications to the substation layout were made.

Minimize Conflict with Proposed Projects. To the extent possible, the new line should be sited to avoid potential conflicts with proposed projects.

Several major proposed projects are within or adjacent to the SL corridor.

- The proposed City and County of Honolulu Rapid Transit System (RTS) project plans show Salt Lake Boulevard as one alternative for the transit corridor, with a transit station, park and ride, and maintenance/storage yard located near Aloha Stadium and a second transit station near Makalapa Substation.

- A shopping center development is proposed by Halawa Associates for the existing Castle Park Amusement Center site on Salt Lake Boulevard.

- Other projects include a new water line proposed by the Board of Water Supply within the SL corridor and widening and related improvements of the Salt Lake Boulevard right-of-way to be completed within the next 6 years by the Department of Transportation Services.

Only one major project is proposed within the KS corridor. This is a possible Rapid Transit alternative alignment along the median of Kam Highway and a transit station located near the U.S.S. Arizona Memorial Visitor Center (part of the City and County of Honolulu RTS).

Permit Requirements. The KS and SL corridor segments were also compared and evaluated for potential permit requirements. Table 6.1-1 identifies each potential permit. Appendix F provides a detailed description of the permit or approval.

The two alternative corridor segments share many permit requirements. Because both contain state highways and other state land, both have the potential to require a Permit for Work on State Highways from the Department of Transportation and permission from the Department of Land and Natural Resources for use of state lands. Those permits might also require a state Environmental Impact Statement (EIS). Both corridors could also require approval from PUC for construction of the line in a residential area, because each of these corridors includes housing. Both might require Corps of Engineers permits (Section 404 or Section 10) or a state Stream Channel Alteration Permit if alignments required siting within steam channels. If these permits are required, a state or federal EIS might also be required; however, they should be avoidable by careful pole and alignment siting.

The KS and SL alternatives differ in the need for two permits. The Energy Corridor runs along Salt Lake Boulevard throughout the SL corridor; therefore, construction in the SL corridor might require the Department of Transportation's permit for Use of the Energy Corridor. The KS corridor segment crosses the Energy Corridor; however, occupying or affecting the Energy Corridor could probably be avoided through the careful placement of transmission poles. Much of the KS area lies within the Special Management Area (SMA) and construction within the SMA requires an SMA Use Permit (issued by the Department of Land Utilization of the City and County of Honolulu, after approval by the City Council). If an SMA Use Permit must be issued, a state Environmental Assessment and/or EIS might also be required. The KS area is also adjacent to the Pearl Harbor shoreline. Work within 40 feet of the shoreline might require a Shoreline Setback Variance, which can require a state EIS.

Table 6.1-1
POTENTIAL PERMITS/APPROVALS REQUIRED FOR TRANSMISSION LINE SITING WITHIN ALTERNATIVE CORRIDOR SEGMENTS

Authorizing Agency	Permit	Corridor[1] Segment KS	Corridor[1] Segment SL
Federal			
Corps of Engineers	General Permit/Section 10 Permit	x	x
Corps of Engineers	Section 404 Permit	x	x
CEQ	NEPA Compliance	x	x
U.S. Navy	Approval for Easement	x	
State			
Dept. of Land & Natural Resources	Use of State Lands	x	x
	Historic Site Review	x	
	Stream Channel Alteration Permit	x	x
Dept. of Transportation	Work on State Highways	x	x
	Use of Energy Corridor		x
Office of Env. Quality Control	State Environmental Impact Statement	x	x
Public Utilities Commission	Approval for Construction in a Residential Area	x	x
City/County			
Dept. of Land Utilization	SMA Use Permit	x	
Dept. of Land Utilization	Shoreline Setback Variance	x	
Public Works Dept.	Easement for Use of County Lands	x	

[1]KS = Kam Highway/Shoreline
SL = Salt Lake Boulevard

6.2 SELECTION OF PREFERRED CORRIDOR

After considering the comparative evaluation and reviewing potential permit requirements (Section 6.1), HECO selected the KS corridor segment as the preferred corridor and eliminated the SL segment from further evaluation (Figure 6.2-1). HECO's decision was based on the following factors.

1. Siting along Salt Lake Boulevard (SL) would require adding a 138 kV line immediately adjacent to residential areas. Within the KS corridor segment, the line can be sited on the opposite side of Kam Highway from most residential areas.

2. Siting the new line along Salt Lake Boulevard would not meet the objective of maintaining adequate separation between 138 kV lines. For more than 1 mile, the new line would be separated from the existing line only by the width of Salt Lake Boulevard. In addition, two existing 138 kV lines and three 46 kV lines exit the north side of Makalapa Substation, and routing a new 138 kV line into the north side of Makalapa Substation would be very difficult electrically and would compromise separation criteria. If the KS corridor is used, the new line will enter Makalapa Substation on the south side, where only one 138 kV line and two 46 kV lines now enter.

3. There are fewer proposed projects in the KS corridor.

4. Although the potential permit requirements were slightly greater for KS than SL, most of the permits required for the KS segment were also required for the common segment from the Waiau Power Plant to Aloha Stadium. When compared on the basis of other criteria, the Kam Highway/ Shoreline alternative was superior and was selected as the preferred corridor.

6.3 EVALUATION OF PREFERRED CORRIDOR

The following subsections present a detailed description and evaluation of the preferred corridor (the KS segment from Aloha Stadium to Makalapa Substation) and the common segment from Waiau Power Plant to Aloha Stadium.

This evaluation is based on a refinement of land use and environmental information mapped at 1 inch = 500 feet scale.

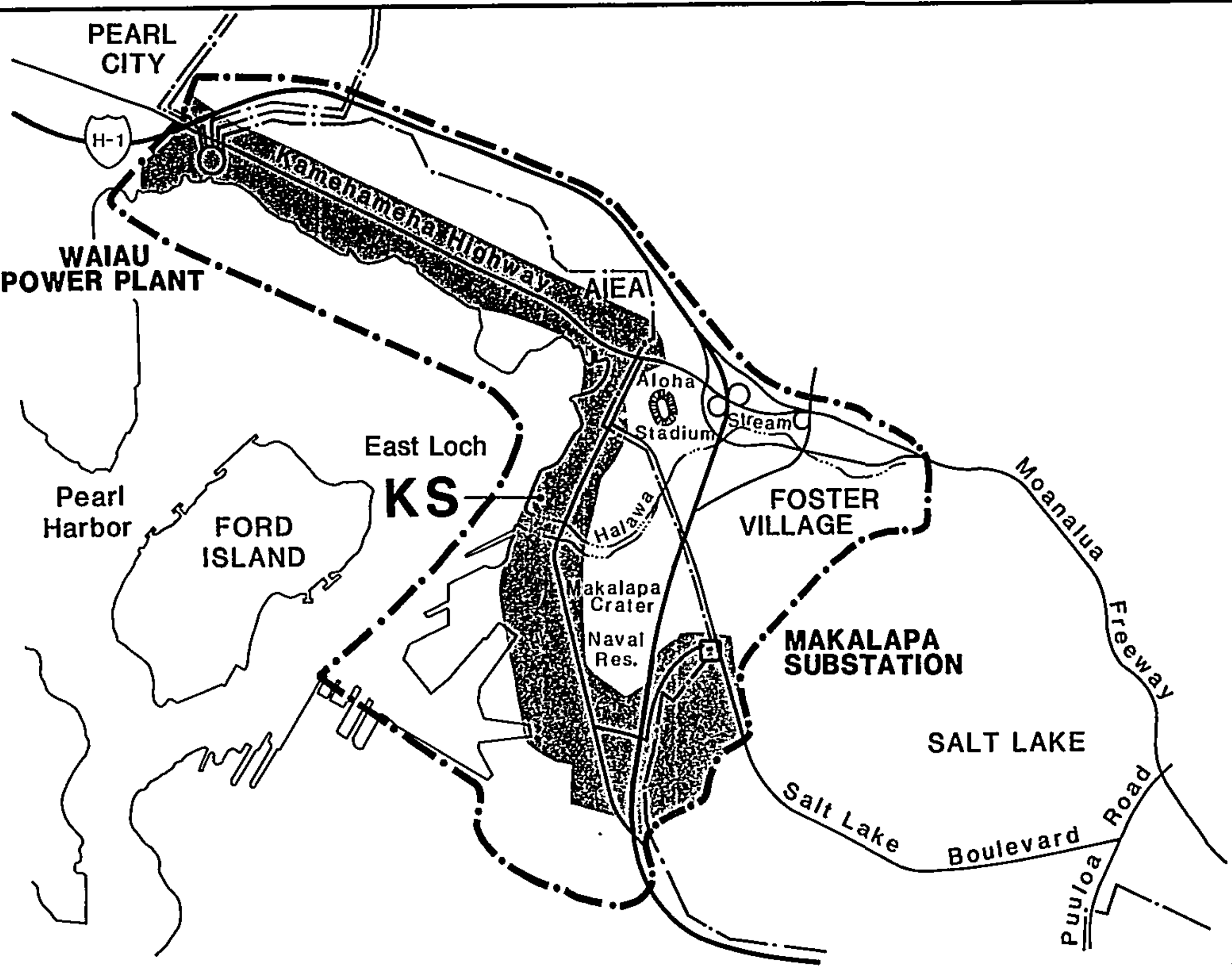


FIGURE 6.2-1

PREFERRED CORRIDOR

- STUDY AREA BOUNDARY
- EXISTING 138 kV TRANSMISSION LINE
- PREFERRED CORRIDOR
- ● POWER PLANT
- ■ SUBSTATION

NORTH

0 1/4 1/2 MILE

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

It is the first step in the identification of alternative alignments discussed in Chapter 7.

6.3.1 Existing Transmission System

Existing 138 kV Lines. The existing Waiau-Makalapa No. 1 line enters the preferred corridor mauka of the Moanalua/Aiea interchange (Figure 6.3-1, Map 1) and crosses the ewa side of Aiea interchange. It then follows the makai side of Kam Highway for about 1,000 feet in the vicinity of Aloha Stadium, before crossing Kam Highway to follow Salt Lake Boulevard. Where the existing 138 kV line is located makai of Kam Highway, the distance from shoreline to transmission line right-of-way is about 300 feet.

To avoid crossing one 138 kV line over another (see Section 6.1), the new Waiau-Makalapa No. 2 line must be sited makai of the Waiau-Makalapa No. 1 line in the Aloha Stadium area. This siting will provide adequate separation (at least 100 feet) from the existing 138 kV line.

Another 138 kV line, Makalapa-Iwilei, is near the Makalapa Substation end of the preferred corridor (Figure 6.3-1, Map 2). This line leaves the southern end of Makalapa Substation and follows the curve of Lawehana Street to Bougainville Drive. It then follows the mauka side of Bougainville Drive across Radford Drive south, beyond the boundary of the preferred corridor. In order to avoid crossing the Makalapa-Iwilei line, the new line must be routed makai of it (Figure 6.3-1, Map 2). The distance between Bougainville Road and the Makalapa-Iwilei line in this area is less than 200 feet. Providing adequate separation is an important issue in this section of the preferred corridor between the H-1 freeway and Makalapa Substation. A potential alignment option involves relocating the Makalapa-Iwilei line to the south in order to provide adequate separation.

Existing 46 kV Lines. Existing 46 kV lines provide siting opportunities for the new line. In many places, the new 138 kV line and the existing 46 kV conductors can be strung on a single set of poles along the existing 46 kV alignment. The existing 46 kV structures will be removed and replaced with steel 138 kV poles.

Between the Waiau Power Plant and the Aloha Stadium, there is an existing 46 kV line that follows the makai side of Kam Highway to the vicinity of the McGrew Point access road before crossing to the mauka side of Kam Highway (Figure 6.3-1, Map 1). A second 46 kV line follows the bicycle path from Waiau Power Plant around to Aiea Bay. Two 46 kV lines follow the makai side of Kam Highway from Aiea Bay to the general area of the Kuahua Substation (Figure 6.3-1, Map 2). A single 46 kV line continues south along Kam Highway. A 46 kV line follows the north side of Radford Drive and then Bougainville Drive to Makalapa Substation. Another 46 kV line that exits the east side of Makalapa Substation and runs south of the Makalapa-Iwilei 138 kV line can provide a new alignment for the Makalapa-Iwilei line, if necessary. This configuration would ensure that adequate separation is maintained between the 138 kV lines.

6.3.2 Land Jurisdiction and Regulation

The analysis of land jurisdiction and regulation within the preferred corridor was enhanced by mapping the data factors at a 1 inch = 500 feet scale (see Figure 6.3-2). Private parcels greater than 5 acres were identified to show the current owner. Those private parcels less than 5 acres were noted, but were not identified by owner.

Land Jurisdiction. Between Waiau Power Plant and Aloha Stadium (Figure 6.3-2, Map 1), the ownership patterns of both civilian and military lands are varied and parcel boundaries are uneven. U.S. Navy lands include McGrew Point Housing and the Richardson Recreation Center. The City and County of Honolulu owns Pearl Harbor (Blaisdell) Park and part of the drainage channel of Waimalu Stream. Lands owned by the State of Hawaii include Aloha Stadium and the surrounding parking lot, the right-of-way of Kam Highway, and the Aiea Interchange. The State also owns eight small parcels of land (approximately 7 acres total) that, together with land owned by the Navy, is proposed to be developed as the Aiea Bay State Recreation Area (Figure 6.3-3).

Private lands exist in large parcels near Blaisdell Park, between Kam Highway and the shoreline. Magba Inc., and Honolulu Ltd., jointly own approximately 18.5 acres and City Mill Company owns adjacent parcels (12 acres) that are in commercial use. Bishop Estate owns the site of the Pearlridge Shopping Center and the watercress farm it surrounds, as well as a large parcel of land across Kam Highway from Pearlridge leased for commercial and multifamily residential use.

South of Aloha Stadium, most of the land in the preferred corridor belongs to the U.S. Navy (Figure 6.3-2, Map 2). Exceptions include land owned by the State of Hawaii: the right-of-way of Kam Highway and a parcel of land south of the intersection of Kam Highway and Salt Lake Boulevard used for the Hawaii Housing Authority's Puuwai Momi apartments. Two small areas of private parcels exist south of Bougainville Drive and mauka of Kam Highway near Halawa Stream.

Land Regulation. Most of the preferred corridor is in the Urban Land Use District. The only exceptions are two small parcels that were once fish ponds, designated Conservation (Resource Subzone). These two parcels are located next to the shoreline ewa of McGrew Point, and total approximately 3.5 acres. One is located on Navy property and the other on adjacent privately owned land.

Approximately half of the preferred corridor is within the Special Management Area (SMA) boundary (Figure 6.3-2). Between Waiau Power Plant and Aloha Stadium, the SMA is defined as the area makai of Kam Highway. The SMA boundary continues to follow Kam Highway past Aloha Stadium to the point just south of Halawa Stream where Kam Highway angles slightly to the east. At that point, the SMA boundary continues straight until it reaches North Road which it follows south out of the study area.

The State's Energy Corridor runs beneath Pearl Harbor in the area between Waiau Power Plant and Aloha Stadium. Near the intersection of Kam Highway and Salt Lake Boulevard the Energy Corridor regains land at the shoreline and crosses the preferred corridor before it continues along Salt Lake Boulevard (Figure 6.3-2, Map 2).

6.3.3 Existing and Proposed Land Use

The existing land use mapping was refined using the Pearl Harbor Naval Complex Master Plan (1986) and field verification of recent black and white (September 1987) and color (June 1988) aerial photographs. Single-family residences were distinguished from multifamily residences, schools were identified by name, and the Energy Corridor and other pipeline routes were mapped from as-built drawings. Pertinent EISs and current information about City and County Development Plan maps were used to update the location and status of the projects proposed for development within the next 6 years.

Existing Land Use. Land uses within the preferred corridor are varied (Figure 6.3-3, Map 1 and Map 2). In the north portion of the preferred corridor (Map 1), commercial and residential uses predominate near the major transportation routes. The southern portion of the preferred corridor (Map 2) is almost entirely in military use, with supply and storage, recreation and community support facilities, and housing dominating.

The preferred corridor extends from Waiau Power Plant to approximately McMorris Drive near Pearl Harbor Kai School. Seven residential neighborhoods (five single family and two multifamily) and seven military housing areas are located in or near the preferred corridor. Residential use spans the entire corridor only in the Aiea/McGrew Point area. The other prominent use throughout the corridor is commercial. In the northern corridor, there are commercial strips on either side of Kam Highway and one large shopping area (Pearlridge) that spans the corridor (Figure 6.3-3, Map 1). Commercial uses in the southern portion center around the Makalapa Substation on the makai side of Salt Lake Boulevard. Recreational uses are common throughout and include a major city park, Pearl Harbor (Blaisdell) Park; the U.S.S. Arizona Memorial; the Richardson Recreation Center; the shoreline along McGrew Point and Aiea Bay; and several smaller parcels within Navy lands.

There is one school, Hale Keiki Elementary, within the preferred corridor between Bougainville Drive and H-1 near the Makalapa Substation; however, there are twelve schools within the vicinity of the corridor (up to one-quarter mile from the corridor boundary). The Aloha Stadium is the major public facility and, in conjunction with the Navy Richardson Recreation Center, forms a highly congested area near the Kam Highway, Salt Lake Boulevard, and H-1 interchange. The U.S.S. Arizona Memorial entrance and visitor center are also located within the corridor. Two pipeline routes, one along Kam Highway and one along the bike trail, are within the corridor for nearly its entire length.

<u>Proposed Land Use</u>. Proposed projects within the preferred corridor are all linear except for the Aiea Bay State Recreation Area, proposed for shorelands owned by the Navy and the state, between McGrew Point and Richardson Recreation Center. The Kalauao Springs nonpotable water system development at the existing watercress farm site in Pearlridge and Salt Lake Boulevard improvements are proposed within the next 6 years (City and County Development Plan, 1987). The portion of Salt Lake Boulevard running south past Makalapa Substation is proposed for right-of-way improvements. Other linear projects include the Kam Highway as an alternative Rapid Transit System Corridor with four transit stations and a branch line proposed within the preferred corridor (Figure 6.3-3, Map 2).

6.3.4 Geophysical and Biological Resources

A geotechnical investigation was made to determine the types of geologic formations and hydrologic features within the preferred corridor (see Appendix B). The characteristics of each factor were analyzed for potential constraints on foundation installation and transmission line design. A biological survey was conducted to examine the natural habitats within the preferred corridor.

Geophysical Resources Data Factors

Five geologic formations exist in the preferred corridor: Koolau basalt (TKb), volcanic tuff (Qht), older alluvium (Qa), man-made fills (Rf), and recent alluvium (Ra) (see Figure 6.3-4, Map 1 and Map 2, and Appendix B).

These soil types differ in their relative suitability for foundation support. Koolau basalt, older alluvium, and volcanic tuff are the most suitable of the five for drilled pier foundations. The other geologic formations have moderate to poor suitability for foundation support, and pile-type foundations are recommended on both recent alluvium and man-made fills (see Table 6.3-1). Similarly, in wet soils near streams, springs, or flood-prone areas, the recommended foundation would be pile type.

Geophysical Resources. In general, makai of Kam Highway, the northern portion of the corridor is characterized by recent alluvium and the southern portion is fill. Mauka of Kam Highway, the predominant geologic formation is older alluvium although, along stream courses, recent alluvium is present. A large area of volcanic tuff exists around Makalapa Substation and Makalapa Crater and extends through the Pearl Harbor Naval Base Complex (Figure 6.3-4, Map 2).

There are no natural streams in the corridor. All the waterways have been modified as open, concrete-lined channels.

From north to south, the channels are: Waimalu Stream, an unnamed channel, Kalauao Stream, Aiea Stream, and Halawa Stream (Figure 6.3-4, Map 1 and Map 2). Each of these channels extends across the corridor. The Kalauao Stream is unchannelized in the reaches mauka of Kam Highway, an area subject to inundation by a 100-year flood event, as defined on FEMA flood insurance maps.

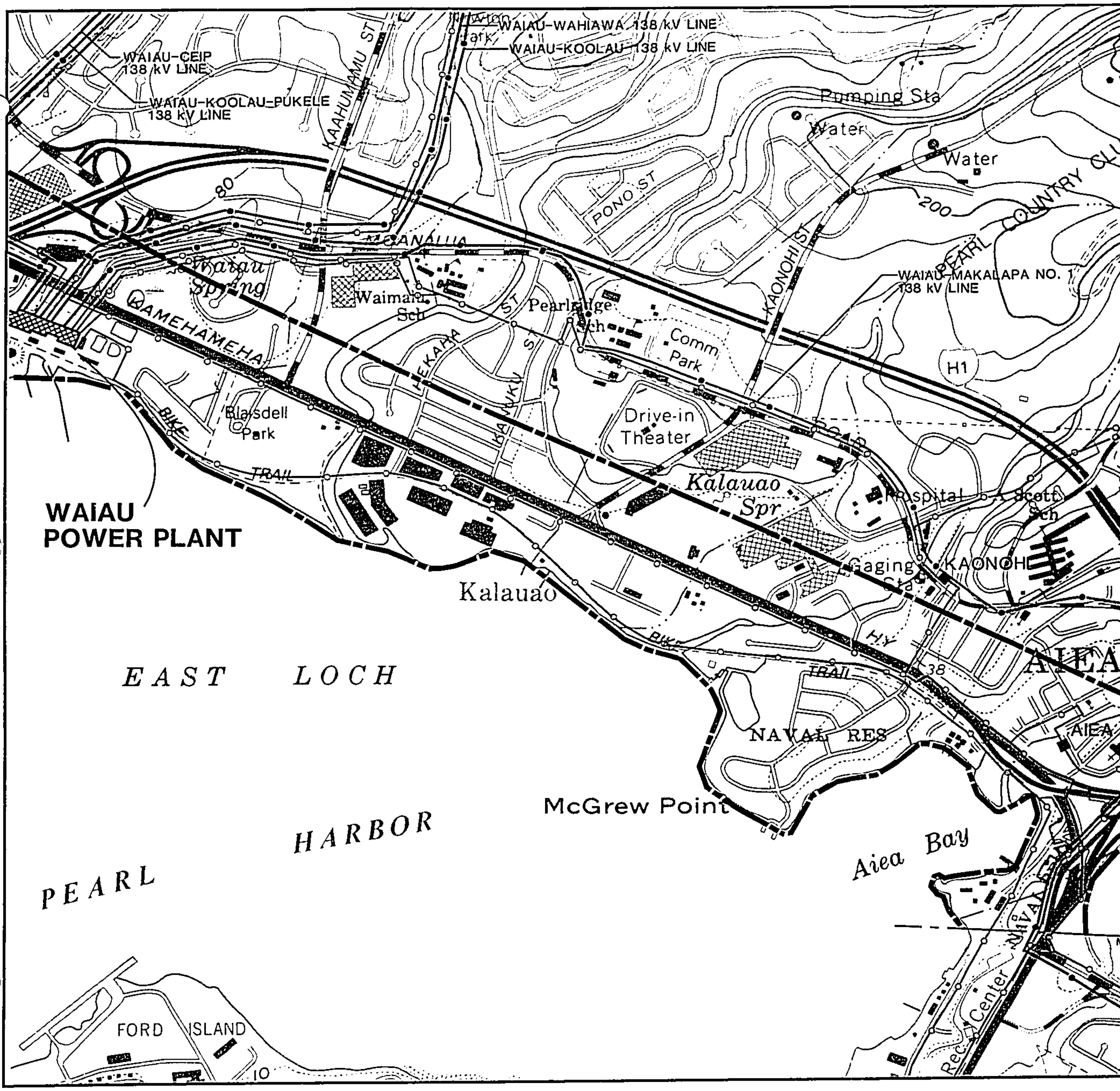
There are two underground springs in the corridor, one at Kalauao in the watercress farm near Pearlridge Shopping

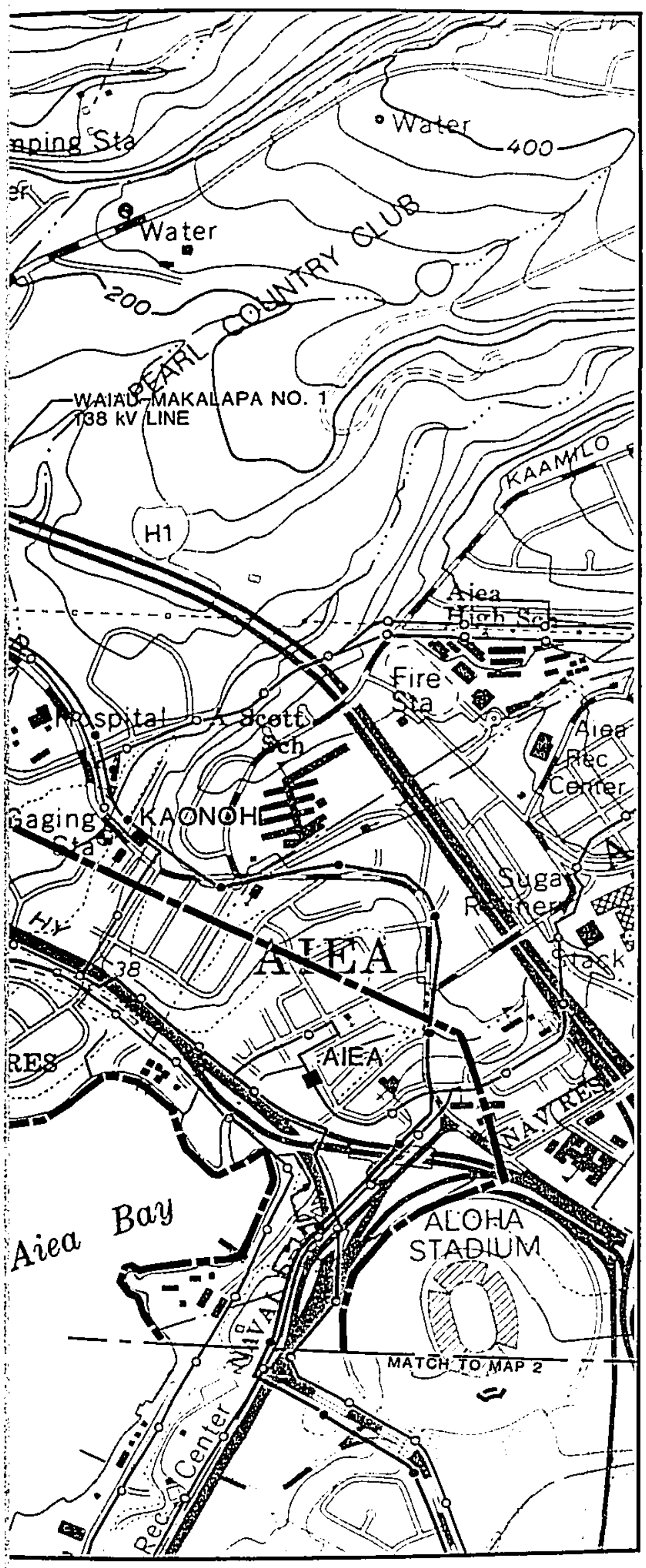
Table 6.3-1
GEOLOGIC FORMATIONS AND FOUNDATION SUPPORT SUITABILITY

Geologic Unit	Description	Foundation Support	Recommended Foundation Type
Koolau basalt (TKb)	Oldest unit consisting of interbedded pahoehoe and a'a flows of basaltic lava	Good	Drilled pier or caisson
Older alluvium (Qa)	Second oldest, consisting of terrigenous sediments, clayey silts, and silty clays	Moderate to good	Drilled pier
Volcanic tuff (Qht)	Consolidated volcanic ash "mud rock"	Good	Drilled pier
Recent alluvium (Ra)	Organic silt with varying amounts of sand and a few pockets of gravel or cobbles	Poor	Pile
Man-made fills (Rf)	Clays to gravels and intermediate mixtures of soils; soft or loose to hard or very dense; consistency variable	Moderate to poor	Pile

Center and one at Waiau on the mauka side of Kam Highway at the Waiau Power Plant. Neither of these springs is within the alignment and, therefore, neither constrains the alignment or construction plans.

Biological Resources. The only natural plant community in the corridor is made up of scattered mangrove swamps along the northern shoreline at Kalauao and McGrew Point. A small cultivated wetland (a watercress farm) is located within the Pearlridge Shopping Center complex. No endangered, threatened, or sensitive plant or wildlife species have been recorded or would be expected to reside within the preferred corridor, because of its urban character.

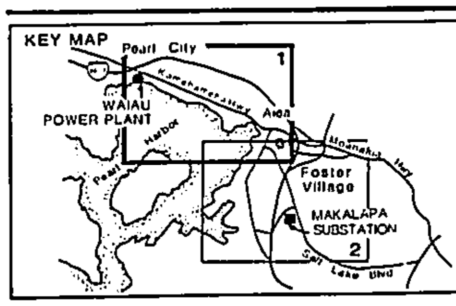

WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
WAIAU-MAKALAPA NO. 1 138 kV LINE
KAAHUMANU ST
Pumping Sta
Water
Water
PONO ST
KAONOHI ST
PEARL COUNTRY CLUB
200
80
MOANALUA
Waiau Spring
KAMEHAMEHA
Waimalu Sch
Pearlridge Sch
Comm Park
H1
KAHUKU ST
Blaisdell Park
Drive-in Theater
BIKE
TRAIL
Kalauao Spr
Hospital
Scott Sch
WAIAU POWER PLANT
Kalauao
Gaging Sta
KAONOHI
HY
AIEA
38
EAST LOCH
NAVAL RES
AIEA
McGrew Point
HARBOR
PEARL
Aiea Bay
Rec Center
FORD ISLAND
10



ALIGNMENT DATA MAP

EXISTING TRANSMISSION SYSTEM

- Corridor Boundary
- Existing 46 kV Line
- Existing 138 kV Line
- Substation



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

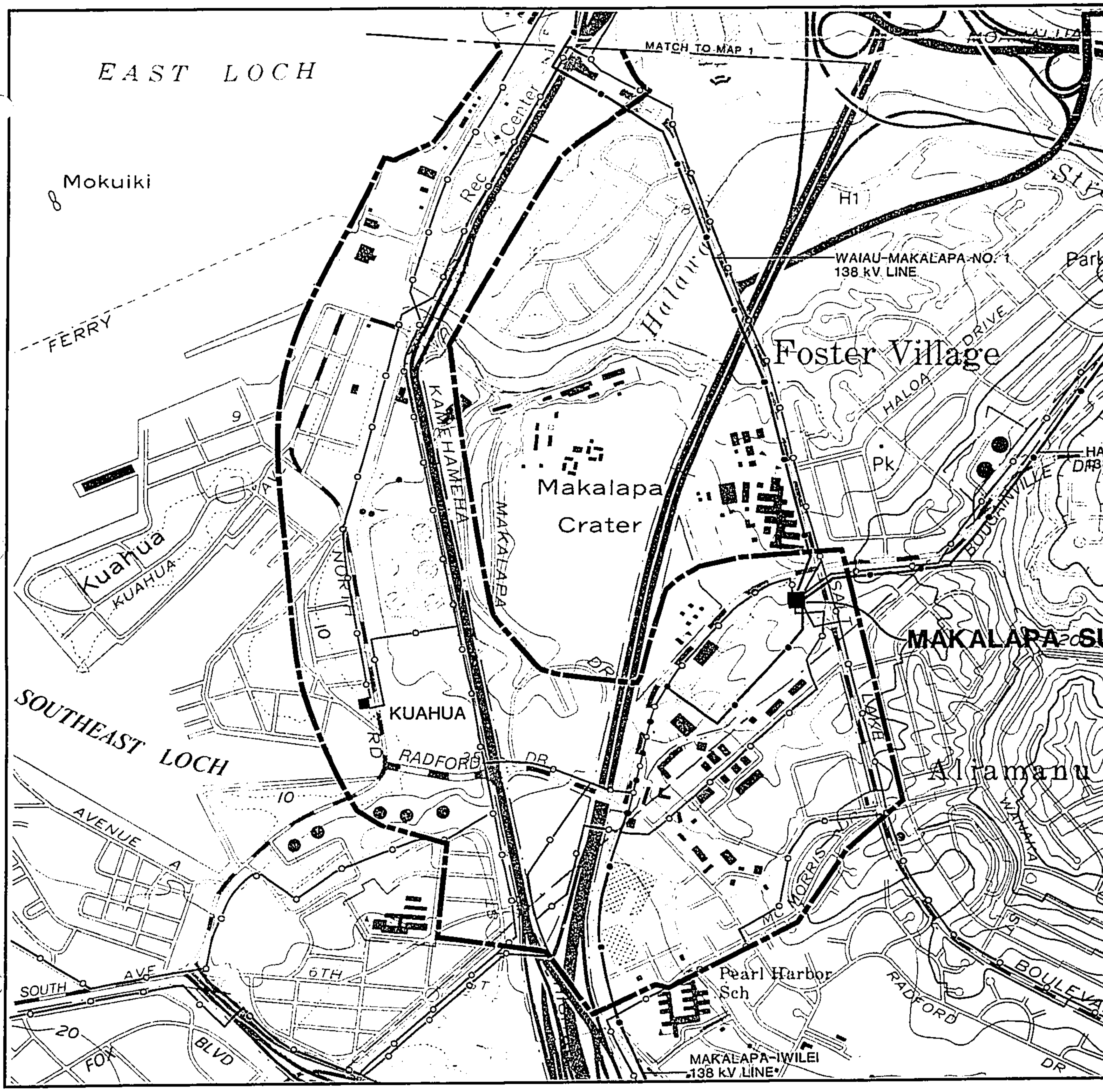
FIGURE 6.3-1

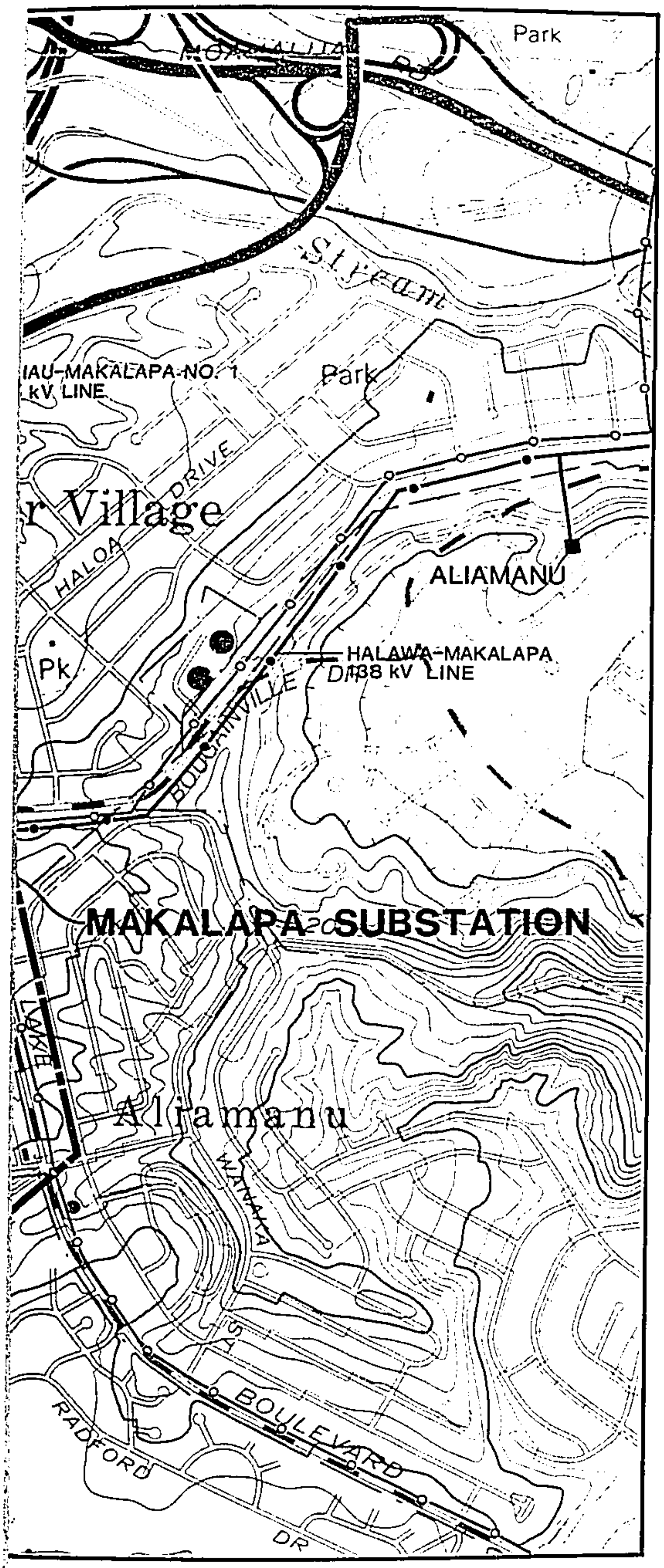
Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

10/89

CH2M HILL

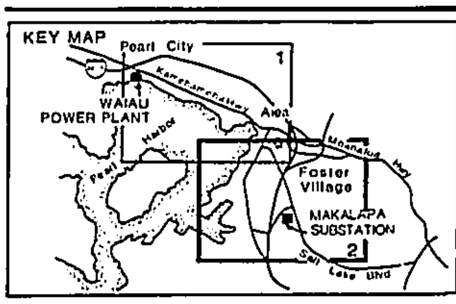

EAST LOCH
MATCH TO MAP 1
Mokuiki
FERRY
Rec Center
H1
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
Foster Village
HALOA DRIVE
Halawa
KAMEHAMEHA
MAKALAPA
Makalapa
Crater
Pk
BOUGAINVILLE DR
Kuahua
KUAHUA
NORTH RD
SALT LAKE
MAKALAPA SU
SOUTHEAST LOCH
KUAHUA
RADFORD DR
Aliamanu
AVENUE A
WANAKA
MC MORRIS
SOUTH AVE
6TH
Pearl Harbor
Sch
RADFORD DR
BOULEVARD
FOX BLVD
MAKALAPA-IWILEI
138 kV LINE



ALIGNMENT DATA MAP

EXISTING TRANSMISSION SYSTEM

- Corridor Boundary
- Existing 46 kV Line
- Existing 138 kV Line
- Substation



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

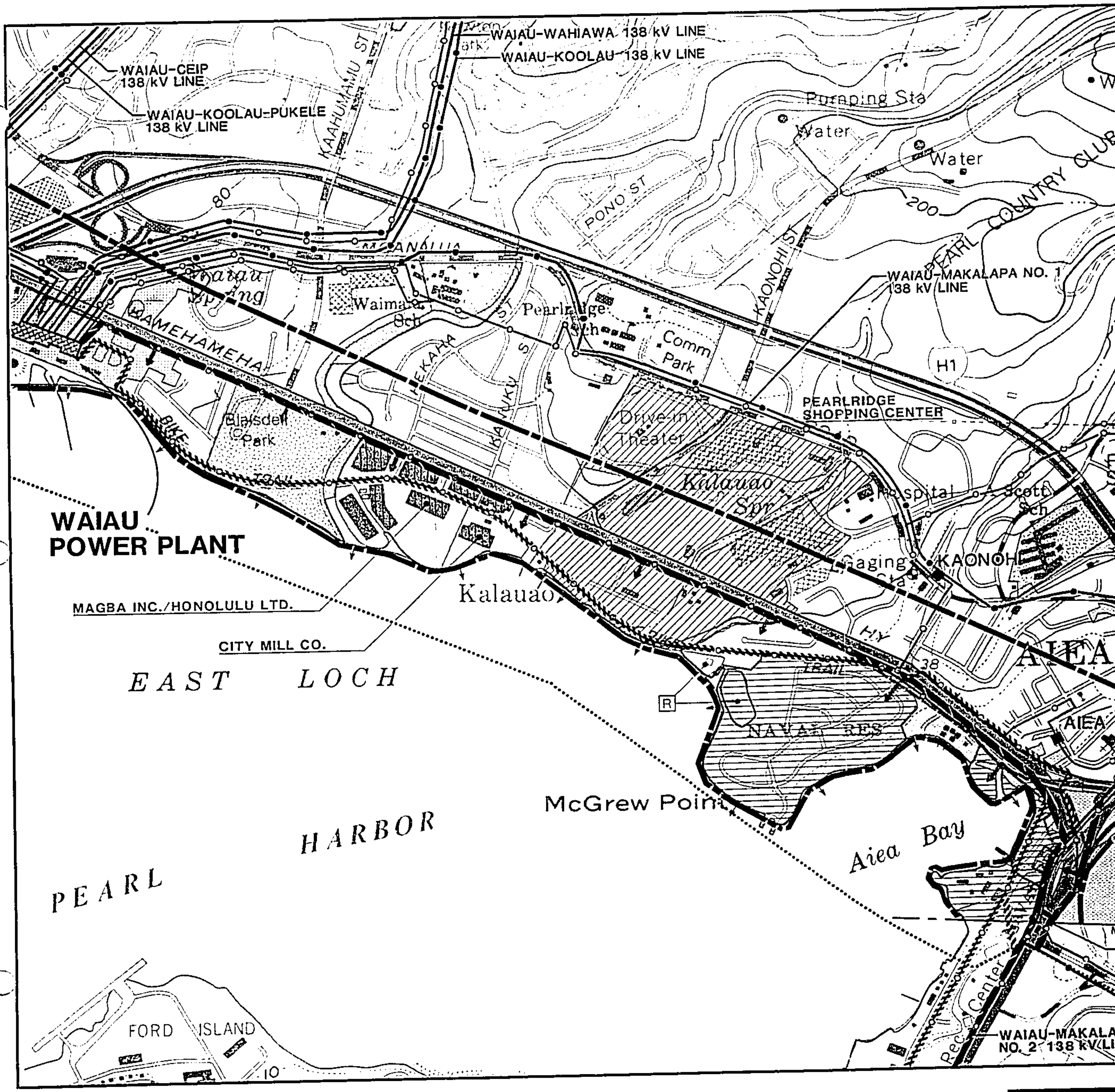
NORTH

FIGURE 6.3-1

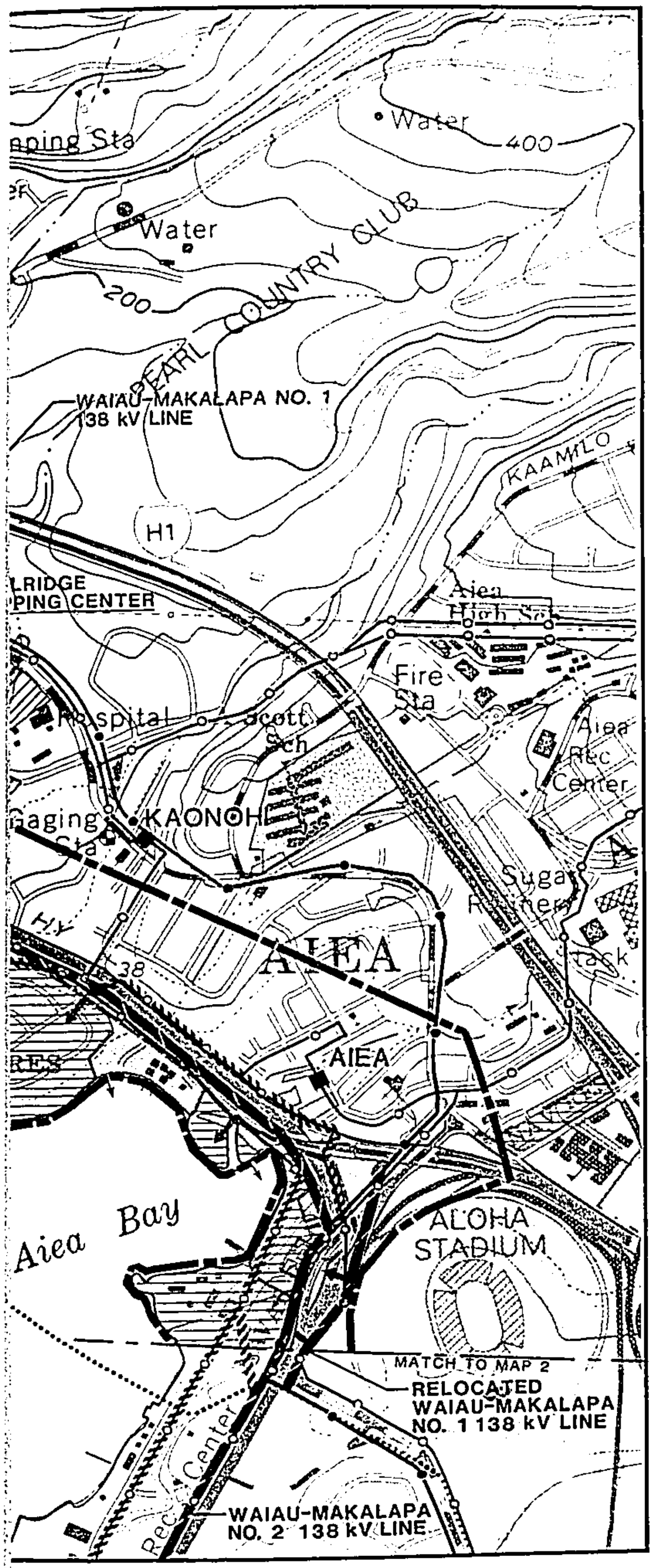
Waiau – Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

10/89

CH2M HILL



WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
WAIAU-MAKALAPA NO. 1 138 kV LINE
Pumping Sta
Water
Water
PEARL COUNTRY CLUB
PONO ST
KAONOHI ST
KAAHUMANU ST
KAMEHAMEHA
Waima Sch
Pearlridge Sch
Comm Park
H1
PEARLRIDGE SHOPPING CENTER
Drive-in Theater
Blaisdell Park
Kalauao Spr
Hospital
Scott Sch
Gaging Sta
KAONOHI
AIEA
WAIAU POWER PLANT
MAGBA INC./HONOLULU LTD.
CITY MILL CO.
Kalauao
EAST LOCH
NAVAL RES
McGrew Point
Aiea Bay
HARBOR
PEARL
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE



ALIGNMENT DATA MAP

LAND JURISDICTION AND REGULATION

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

LAND JURISDICTION

MILITARY LANDS

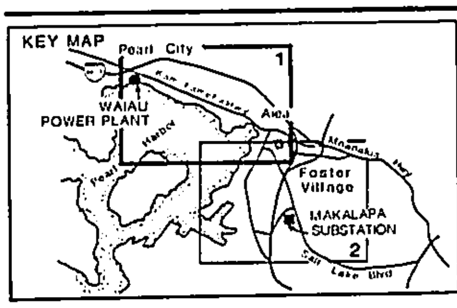
- Navy

STATE, CITY/COUNTY & PRIVATE LANDS

- State of Hawaii
- City/County of Honolulu
- Hawaiian Electric Co.
- Bishop Estate
- Other Private Parcels (≥5 Acres)
- Other Private Parcels (<5 Acres)

LAND REGULATION

- G Conservation [General (G) Subzone]
- R Conservation [Resource (R) Subzone]
- Special Management Area Boundary
- Energy Corridor
- National Historic Landmark Boundary



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 6.3-2

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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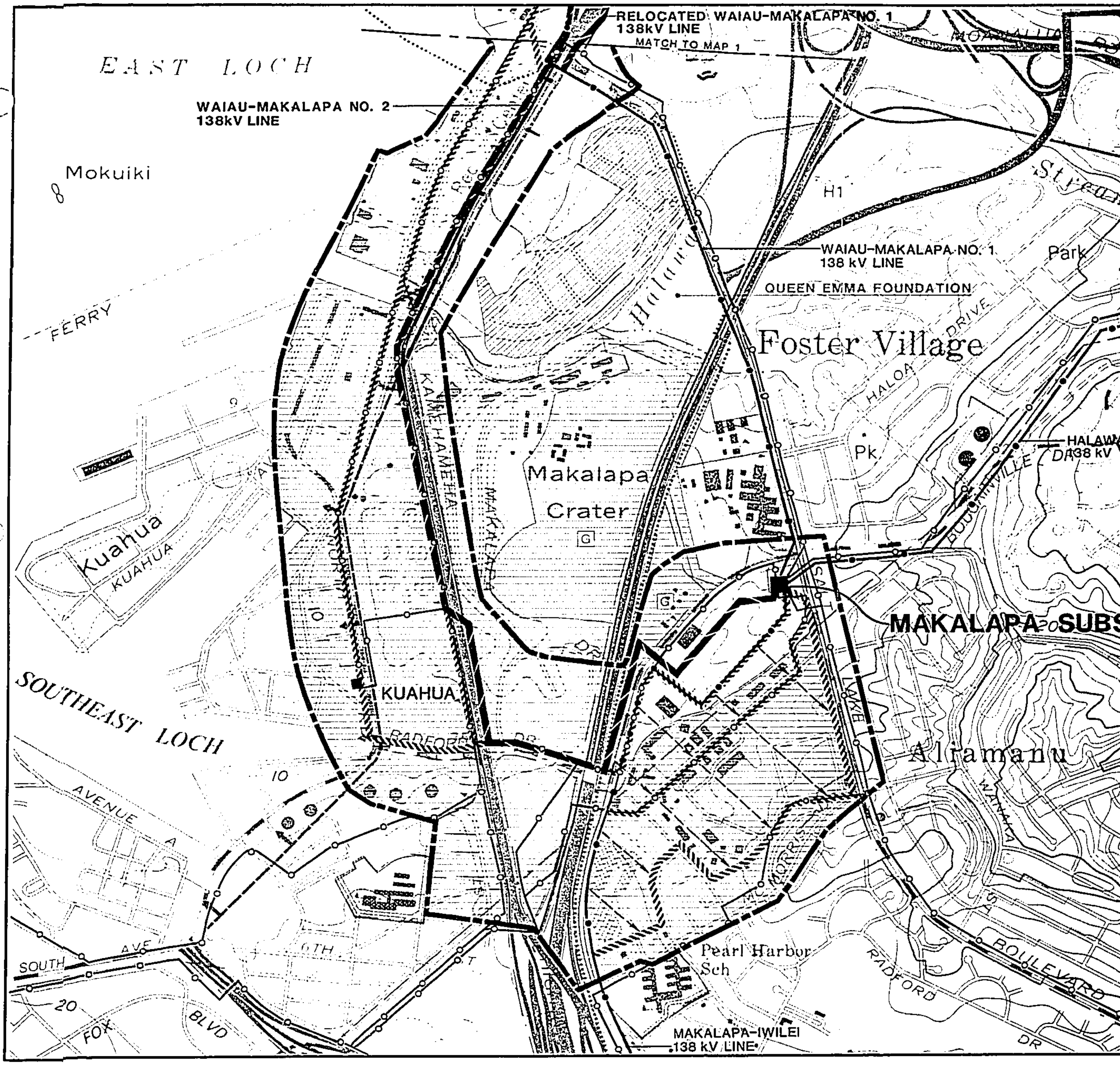
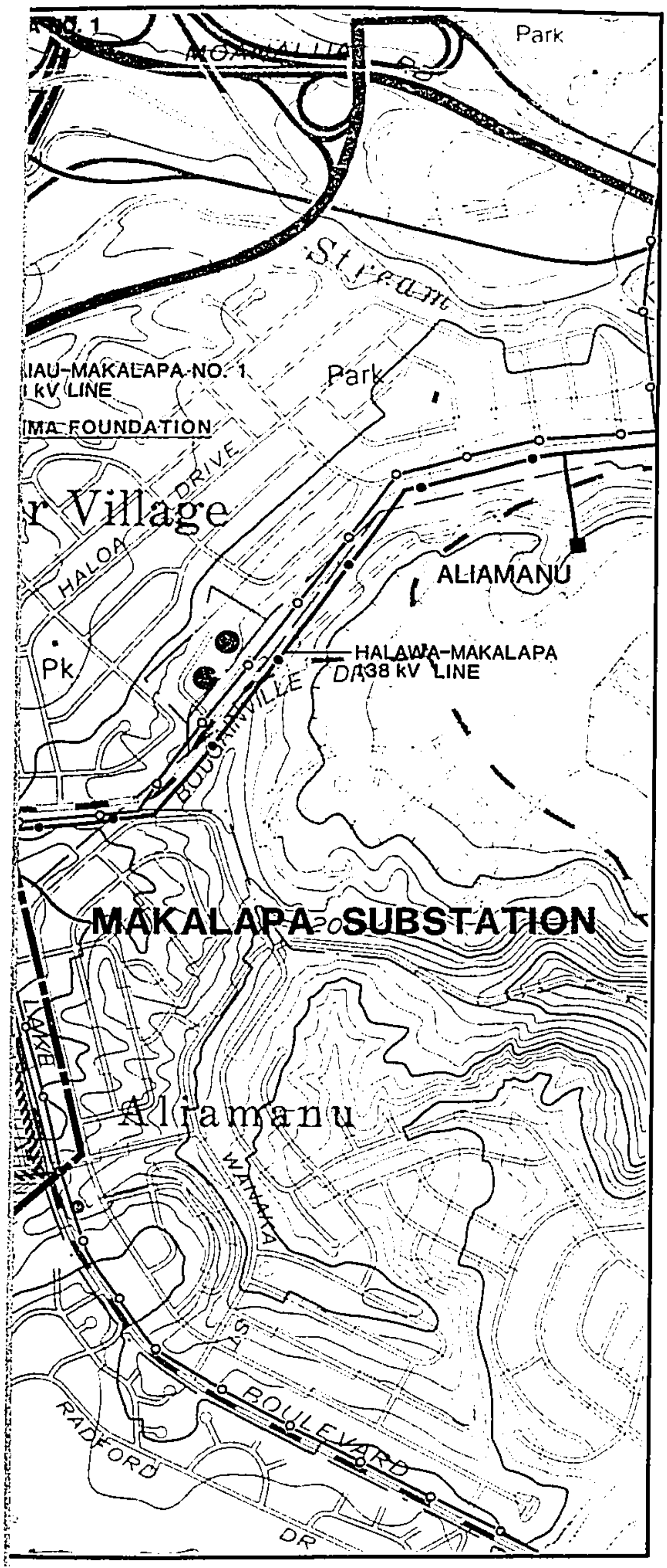
10/89



RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
H1
WAIAU-MAKALAPA NO. 1
138 kV LINE
QUEEN EMMA FOUNDATION
Park
FERRY
Foster Village
Pk.
Makalapa
Crater
Kuahua
KUAHUA
SOUTHEAST LOCH
KUAHUA
RADFORD DR
AVENUE
SOUTH AVE
FOX BLVD
Pearl Harbor
Sch
MAKALAPA-IWILEI
138 kV LINE
RADFORD
BOULEVARD



ALIGNMENT DATA MAP

LAND JURISDICTION AND REGULATION

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

LAND JURISDICTION

MILITARY LANDS

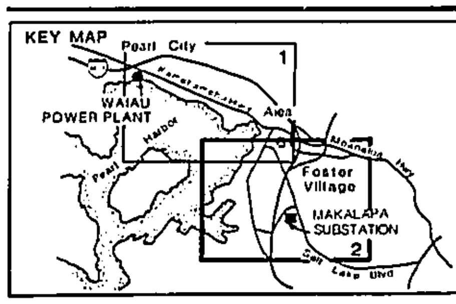
- Navy

STATE, CITY/COUNTY & PRIVATE LANDS

- State of Hawaii
- City/County of Honolulu
- Hawaiian Electric Co.
- Bishop Estate
- Other Private Parcels (≥5 Acres)
- Other Private Parcels (<5 Acres)

LAND REGULATION

- G Conservation [General (G) Subzone]
- R Conservation [Resource (R) Subzone]
- Special Management Area Boundary
- Energy Corridor
- National Historic Landmark Boundary



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 6.3-2

Waiau – Makalapa No. 2 Transmission Line Project
Hawaiian Electric Company

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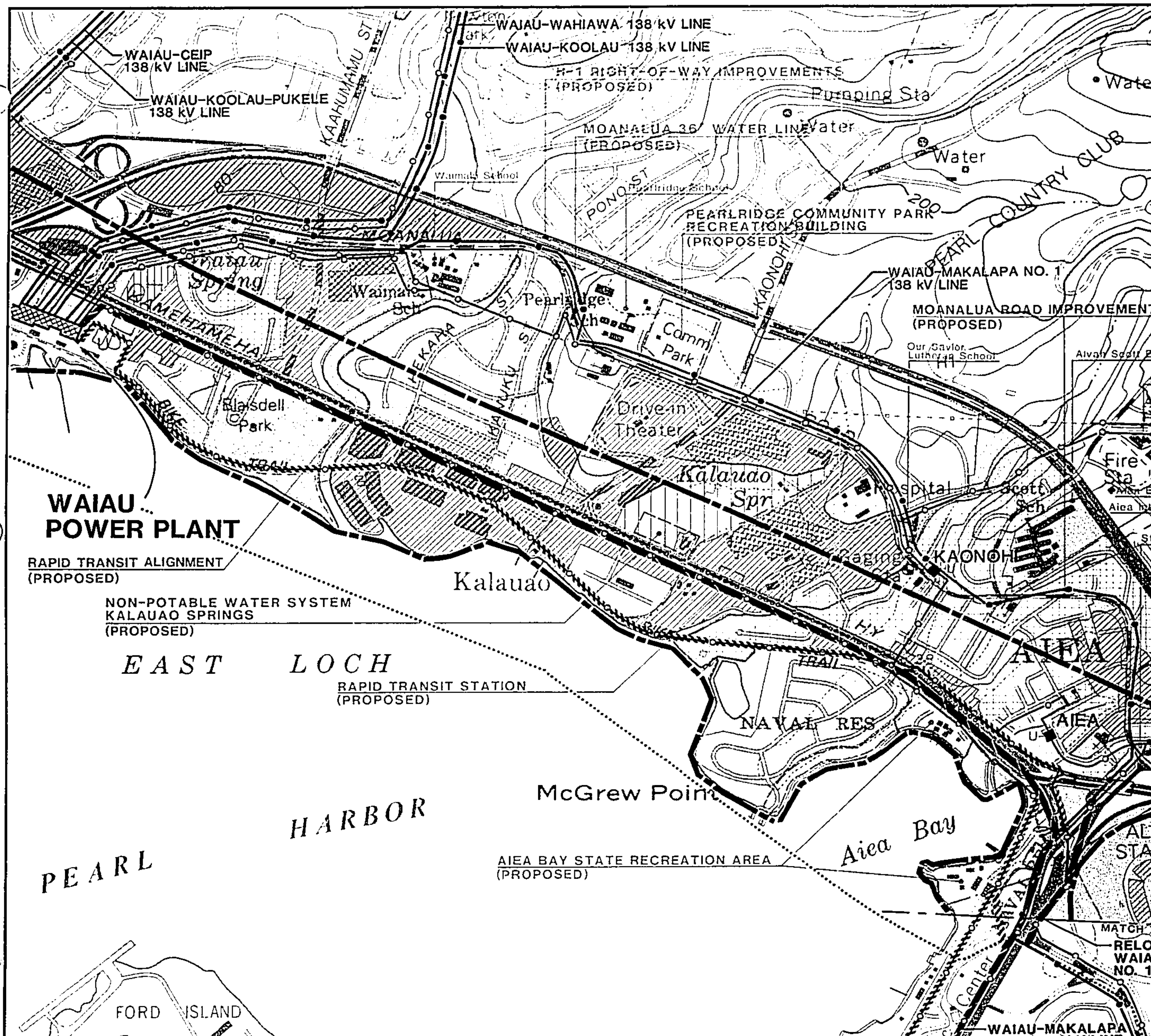
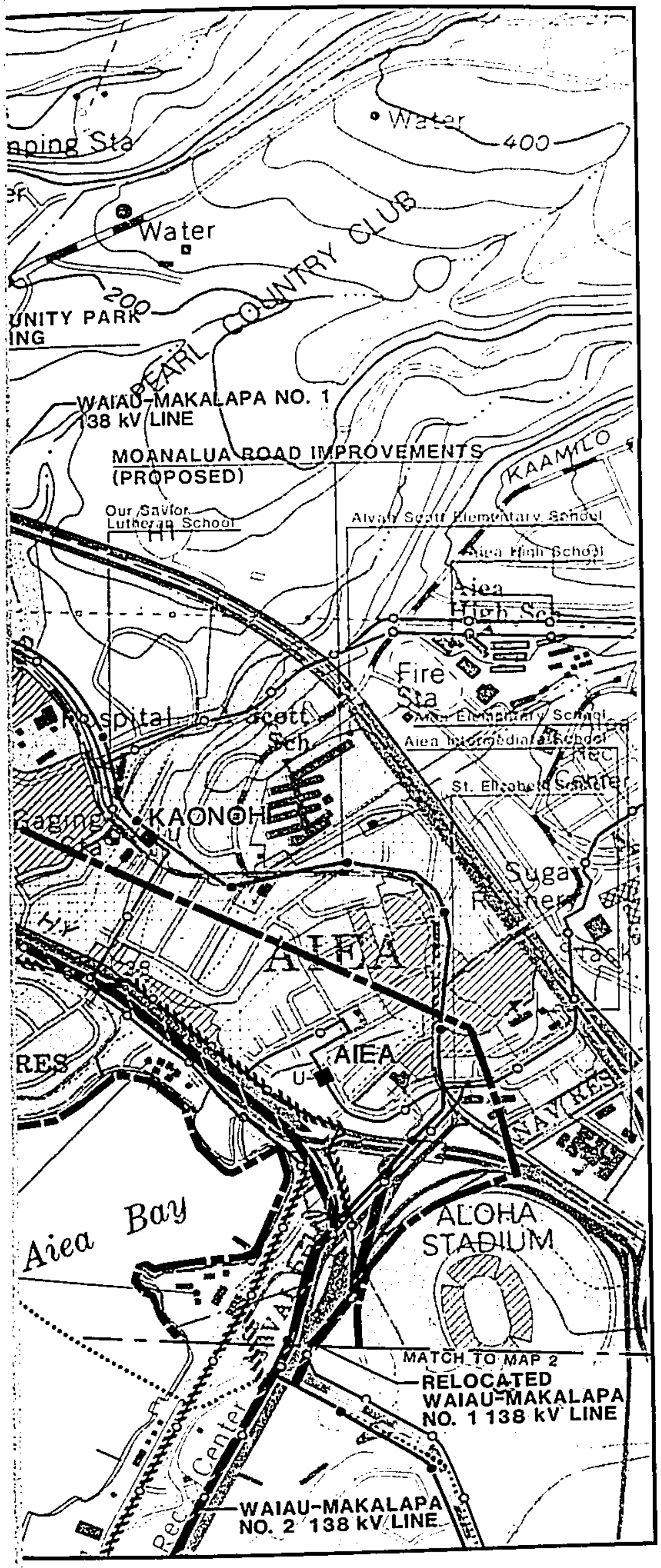


WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
H-1 RIGHT-OF-WAY IMPROVEMENTS (PROPOSED)
MOANALUA 36" WATER LINE (PROPOSED)
PEARLRIDGE COMMUNITY PARK RECREATION BUILDING (PROPOSED)
WAIAU-MAKALAPA NO. 1 138 kV LINE
MOANALUA ROAD IMPROVEMENT (PROPOSED)
PEARL COUNTRY CLUB
Pumping Sta
Water
Waimalu School
Pearlridge School
Our Savior Lutheran School
Drive-in Theater
Kalauao Spr
Blaisdell Park
KAONOHI
AIEA
WAIAU POWER PLANT
RAPID TRANSIT ALIGNMENT (PROPOSED)
NON-POTABLE WATER SYSTEM KALAUAO SPRINGS (PROPOSED)
Kalauao
EAST LOCH
RAPID TRANSIT STATION (PROPOSED)
NAVAL RES
McGrew Point
HARBOR
PEARL
Aiea Bay
AIEA BAY STATE RECREATION AREA (PROPOSED)
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE



ALIGNMENT DATA MAP

EXISTING AND PROPOSED LAND USE

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

EXISTING LAND USE

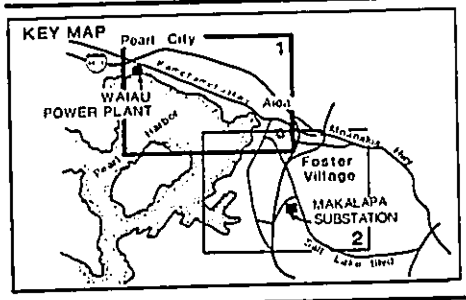
- Residential (Single Family)
- Residential (Multi-Family)
- Commercial
- Industrial
- Public and Semi-Public Facilities
- Parks Recreation and Preservation
- Agriculture
- U Utilities
- Undeveloped Land
- Pipelines
- Energy Corridor

USES WITHIN MILITARY LANDS

- Housing
- Training and Operations
- Supply, Storage and Maintenance
- Administration, Community and Medical Facilities
- Recreation and Conservation Buffer

PROPOSED LAND USE

- Public and Private Proposed Projects



MAP 1

SCALE 0 500 1000 FEET

0 1/8 1/4 MILE

NORTH

FIGURE 6.3-3

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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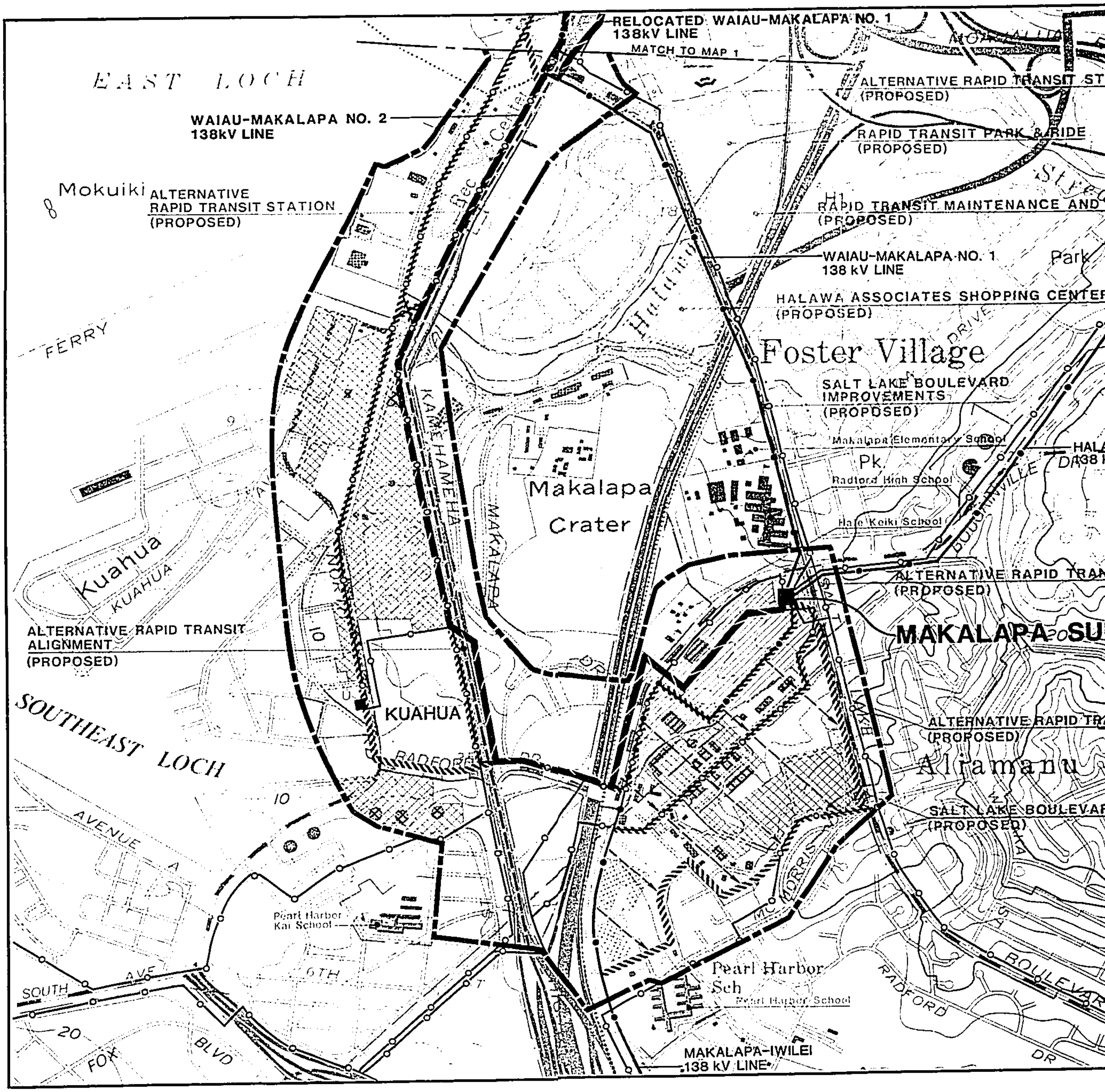
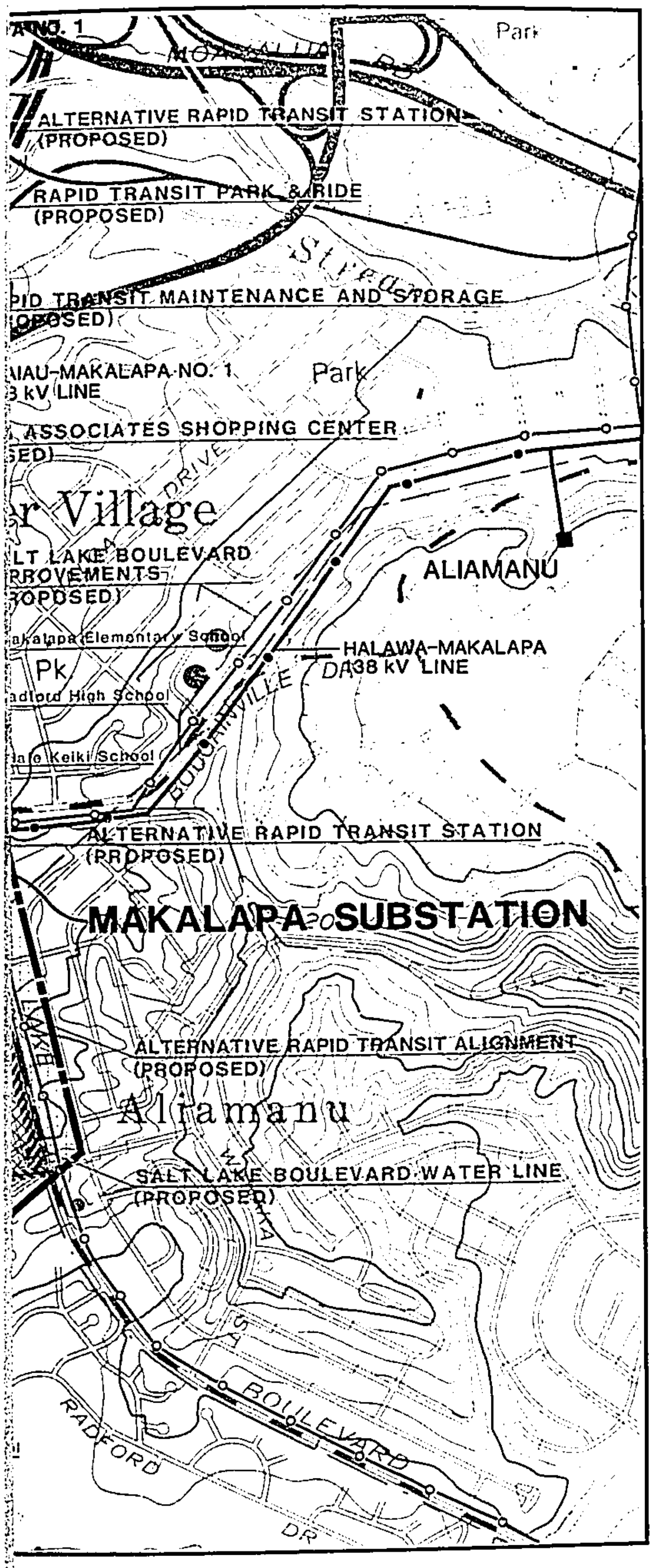


RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
ALTERNATIVE RAPID TRANSIT ST
(PROPOSED)
RAPID TRANSIT PARK & RIDE
(PROPOSED)
Mokuiki
ALTERNATIVE
RAPID TRANSIT STATION
(PROPOSED)
RAPID TRANSIT MAINTENANCE AND
(PROPOSED)
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
HALAWA ASSOCIATES SHOPPING CENTER
(PROPOSED)
FERRY
Foster Village
SALT LAKE BOULEVARD
IMPROVEMENTS
(PROPOSED)
Makalapa Elementary School
Radford High School
Hale Keiki School
Makalapa
Crater
KAMEHAMEHA
MAKALAPA
Kuahua
KUAHUA
ALTERNATIVE RAPID TRANSIT
(PROPOSED)
ALTERNATIVE RAPID TRANSIT
ALIGNMENT
(PROPOSED)
MAKALAPA SU
SOUTHEAST LOCH
KUAHUA
RADFORD DR
ALTERNATIVE RAPID TR
(PROPOSED)
Aliamanu
SALT LAKE BOULEVAR
(PROPOSED)
AVENUE
MORRIS
Pearl Harbor
Kai School
6TH
SOUTH AVE
Pearl Harbor
Sch
Pearl Harbor School
RADFORD DR
BOULEVARD
FOX BLVD
MAKALAPA-IWILEI
138 kV LINE



ALIGNMENT DATA MAP

EXISTING AND PROPOSED LAND USE

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

EXISTING LAND USE

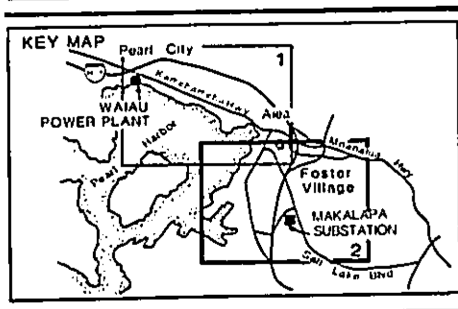
- Residential (Single Family)
- Residential (Multi-Family)
- Commercial
- Industrial
- Public and Semi-Public Facilities
- Parks Recreation and Preservation
- Agriculture
- U Utilities
- Undeveloped Land
- Pipelines
- Energy Corridor

USES WITHIN MILITARY LANDS

- Housing
- Training and Operations
- Supply, Storage and Maintenance
- Administration, Community and Medical Facilities
- Recreation and Conservation Buffer

PROPOSED LAND USE

- Public and Private Proposed Projects



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 6.3-3

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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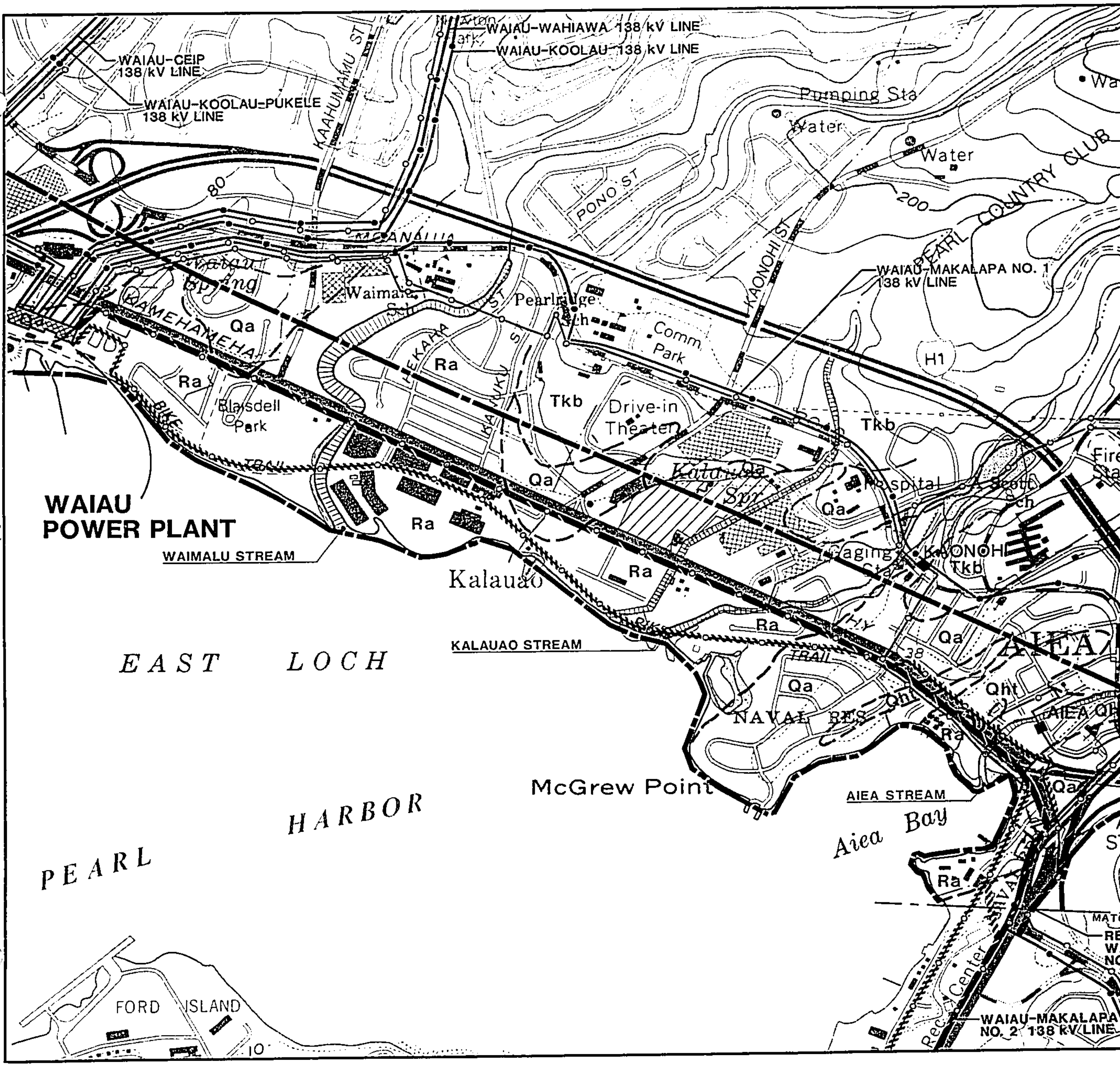
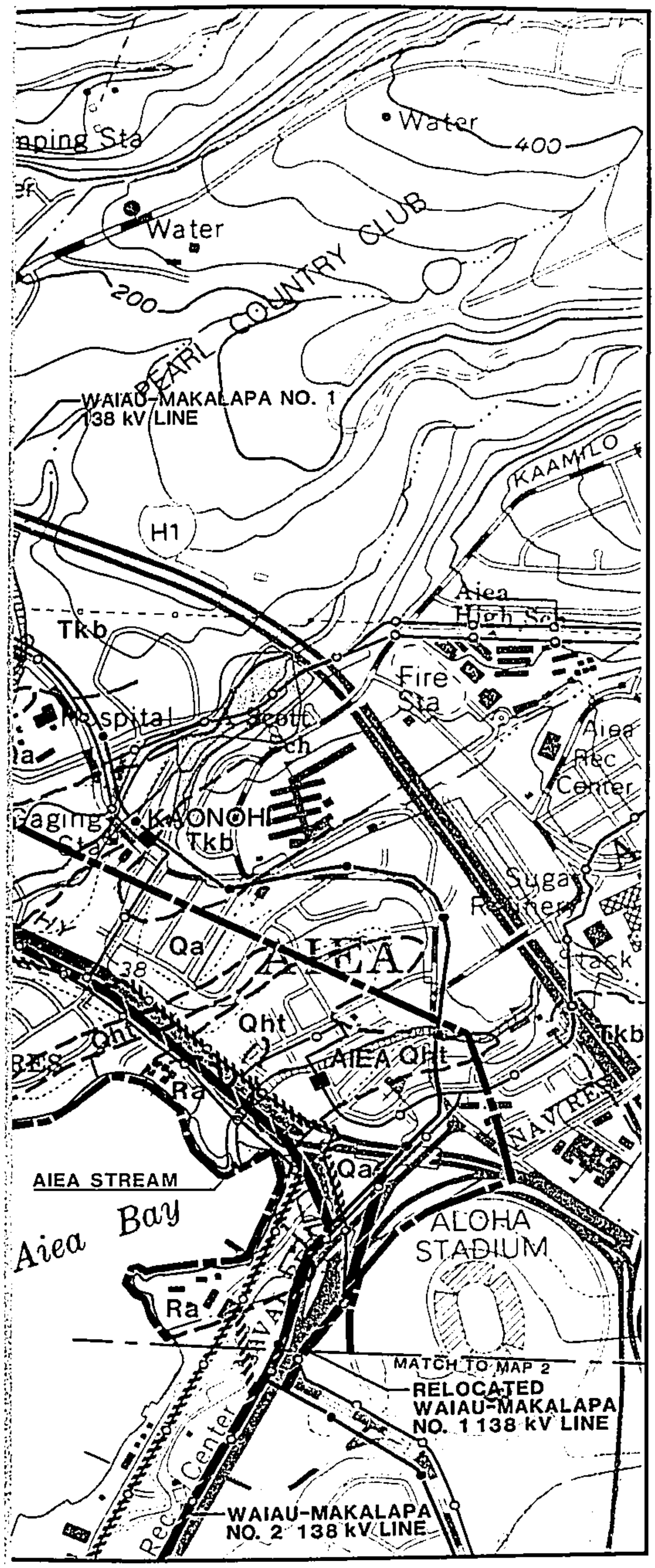

WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
KAAHUMANU ST
Pumping Sta
Water
Water
PONO ST
200
PEARL COUNTRY CLUB
KAONOHI ST
WAIAU-MAKALAPA NO. 1 138 kV LINE
MOANALUA
Waimalu
Pearlridge Sch
Comm Park
H1
KAMEHAMEHA
Qa
Ra
Tkb
Drive-in Theater
Blaisdell Park
BIKE TRAIL
Hospital
Scott Sch
KAONOHI
Gaging Sta
WAIAU POWER PLANT
WAIMALU STREAM
Kalauao
KALAUAO STREAM
EAST LOCH
AIEA
NAVAL RES
Qht
McGrew Point
AIEA STREAM
Aiea Bay
HARBOR
PEARL
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE



ALIGNMENT DATA MAP

GEOLOGICAL AND BIOLOGICAL

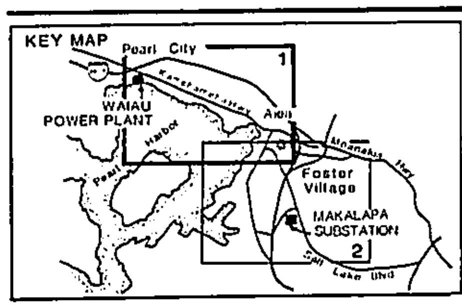
- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

GEOLOGICAL

- Tkb Koolau Basalt
- Qht Volcanic Tuff
- Qa Older Alluvium
- Rf Man-Made Fills
- Ra Recent Alluvium
- Stream
- Open-Lined Channel
- Spring
- Flood-Prone Area (100-year flood)

BIOLOGICAL

- Koa-Haole Scrub
- Mangrove Swamp
- Non-Woody Wetland
- Cultivated Wetland



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 6.3-4

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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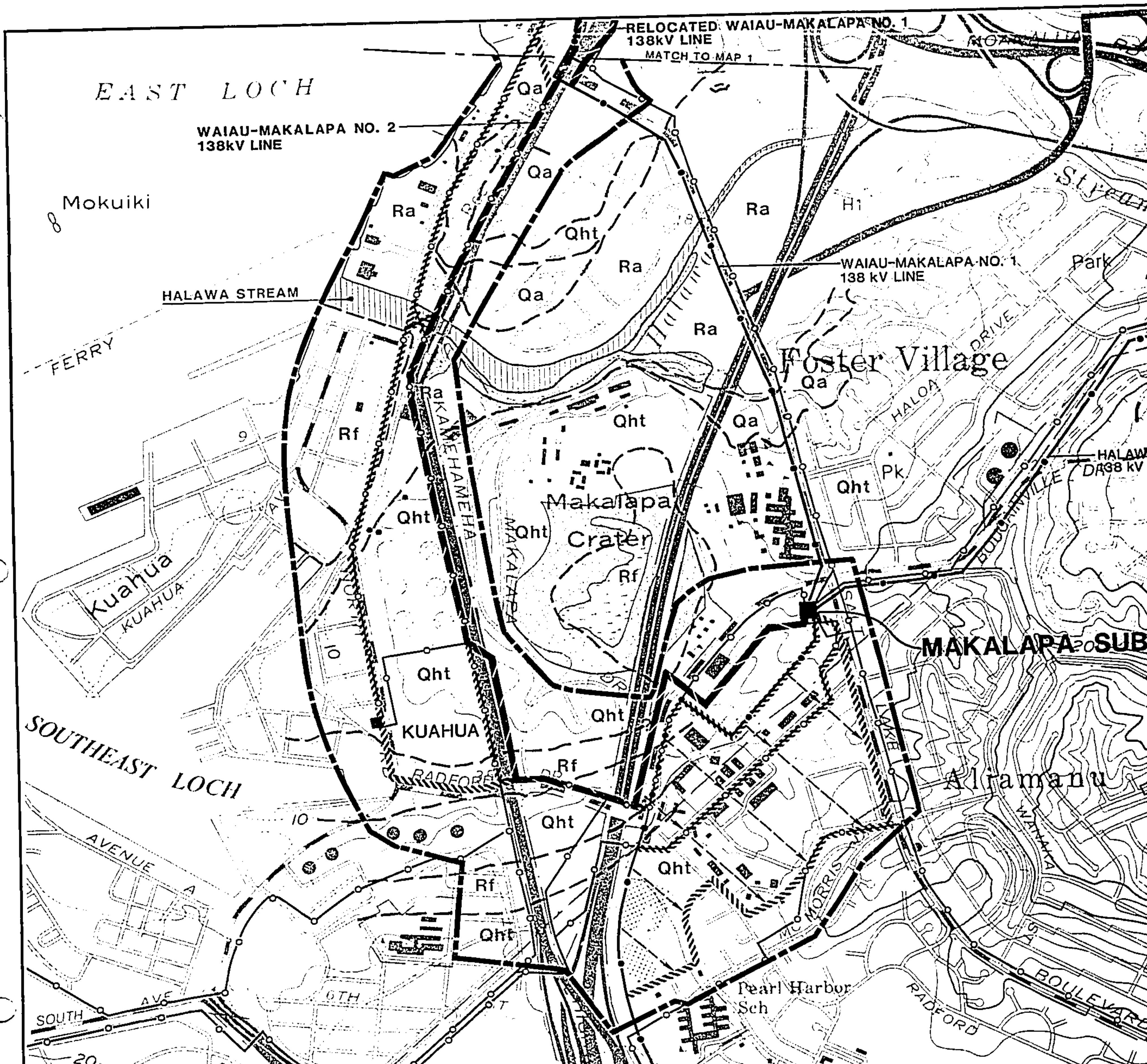
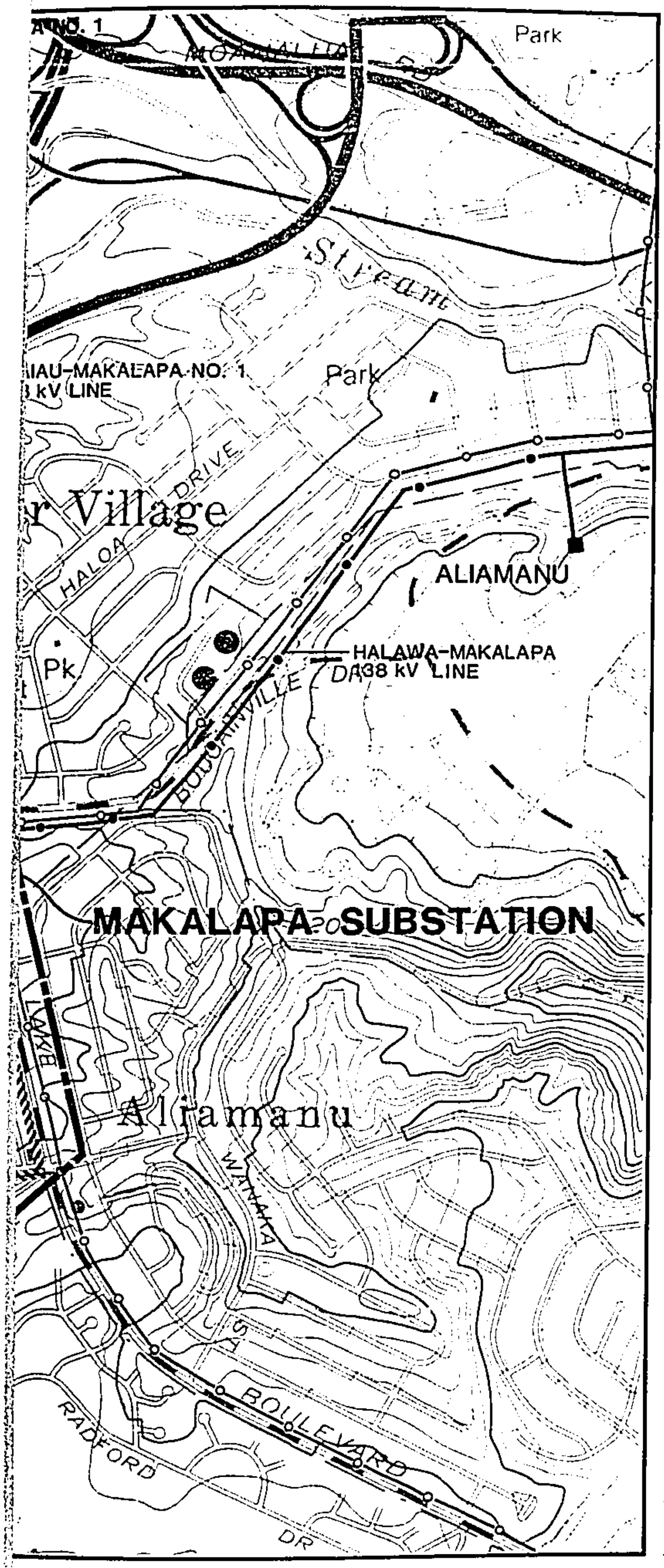

RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
HALAWA STREAM
FERRY
WAIAU-MAKALAPA NO. 1
138 kV LINE
Foster Village
Park
HALOA DRIVE
Makalapa
Crater
KAMEHAMEHA
MAKALAPA
Kuahua
KUAHUA
KUAHUA
SOUTHEAST LOCH
RADFORD DR
MAKALAPA SUB
Aliamanu
AVENUE A
SOUTH AVE
FOX BLVD
6TH
MC MORRIS
SALT LAKE
Pearl Harbor
Sch
RADFORD DR
BOULEVARD
MAKALAPA-IWILEI
138 kV LINE
Qa
Qa
Qa
Qa
Ra
Ra
Ra
Ra
Ra
Qht
Qht
Qht
Qht
Qht
Qht
Qht
Qht
Qht
Rf
Rf
Rf
Rf
Pk
H1



ALIGNMENT DATA MAP

GEOLOGICAL AND BIOLOGICAL

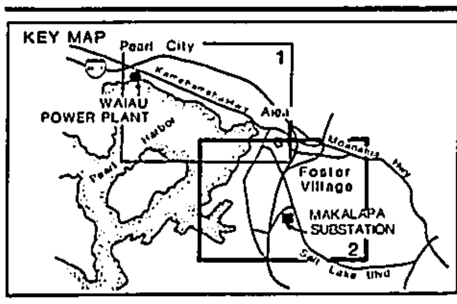
- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

GEOLOGICAL

- Tkb Koolau Basalt
- Qht Volcanic Tuff
- Qa Older Alluvium
- Rf Man-Made Fills
- Ra Recent Alluvium
- Stream
- Open-Lined Channel
- Spring
- Flood-Prone Area (100-year flood)

BIOLOGICAL

- Koa-Haole Scrub
- Mangrove Swamp
- Non-Woody Wetland
- Cultivated Wetland



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 6.3-4

Waiau – Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

10/89

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Chapter 7
Alternative Alignment Evaluation

Chapter 7
ALTERNATIVE ALIGNMENT EVALUATION

7.1 ALTERNATIVE ALIGNMENT IDENTIFICATION

7.1.1 Alternative Alignment Selection Criteria

After the characteristics of the preferred corridor had been investigated, the next step in the route selection process was to identify and evaluate alternative alignments, each approximately 100 feet in width, within the preferred corridor. The following environmental/land use and engineering criteria guided the identification and evaluation of alignments:

Environmental/Land Use Criteria

1. **Avoid, to the extent possible, residential areas, schools, recreation areas, and other high-public-use areas.**

   A recurrent comment at public meetings was that the line should be sited to avoid residential areas, schools, parks, and other high-public-use areas because of concerns about aesthetics, property values, and potential health effects. In areas as densely populated as Pearl City, Aiea, and Foster Village, avoiding high-public-use areas altogether is difficult; however, minimizing siting through these areas was an important goal of the alignment selection process.

2. **Minimize conflict with proposed projects.**

   A number of commercial and public works projects have been proposed for the project area. Proponents, landowners, and government officials have expressed concerns about potential conflicts between these projects and the Waiau-Makalapa No. 2 138 kV Transmission Line. Because many of the proposed projects are in the planning stages, potential conflicts can be minimized by early consultation with project proponents and by selecting an alignment that minimizes conflicts.

3. **Avoid certain classes of publicly owned land, to the extent possible.**

   Siting within publicly owned land generally requires more complex and time-consuming permitting processes than other lands because public agencies are responsible for managing public lands for a number of public benefits. Among publicly owned lands, certain classes have special restrictions or permit requirements. For example, the U.S. Navy would evaluate potential conflicts with Pearl Harbor Naval Base operations if the line is proposed to be sited across Navy land. State highway regulations generally prohibit siting utilities parallel to freeways within the freeway right-of-way. It is unlikely that the City and County of Honolulu would give permission to site a transmission line through the middle of a county school or park. The special characteristics, uses, and permit requirements of publicly owned lands must be taken into account in selecting and evaluating alignments.

4. **Make use, wherever possible, of alignments of existing 46 kV subtransmission lines.**

   Combining the new line and existing 46 kV lines on a single set of poles may eliminate the need to acquire new right-of-way for the proposed line. In addition, combining the new line with existing 46 kV lines reduces the incremental visual effect of the new line and can simplify maintenance because only a single set of poles is involved.

5. **Follow roads and highways.**

   Roads and highways are linear rights-of-way that present opportunities for transmission line siting. Following existing roadways is particularly desirable in urban areas where few other clear paths exist through congested, populated areas. In addition, HECO's franchise with the State of Hawaii grants it the right to use state and city/county roads for transmission and distribution lines.

Engineering Criteria

1. **Minimize alignment length.**

   The shorter the alignment length, the lower the cost of constructing the transmission line (all other things being equal).

2. **Maintain adequate separation between the proposed line and existing 138 kV lines.**

As described in Chapter 6, Alternative Corridor Evaluation, an important HECO siting criterion for new 138 kV lines is to maintain adequate separation of new 138 kV lines from existing 138 kV lines. The purpose of this criterion is to reduce the probability that a single transmission emergency (such as a storm or accident) could damage two 138 kV lines at the same time and perhaps trigger a wider outage. Separation can be accomplished by avoiding crossovers and by separating parallel 138 kV transmission lines by at least a distance equal to 60 percent of the height of the higher of the two poles (i.e., 48 to 72 feet for poles 80 to 135 feet high). In a highly urban area that contains several 138 kV lines, upholding an inflexible separation criterion would be difficult. Instead, maintaining adequate separation between the new line and existing 138 kV lines must be treated as a siting goal observed to the maximum extent feasible given the available options.

3. **Avoid areas where complex or costly foundation engineering would be required to give adequate support for transmission poles (i.e., areas with soils classified as recent alluvium or man-made fills).**

In the geotechnical reconnaissance, soils were identified in the recent alluvium and man-made fill classes as probably requiring special and potentially very costly foundation support (see Chapter 6, Subsection 6.4.4). For this reason, areas containing soils in these classes should be avoided, if possible.

4. **Avoid alignments located adjacent to underground fuel or other pipelines.**

Building a transmission line near underground pipelines can increase construction costs because of the possible need to install cathodic protection to prevent the underground pipes from increased corrosion resulting from currents induced by the transmission line. In addition, special care must be taken to not damage pipelines during construction.

7.1.2 Alignment Segment Identification

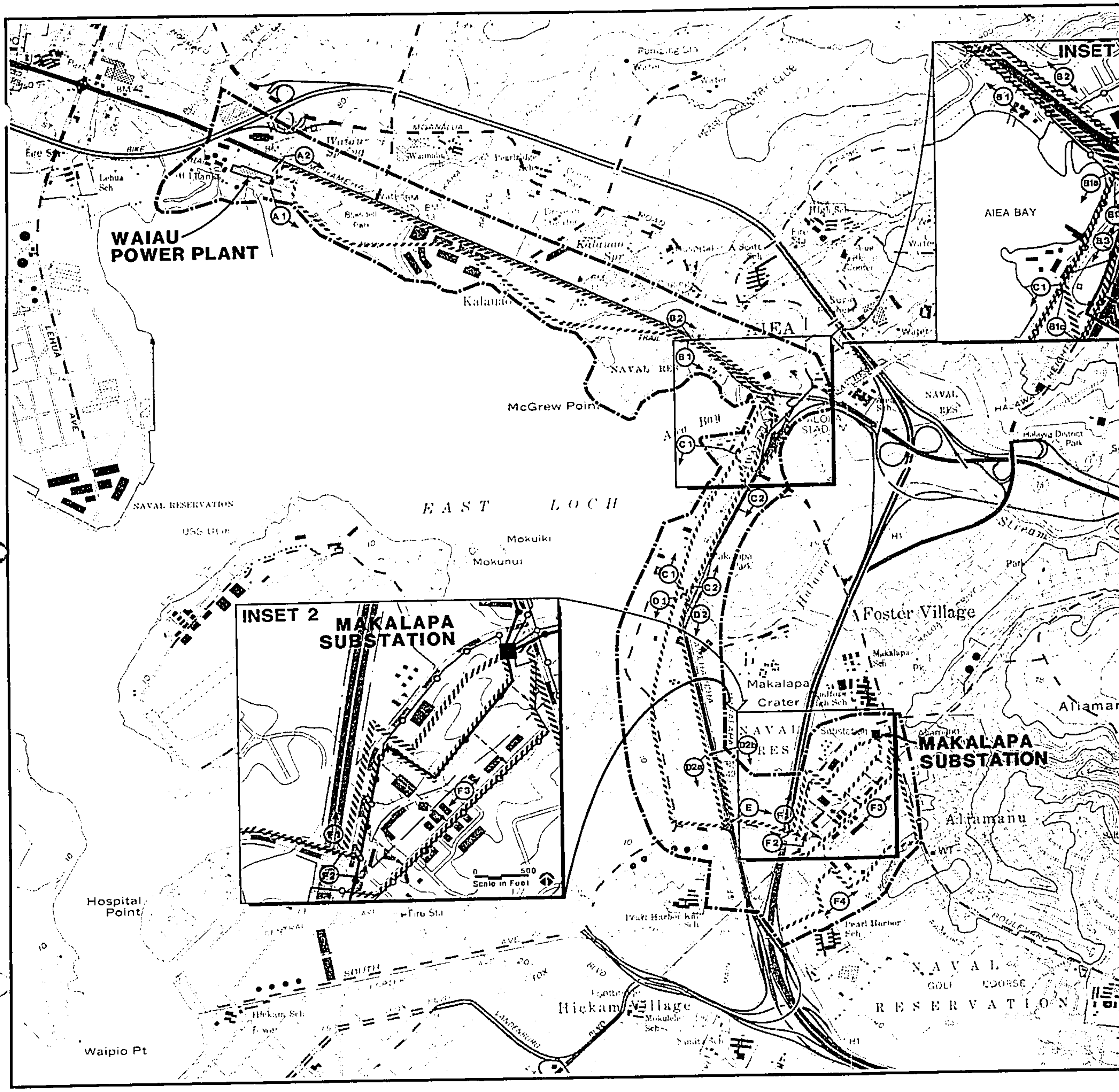
Based on the guidelines described above, several alignment alternatives were identified and mapped (Figure 7.1-1, Alternative Alignments, and Figure 7.1-2, Preferred Alignments [Maps 1 and 2]). The alignment alternatives are divided into five sections. Within each section, A to F, two or more alternative segments exist, with the exception of Section E, along Radford Drive, where only one alternative was identified.

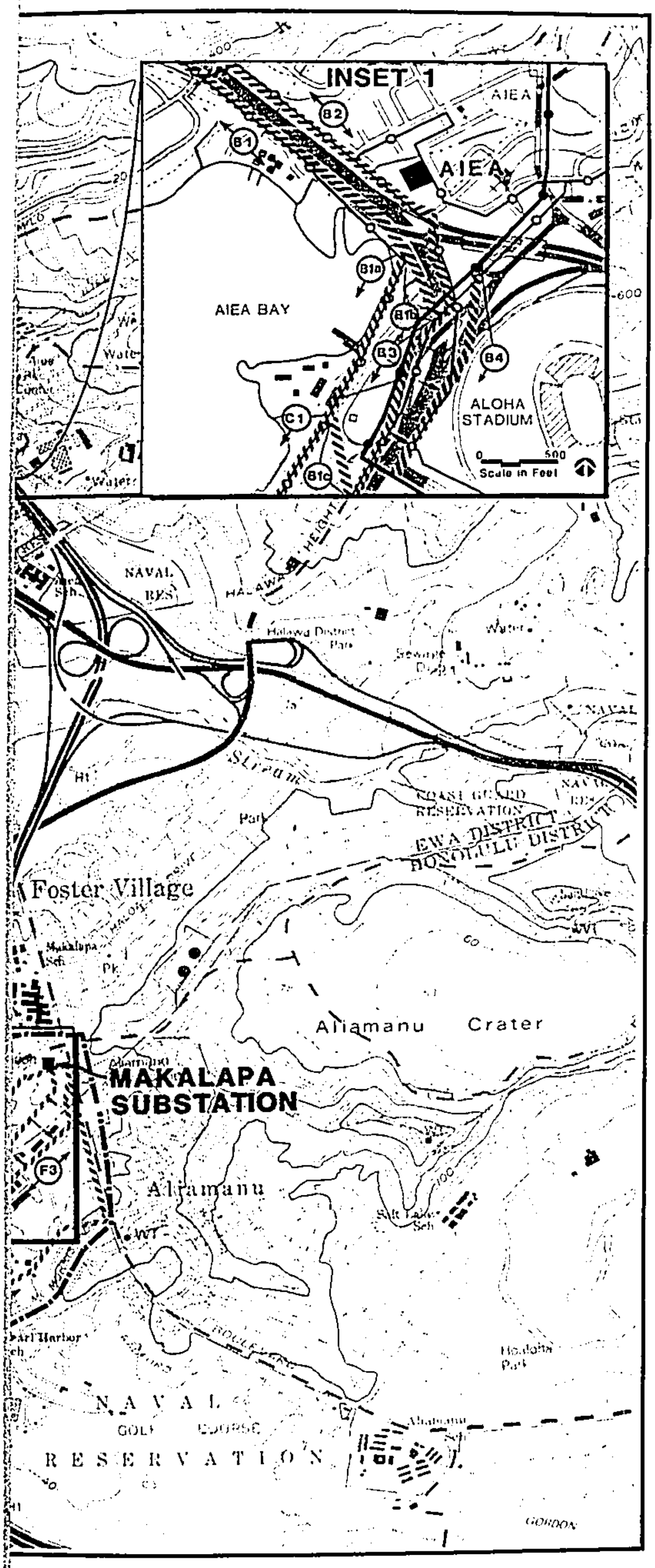
Section A includes two alignment segment alternatives, each centered on existing 46 kV lines running from the Waiau Power Plant to the access road at McGrew Point where the two lines approach within a few feet of one another. Alignment Segment A1 follows the 46 kV line that is sited along the bicycle path between Kam Highway and the shoreline of Pearl Harbor. Segment A2 follows the 46 kV line that runs along the makai side of Kam Highway (Figures 7.1-1 and 7.1-2, Map 1).

Section B includes three alignment alternatives between the McGrew Point Loop and the intersection of Kam Highway and Salt Lake Boulevard. Segment B1/B1a would follow the makai side of Kam Highway to the northeastern corner of Aiea Bay and then turn south to follow an existing 46 kV line through the Richardson Recreation Center. Segment B1/B1b/B3/B4 follows the same alignment as B1/B1a to the point where B1/B1a turns south to join the 46 kV line near the Aiea interchange. At that point, Segment B1/B1b/B3/B4 continues east, along Kam Highway to join the alignment of a 46 kV line and a 138 kV line (Waiau-Makalapa No. 1) that runs along the makai side of Kam Highway on the same set of poles. If this option were selected, the Waiau-Makalapa No. 1 line would have to be relocated to the other side of Kam Highway in order to provide adequate separation between the two 138 kV lines.

The Waiau-Makalapa No. 1 line would be relocated to a new alignment (Segment B4) 250 to 500 feet to the east along the edge of the Aloha Stadium parking lot to Salt Lake Boulevard. The maximum distance between the existing and new alignments of the Waiau-Makalapa No. 1 line would be approximately 500 feet.

Segment B2/B3/B4 begins by following a 46 kV line that crosses Kam Highway at the McGrew Point Loop and follows the mauka side of Kam Highway to the Aiea interchange. Where the 46 kV line crosses the existing alignment of the Waiau-Makalapa No. 1, Segment B1/B3/B4 would follow the Waiau-


WAIAU POWER PLANT
INSET
AIEA BAY
AIEA
McGrew Point
EAST LOCH
Mokuiki
Mokunui
NAVAL RESERVATION
INSET 2
MAKALAPA SUBSTATION
Scale in Feet
Foster Village
Makalapa
Crater
MAKALAPA SUBSTATION
Aliamanu
Hospital Point
Waipio Pt
Hickam Village
NAVAL GOLF COURSE RESERVATION



ALIGNMENT DATA MAP

ALTERNATIVE ALIGNMENTS

- Alternative Alignment
- Alignment Segment Identifier
- Corridor Boundary
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

0 1000 2000 FEET

0 1/8 1/4 MILE

NORTH

FIGURE 7.1-1

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

10/89

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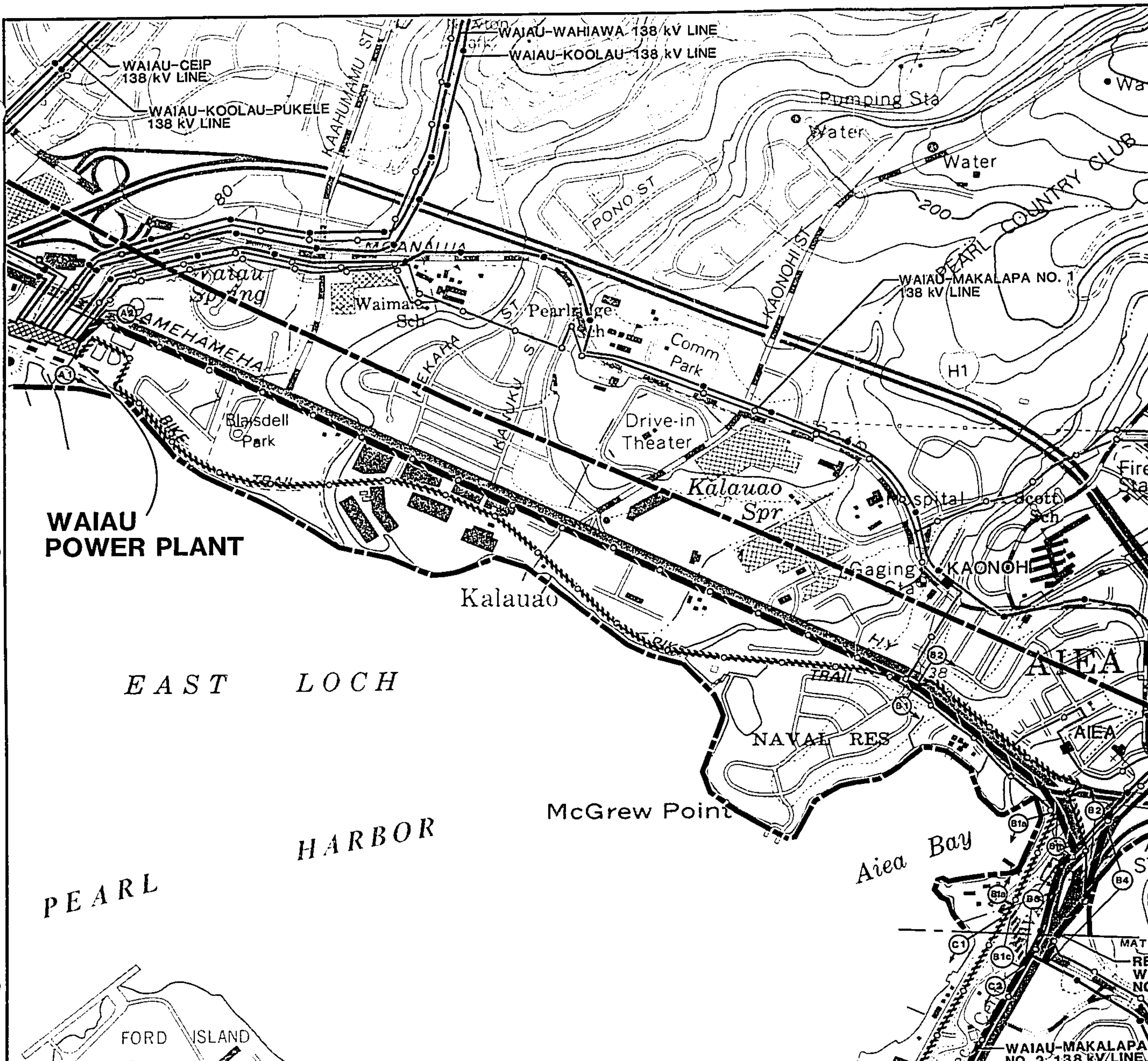
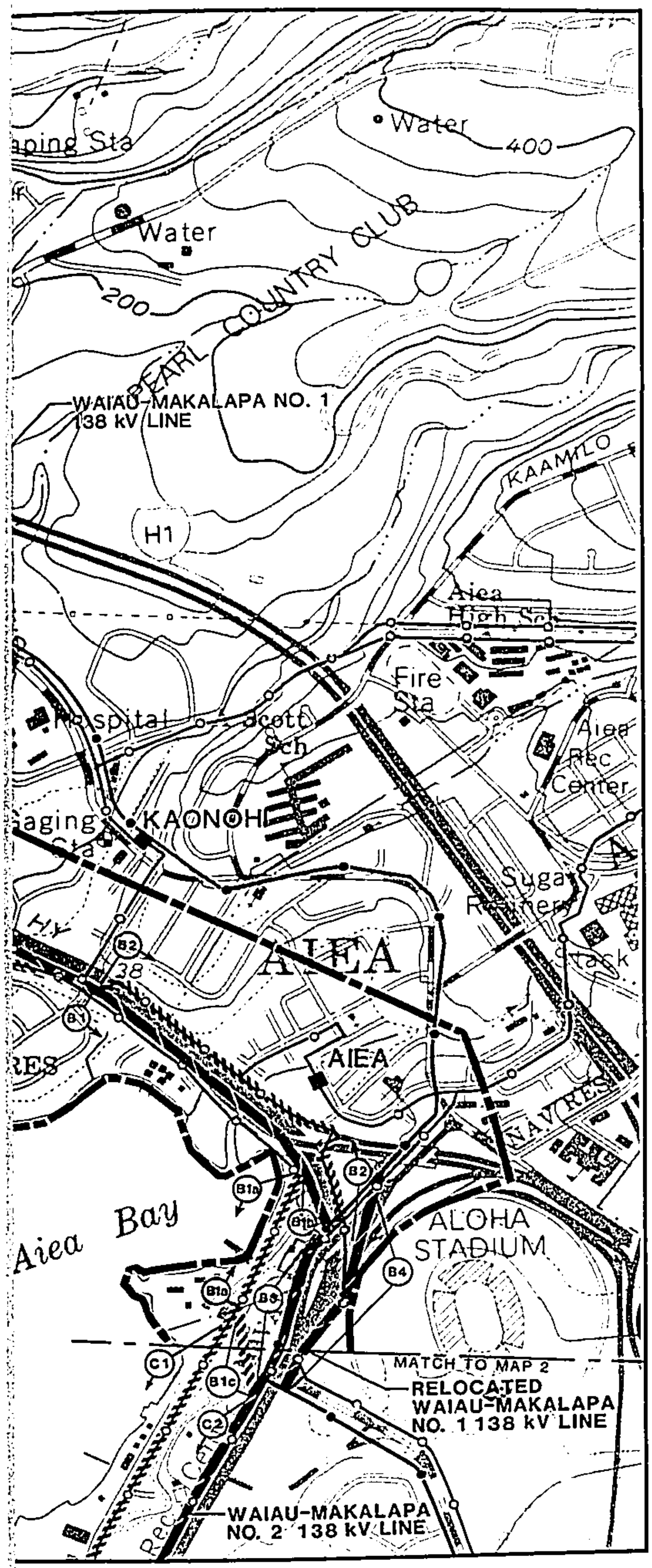

WAIAU-WAHIAWA 138 kV LINE
WAIAU-KOOLAU 138 kV LINE
WAIAU-CEIP 138 kV LINE
WAIAU-KOOLAU-PUKELE 138 kV LINE
KAAHUMANU ST
Pumping Sta
Water
Water
PONO ST
PEARL COUNTRY CLUB
KAONOHI ST
WAIAU-MAKALAPA NO. 1 138 kV LINE
Waiau Spring
Waimalu Sch
Pearlridge Sch
Comm Park
KAMEHAMEHA
HY
Blaisdell Park
Drive-in Theater
Kalauao Spr
Hospital
Scott Sch
Gaging Sta
KAONOHI
WAIAU POWER PLANT
BIKE TRAIL
Kalauao
AIEA
EAST LOCH
NAVAL RES
McGrew Point
PEARL HARBOR
Aiea Bay
FORD ISLAND
WAIAU-MAKALAPA NO. 2 138 kV LINE

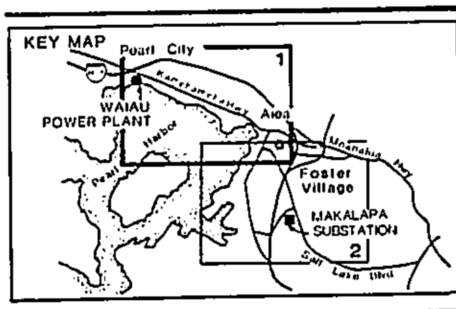


ALIGNMENT DATA MAP

PREFERRED ALIGNMENT

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

(A1) Alignment Segment Identifier



MAP 1

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 7.1-2

Waiau – Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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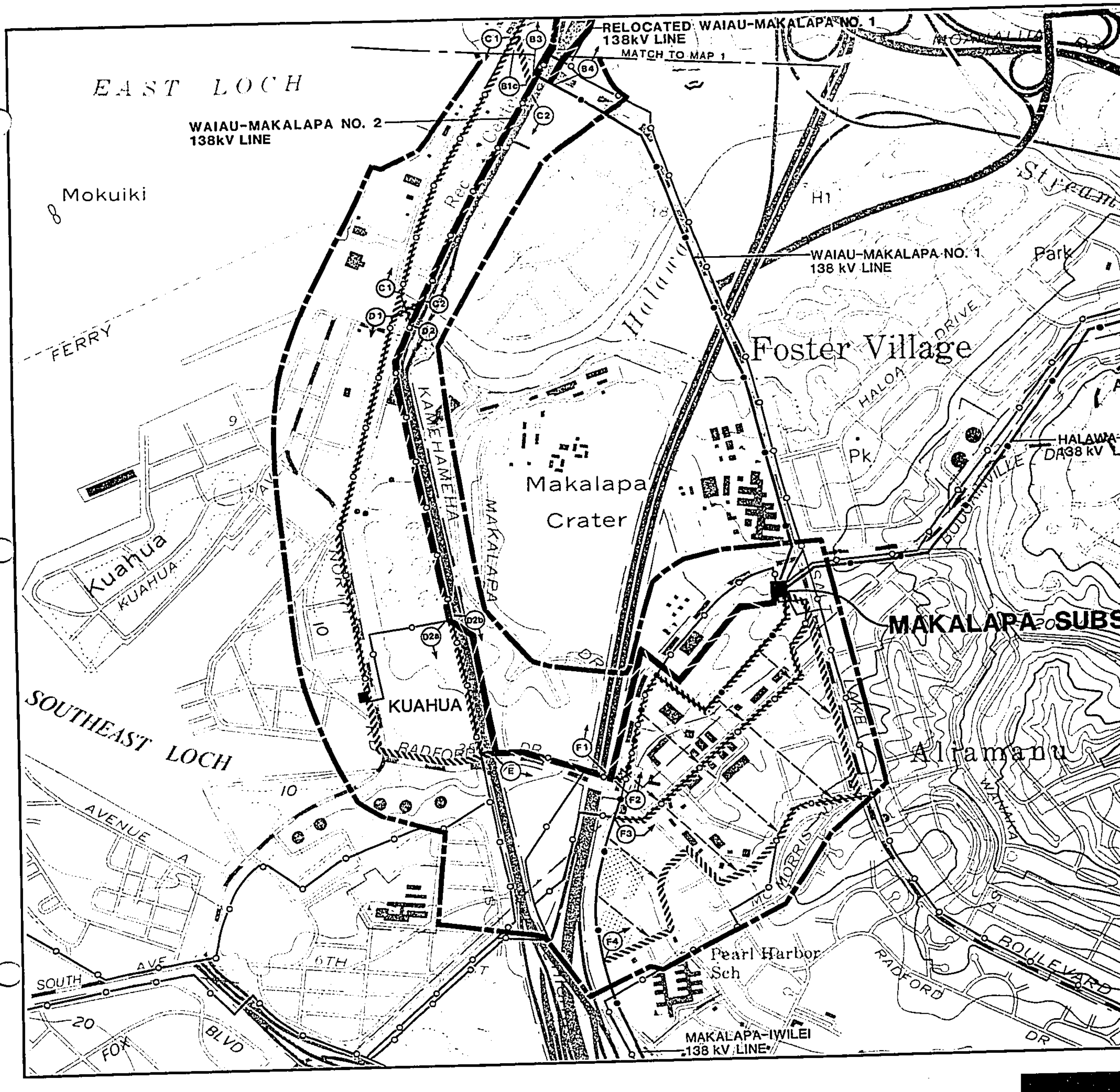
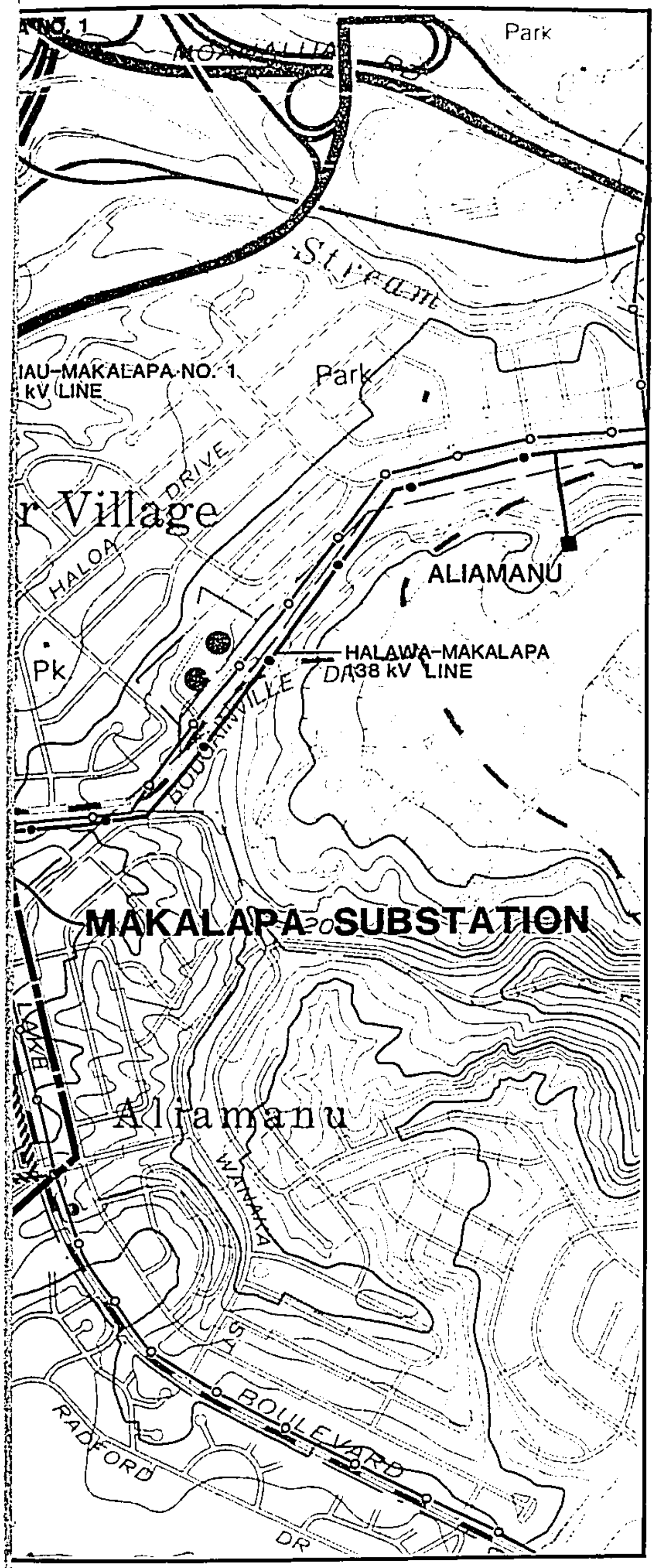


RELOCATED WAIAU-MAKALAPA NO. 1
138kV LINE
MATCH TO MAP 1
EAST LOCH
WAIAU-MAKALAPA NO. 2
138kV LINE
Mokuiki
H1
WAIAU-MAKALAPA NO. 1
138 kV LINE
Park
FERRY
Foster Village
HALOA DRIVE
HALAWA-
138 kV L
Pk
Makalapa
Crater
Kuahua
KUAHUA
KAMEHAMEHA
MAKALAPA
NORTH
MAKALAPA SUBS
KUAHUA
SOUTHEAST LOCH
RADFORD DR
Aiea
AVENUE A
Pearl Harbor
Sch
MORRIS
SOUTH AVE
6TH
20
FOX BLVD
MAKALAPA-IWILEI
138 kV LINE
RADFORD DR
BOULEVARD

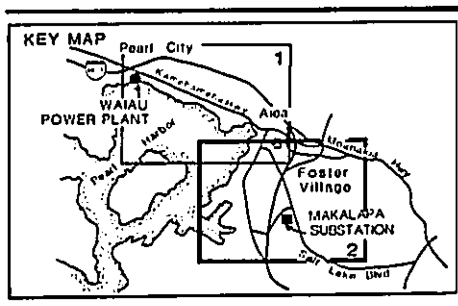


ALIGNMENT DATA MAP

PREFERRED ALIGNMENT

- Corridor Boundary
- Alternative Alignment
- Preferred Alignment
- Existing 46 kV Line
- Existing 138 kV Line
- Substation

A1 Alignment Segment Identifier



MAP 2

SCALE
0 500 1000 FEET
0 1/8 1/4 MILE

NORTH

FIGURE 7.1-2

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

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Makalapa No. 1 alignment along the makai side of Kam Highway. As with Segment B1/B1b/B3/B4 (with which it shares part of an alignment), Segment B2/B3/B4 would require the relocation of the Waiau-Makalapa No. 1 line to the B4 alignment.

Section C extends from the Kam Highway/Salt Lake Boulevard intersection to the Halawa Stream. Segment C1 follows a 46 kV line that parallels Kam Highway within the Navy's Richardson Recreation Center. Segment C2 follows a second 46 kV line that parallels, and is adjacent to, the makai side of Kam Highway. Segments C1 and C2 end at Halawa Stream at the point where the two 46 kV lines intersect.

Section D runs from Halawa Stream to the intersection of Radford Drive and Kam Highway. Segment D1 follows a 46 kV line from Halawa Stream to North Road. Where the 46 kV line ends at Kuahua Substation, Segment D1 continues along North Road to Radford Drive and follows it to Kam Highway. Segment D2 parallels and is adjacent to the makai side of Kam Highway from Halawa Stream to a point approximately 1,500 feet north of the Kam Highway/Radford Drive intersection. Segment D2a continues along the makai side of the intersection. Segment D2b crosses over to the mauka side of Kam Highway and continues along the mauka side of the highway to the intersection.

Section E consists of a single segment in the vicinity of Radford Drive between Kam Highway and Bougainville Drive. An existing 46 kV line along the north side of Radford Drive could be used as the route for the new line. The areas north and south of Radford Drive are highly developed in residential and administrative uses within Navy property, and no transmission line alignments appear feasible other than along Radford Drive.

Section F includes segment alternatives between the Radford/Bougainville Drive intersection and Makalapa Substation.

Segment F1 parallels the mauka side of the H-1 freeway for approximately 1,250 feet before cutting across Bougainville Drive to follow the south side of Lawehana Street and Malaai Street to the south side of the Makalapa Substation.

Segment F2 is the alignment of the exiting Makalapa-Iwilei 138 kV line. Using F2 for the alignment of the new line could be accomplished only by moving the existing Makalapa-Iwilei line to another alignment (either Segment F3 or Segment F4, described below). Segment F2 parallels the mauka (south) side of Bougainville Drive and Lawehana Street from Radford Drive to Makalapa Substation.

Segment F3 is one alternative alignment for relocating the existing Makalapa-Iwilei line. Segment F3 follows the alignment of an existing 46 kV line along the mauka (south) side of Marshall Road through the Pearl Harbor Public Works Center (U.S. Navy). Approximately 250 feet before the intersection of Marshall Road and Salt Lake Boulevard, Segment F3 turns north for approximately 300 feet before angling toward Salt Lake Boulevard near the segment's termination at the southeastern corner of the Makalapa Substation.

Segment F4 is another alternative for the realignment of the Makalapa-Iwilei transmission line if that line's current alignment is used for the Waiau-Makalapa No. 2 138 kV Transmission Line. It begins at the intersection of Bougainville Drive and Borie Drive and follows Borie Drive along the south side of the Navy Exchange Commissary complex. It then turns north and east along the edge of the exchange parking lot before turning south along the mauka side of Radford Drive. The segment then follows the south side of Namur Drive along the edge of the Moanalua Terrace Family Housing area to Salt Lake Boulevard for the last 1,000 feet following the alignment of an existing 46 kV line. The segment then turns north to follow the makai side of Salt Lake Boulevard for approximately 2,000 feet to the substation.

7.2 ALTERNATIVE ALIGNMENT EVALUATION

After suitable alignment segments had been identified, their suitability for the location of the proposed line was evaluated through a two-stage process. First, an inventory of existing conditions and characteristics along the alternative alignment segments was prepared (Subsection 7.2.1). The inventory provided the data that allowed each alignment segment alternative to be evaluated against potential permit requirements as well as against the environmental/land use and engineering criteria that were used to select the alternative alignment segments.

7.2.1 Alternative Alignment Segment Inventory

The conditions and characteristics of each alternative alignment segment were inventoried by measuring the distance that each segment crosses the data factors identified in the regional and corridor-level analyses.

Methodology

For the purpose of this exercise, alignment segments were treated as one-dimensional lines and measurements of each data factor were made using linear distances.

Alignment evaluation factors were drawn from the data mapped at the regional and corridor level analyses (see Sections 5.2 and 6.3). If an alignment segment passed through a data factor, the distance that factor crossed was measured and recorded in hundredths of a mile. A few evaluation factors (such as significant stationary views) were simply identified and noted.

Where an alignment segment is adjacent to an evaluation factor, the distance measured was notated with an "A." The purpose of distinguishing "adjacent" from "crossing through" becomes important at the alignment selection level in that often the new right-of-way can be sited to avoid a certain area if the alignment is planned adjacent to a factor. The term "adjacent" applies to the alignment even when the data factor is separated by a road or other right-of-way that is less than or equal to 50 feet wide. Data factors on either side of rights-of-way greater than 50 feet wide (e.g., Kam Highway) are not considered adjacent.

In Sections B and F where an existing 138 kV line would have to be relocated, a series of three measurements was taken to distinguish the potential impacts associated with the three types of construction within that alignment.

Measurement I is the portion of the proposed alignment that would require new construction for the Waiau-Makalapa No. 2 138 kV Transmission Line. This often includes alignment segments that parallel an existing 46 kV line.

Measurement II is along the potential route of a relocated 138 kV transmission line and it assumes new construction of the line is necessary. The construction and post-construction impacts would be essentially the same as in Type I measurements.

The third measurement, III, inventories factors along the existing 138 kV alignment that is proposed to be relocated and replaced with the Waiau-Makalapa No. 2 138 kV Transmission Line. The construction impacts along these segments would be similar to new construction; however, the post-construction effects would not be significantly different from the existing conditions.

In one location (the F segments), relocating an existing 138 kV line to make way for the new line would mean that the 138 kV line would be removed in certain areas and not replaced with a new 138 kV line. There would be construction-related impacts as the line segment and poles are removed. Measurement IV records factors along such segments.

Section A Inventory

Segment A1 is the makai alterative, which follows the existing bike path route from Waiau Power Plant to McGrew Point Loop. This alternative parallels an existing 46 kV line and the Chevron USA pipeline rights-of-way. Segment A2 is the mauka alternative, which follows the makai side of Kam Highway and an existing 46 kV line for its entire 1.63-mile length (Figure 7.1-2). The resources for this segment are summarized in Table 7.2-1.

The shoreline route, A1, contains alluvial soils and a few scattered mangrove swamp areas. The area includes residential areas near Kaluamoi Drive and Lipoa Place, and a major county park, Pearl Harbor (Blaisdell) Park, is located along the alignment. The shoreline includes a "significant stationary view," identified in the City and County of Honolulu's Coastal View Study, at Pearl Harbor (Blaisdell) Park. A variance would be required for any poles proposed for construction within the shoreline setback area (i.e., 40 feet inland from the upper reaches of the wash of waves). This could be a concern in selected locations along the A route, but only if it were necessary to place a structure within the setback as established by the state surveyor. For approximately one-quarter mile, the A1 segment is aligned between military and civilian residential areas near McGrew Point.

A2, the mauka alternative, is located adjacent to Kam Highway; therefore, the existing and proposed uses and the visual quality differ slightly from A1 (Table 7.2-1 and Figure 7.1-2, Map 1).

This segment passes through primarily commercial uses that surround Kam Highway. The A2 segment is, however, adjacent to the civilian housing near McGrew Point at Aiea Kai Place and the mauka edge of Pearl Harbor (Blaisdell) Park. The A2 segment parallels the preferred corridor for the Rapid Transit System (RTS) proposed by the Department of Transportation Services (the median of Kam Highway). It has fewer shoreline issues, fewer significant shorelines views, is beyond the shoreline setback area, and there are no shoreline wetlands.

Table 7.2-1
ALIGNMENT INVENTORY--SECTION A

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment A1	Segment A2
ALTERNATIVE ALIGNMENTS MAP	I	I
Location	Makai	Mauka
Segment length	1.79	1.63
Parallels existing 138 kV lines	No	No
Parallels existing 46 kV lines	1.79	1.63
Parallels public rights-of-way	1.60 (bike path)	1.63
Crosses public rights-of-way entrance(Blaisdell) Park entrance	McGrew Point	Pearl Harbor McGrew Point entrance
LAND JURISDICTION AND REGULATION MAP		
Jurisdiction		
U.S. Navy land	0.28	0.38(A)
State of Hawaii lands	0	0
City and County of Honolulu lands	0.28	0.28(A)
Hawaiian Electric lands	0	0
Other private parcels (<5 acres)	0.19	0.12(A), 0.07
Other private parcels (>5 acres)	0.18(A) crosses two parcels for 0.09 mi	0.14(A)
Regulation		
ecial Management Area (SMA)	1.79	1.63(A)
Shoreline setback area	Adjacent to shoreline	
Conservation District lands		
Resource subzone	0	0
General subzone	0	0
Energy corridor	0	0
Historic Preservation		
National historic site or district	0	0
State historic site or district	0	0
Nominated state or national historic site	0	0
Hawaiian fishpond or historic settlement area	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-1
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives	
	Segment A1	Segment A2
EXISTING AND PROPOSED LAND USE MAP	I	I
Existing Uses		
Residential development	0.26(A), 0.33	0.09(A)
Agricultural	0	0
Commercial	0.07(A), 0.47	1.06
Industrial	0	0.07
Parks, recreation, and preservation	0.28	0.28(A)
Schools	0	0
Churches, hospitals, or medical facilities	0	0
Utilities	Waiau Power Plant	Waiau Power Plant
Parallels existing pipeline routes	1.6 Chevron Oil	0
Substations	0	0
Military housing	0.18(A)	0
Military supply, storage, and maintenance	0	0
Military administration, community, and medical	0	0
Military operations and training	0	0
Military recreation and conservation	0.02	0
Visual Resources		
Significant stationary views	Blaisdell Park	Blaisdell Park (A)
Structure visible between coastal roadway and shoreline	Yes	Yes
Proposed Land Use		
Proposed linear facilities	0	1.58 Rapid Transit System (A)
Other proposed developments	0	Rapid transit station
Projects under construction	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-1
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment A1	Segment A2
GEOLOGICAL AND BIOLOGICAL RESOURCES MAP	I	I
Geological		
Koolau basalt	0	0
Volcanic tuff	0	0
Older alluvium	0.17	0.20
Man-made fills	0	0
Recent alluvium	1.62	1.42
Stream	0	0
Open lined channel	3 channels	3 channels
Spring	0	0
Flood-prone area	0.14	0.19(A)
Biological		
Koa-haole scrub	0	0
Mangrove swamp	0.12	0
Cultivated wetlands	0	0
Nonwoody wetlands	0	0
Rare, endangered, threatened wildlife species	0	0
Rare, endangered, threatened plant species	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Section B Inventory

Two of the corridor segment alternatives in Section B (B1/B1b/B3/B4 and B2/B3/B4) involve relocating the existing Waiau-Makalapa No. 1 line, while the third (B1/B1a) would involve building the new 138 kV line along an existing 46 kV alignment for part of the segment length. Table 7.2-2 summarizes the resources for the B alternatives.

The B1/B1a segment parallels the makai side of Kam Highway adjacent to the proposed Aiea Bay State Recreation Area to the northeastern corner of Aiea Bay and then turns south to follow an existing 46 kV transmission line through the Navy's Richardson Recreation Center (Figure 7.1-1). The land within the alignment is owned by the U.S. Navy. Most of the segment is in or on the boundary of the Special Management Area, and a small portion (0.05 mile) crosses the Pearl Harbor National Historic Landmark. Portions of the segment (approximately 0.1 mile) approach within approximately 100 feet of the shoreline. The segment does not appear to approach the Shoreline Setback Area (generally located within 40 feet of the shoreline). However, this stretch of shoreline has not gone through a shoreline setback area certification and the exact location of the shoreline and setback area can be determined only through a survey whose results are certified by the state. Along most of its length, the B1 section of the alignment parallels or is located along the same alignment as two Chevron 8-inch oil pipelines (black oil and white oil), two GASCO gas lines (4-inch and 10-inch), a city/county 8-inch sewer line and 36-inch water main, a Navy underground telephone line, and an Army signal cable. The B1a segment includes an 8-inch Chevron oil line and a Navy water line, and crosses a 30-inch sewer line. Constructing the new line in this alignment would add structures visible between the nearest coastal road and the shoreline, and could affect a significant stationary view (Department of Land Utilization, Coastal View Study), at Richardson Recreation Center. The alignment is located in volcanic tuff, older alluvium, and recent alluvial soils, with more of the alignment segment crossing recent alluvium than the other B segments.

The B1/B1b/B3/B4 segment shares part of its alignment (the B1 portion) with the B1/B1a segment. It follows Kam Highway adjacent to the proposed Aiea Bay State Recreation Area on land owned by the U.S. Navy and State of Hawaii. In addition to the pipelines in the B1 segment, the B1b portion parallels the alignment of a 4-inch gas line, a 24-inch water line, and a Navy underground telephone line, and it crosses a 30-inch sewer line.

Table 7.2-2
ALIGNMENT INVENTORY--SECTION B

Data Map and Evaluation Factors	Segment B1/B1a I	Segment B1/B1a II	Segment B1/B1a III	Segment B1/B1b/B3/B4 I	Segment B1/B1b/B3/B4 II	Segment B1/B1b/B3/B4 III	Segment B2/B3/B4 I	Segment B2/B3/B4 II	Segment B2/B3/B4 III
ALTERNATIVE ALIGNMENT MAP									
Location	Makai	Makai	Makai	Intermediate	Intermediate	Intermediate	Mauka	Mauka	Mauka
Segment length	0.54	0	0	0.40	0.28	0.19	0.50	0.28	0.19
Parallels existing 138 kV lines	0	0	0	0	0	0.19	0	0	0.19
Parallels existing 46 kV lines	0.19	0	0	0	0.12	0.19	0.50	0.12	0.19
Parallels public rights-of-way	0.24 (bike path) 0.36 (Kam Hwy)	0	0	0.36 (bike path) 0.40 (Kam Hwy)	0.28 (Kam Hwy)	0.19 (Kam Hwy)	0.50 (Kam Hwy)	0.28 (Kam Hwy)	0.19 (Kam Hwy)
Crosses public rights-of-way	0	0	0	1	2	0	2	2	1
LAND JURISDICTION AND REGULATION MAP									
Jurisdiction									
U.S. Navy lands	0.54	0	0	0.36	0	0.17(A)	0	0	0.17(A)
State of Hawaii lands	0.33(A)	0	0	0.05, 0.33(A)	0.26	0.02, 0.17(A)	0.20, 0.30(A)	0.26	0.02, 0.17(A)
City and County of Honolulu lands	0	0	0	0	0	0	0	0	0
Hawaiian Electric lands	0	0	0	0	0	0	0	0	0
Other private parcels (≤5 acres)	0	0	0	0	0	0	0	0	0
Other private parcels (>5 acres)	0	0	0	0	0	0	0.26(A)	0	0
Regulation									
Special Management Area (SMA)	0.19, 0.17(A)	0	0	0.9, 0.31(A)	0.28(A)	0.19	0	0.28(A)	0.19
Shoreline setback area	Near for 0.1	0	0	Near for 0.1	0	0	0	0	0
Conservation District lands	0	0	0	0	0	0	0	0	0
Resource subzone	0	0	0	0	0	0	0	0	0
General subzone	0	0	0	0	0	0	0	0	0
Energy corridor	0	0	0	0	Crosses	Crosses	0	Crosses	Crosses
Historic Preservation									
National historic site or district	0.05	0	0	0	0	0	0	0	0
State historic site or district	0	0	0	0	0	0	0	0	0
Nominated state or national historic site	0	0	0	0	0	0	0	0	0
Hawaiian fishpond or historic settlement area	0	0	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-2
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment B1/B1a I	Segment B1/B1a II	Segment B1/B1a III	Segment B1/B1b/B3/B4 I	Segment B1/B1b/B3/B4 II	Segment B1/B1b/B3/B4 III	Segment B2/B3/B4 I	Segment B2/B3/B4 II	Segment B2/B3/B4 III
EXISTING AND PROPOSED LAND USE MAP									
Existing Uses									
Residential	0	0	0	0	0	0	0.16(A)	0	0
Agricultural	0	0	0	0	0	0	0	0	0
Commercial	0	0	0	0.05(A)	0	0	0.14(A)	0	0
Industrial	0	0	0	0	0	0	0	0	0
Parks, recreation, and preservation	0	0	0	0	0	0	0	0	0
Schools	0	0	0	0	0	0	0	0	0
Churches, hospitals, or medical facilities	0	0	0	0	0	0	0	0	0
Utilities	0	0	0	0	0	0	0	0	0
Parallels existing pipeline routes	0.54	0	0	0.40	0.09	0.19	0	0.09	0.19
Substations	0	0	0	0	0	0	0	0	0
Military housing	0	0	0	0	0	0	0	0	0
Military supply, storage, and maintenance	0	0	0	0	0	0	0	0	0
Military administration, community, and medical	0	0	0	0	0	0	0	0	0
Military operations and training	0	0	0	0	0	0	0	0	0
Military recreation and conservation	0.28, 0.26(A)	0	0	0.12, 0.23(A)	0	0.19(A)	0	0	0.19(A)
Visual Resources									
Significant stationary views	Richardson Rec Ctr	0	0	No	No	No	No	No	No
Structure visible between coastal roadway and shoreline	Yes	0	0	Yes	No	Yes	No	No	Yes
Proposed Land Use									
Proposed linear facilities	- - - - - - - - - - - - - - Rapid Transit System (A) - - - - - - - - - - - - - -								
Other proposed developments	0.19, 0.35(A) Aiea Bay SRA	0	0	0.40(A) Aiea Bay SRA	0	0	0	0	0
Projects under construction	0	0	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-2
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment B1/B1a I	II	III	Segment B1/B1b/B3/B4 I	II	III	Segment B2/B3/B4 I	II	III
GEOLOGICAL AND BIOLOGICAL RESOURCES MAP									
Geological									
Koolau basalt	0	0	0	0	0	0	0	0	0
Volcanic tuff	0.09	0	0	0.09	0	0	0.19	0	0
Older alluvium	0.19	0	0	0.24	0.28	0.14	0.25	0.28	0.14
Man-made fills	0	0	0	0	0	0	0	0	0
Recent alluvium	0.26	0	0	0.07	0	0.05	0.06	0	0.05
Stream	0	0	0	0	0	0	0	0	0
Open lined channel	0.02	0	0	0.02	0	0	0.02	0	0
Spring	0	0	0	0	0	0	0	0	0
Flood-prone area	0	0	0	0	0	0	0	0	0
Biological									
Koa-haole scrub	0	0	0	0	0	0	0	0	0
Mangrove swamp	0	0	0	0	0	0	0	0	0
Cultivated wetlands	0	0	0	0	0	0	0	0	0
Nonwoody wetlands	0	0	0	0	0	0	0	0	0
Rare, endangered, threatened wildlife species	0	0	0	0	0	0	0	0	0
Rare, endangered, threatened plant species	0	0	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

The B4 portion of the segment would be the new alignment of the existing (relocated) Waiau-Makalapa No. 1 line. The B4 segment crosses the Aiea interchange and follows the edge of the Aloha Stadium parking lot to the south side of Salt Lake Boulevard. It is entirely on state-owned land, and is located outside the SMA. The B4 section is located on older alluvium soil.

The B3 segment is the existing alignment of the Waiau-Makalapa No. 1 line. After that line is relocated to the B4 alignment, the new line would be sited in the B3 segment. Because the new line has different conductor requirements than the old line, new poles would be installed near or adjacent to the existing poles, and the existing poles would be removed. The B3 segment is located adjacent to Kam Highway, adjacent to land owned by the state and the U.S. Navy.

B2/B3/B4 also involves relocating the Waiau-Makalapa No. 1 line to the B4 alignment, so it shares the B4 section with B1/B1b/B3/B4. The B2 portion of the segment, however, is adjacent to the mauka side of Kam Highway, adjacent to privately owned land and outside the SMA. A portion of the B2 segment (0.16 mile) is adjacent to residences, and 0.14 mile are adjacent to commercial uses. The soil under the B2 portion of the alignment is primarily older alluvium, with smaller areas of volcanic tuff and recent alluvium.

Section C Inventory

Section C includes two segment alternatives between the intersection of Kam Highway and Salt Lake Boulevard and Halawa Stream. Both cross the public entrance to the U.S.S. Arizona Memorial and the Energy Corridor (Figure 7.1-2, Map 2, and Table 7.2-3). Constructing the line in either segment would involve constructing structures between the coastal roadway (Kam Highway) and the shoreline.

The C1 alternative follows a 46 kV line that runs through the Richardson Recreation Center. Its entire length is on Navy property within the Pearl Harbor National Historic Landmark and it is also within the SMA. The northern portion is used for Richardson Recreation Center, while the southern portion crosses parking lots of the U.S.S. Arizona Memorial visitor center. The soils underlying the C1 segment are primarily recent alluvium and older alluvium. The C1 segment parallels fuel pipelines for its entire length.

The C2 alternative follows an existing 46 kV line along the makai side of Kam Highway for 0.43 mile. The alignment is

Table 7.2-3
ALIGNMENT INVENTORY--SECTION C

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment C1	Segment C2
ALTERNATIVE ALIGNMENTS MAP	I	I
Location	Makai	Mauka
Segment length	0.57	0.43
Parallels existing 138 kV lines	0	0
Parallels existing 46 kV lines	0.57	0.43
Parallels public rights-of-way	0.57	0.43 (Kam Highway)
Crosses public rights-of-way	1 USS Arizona Memorial entrance	1 USS Arizona Memorial entrance
LAND JURISDICTION AND REGULATION MAP		
Jurisdiction		
U.S. Navy land	0.57	0.43(A)
State of Hawaii lands	0	0.43(A)
City and County of Honolulu lands	0	0
Hawaiian Electric lands	0	0
Other private parcels (<5 acres)	0	0
Other private parcels (>5 acres)	0	0
Regulation		
Special Management Area (SMA)	0.57	0.43
Shoreline setback area	0	0
Conservation District lands		
Resource subzone	0	0
General subzone	0	0
Energy corridor	Crosses	Crosses
Historic Preservation		
National historic site or district	0.57	0.43(A)
State historic site or district	0	0
Nominated state or national historic site	0	0
Hawaiian fishpond or historic settlement area	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-3
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives: Segment C1	Segment C2
EXISTING AND PROPOSED LAND USE MAP	I	I
Existing Uses		
Residential development	0	0
Agricultural	0	0
Commercial	0	1
Industrial	0	0
Parks, recreation, and preservation	0	0
Schools	0	0
Churches, hospitals, or medical facilities	0	0
Utilities	0	0
Parallels existing pipeline routes	0.57	0
Substations	0	0
Military housing	0	0
Military supply, storage, and maintenance	0	0
Military administration, community, and medical	0.20	0.15(A)
Military operations and training	0.38	0.28(A)
Military recreation and conservation	0	0
Visual Resources		
Significant stationary views	0	0
Structure visible between coastal roadway and shoreline	Yes	Yes
Proposed Land Use		
Proposed linear facilities	0	0.43(A) Rapid Transit System
Other proposed developments	0	Rapid transit station
Projects under construction	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

Table 7.2-3
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives — Segment C1	Alignment Segment Alternatives — Segment C2
GEOLOGICAL AND BIOLOGICAL RESOURCES MAP	I	I
Geological		
Koolau basalt	0	0
Volcanic tuff	0.12(A)	0.07
Older alluvium	0.19, 0.05(A)	0.33
Man-made fills	0	0
Recent alluvium	0.19, 0.07(A)	0.05
Stream	0	0
Open lined channel	0.05	0.05
Spring	0	0
Flood-prone area	0	0
Biological		
Koa-haole scrub	0	0
Mangrove swamp	0	0
Cultivated wetlands	0	0
Nonwoody wetlands	0	0
Rare, endangered, threatened wildlife species	0	0
Rare, endangered, threatened plant species	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Highway).

on the boundary between Navy land and the right-of-way of Kam Highway owned by the State of Hawaii. That boundary also marks the edge of the SMA. The C2 alignment is adjacent to a proposed RTS alternative corridor along Kam Highway. The soils underlying the segment are somewhat better suited for foundations than those in the Cl alternative, as only 0.05 mile of the C2 segment is on recent alluvium, 0.33 mile is in older alluvium, and 0.07 mile in volcanic tuff.

Section D Inventory

The Dl segment joins North Road south of Halawa Stream, follows it past the Kuahua Substation, and then follows Radford Drive to its intersection with Kam Highway (Figure 7.1-2, Map 2).

Segment D2/D2a follows the makai side of Kam Highway before crossing the highway at Radford Drive. Segment D2/D2b follows the makai side of Kam Highway before crossing to the mauka side of the road about 1,500 feet north of Radford Drive. Table 7.2-4 summarizes the resources within the Dl, D2/D2a, and D2/D2b alternatives. For the Dl segment's entire length, it runs within Navy property in the Pearl Harbor National Historic Landmark. The SMA boundary runs along North Road through part of the alignment: 0.40 mile of the alignment are adjacent to the SMA, and an equal length of the alignment is within the SMA. The Navy fuel pipeline follows the alignment for 0.33 mile. Military uses within the alignment include a fuel tank farm along North Road (opposite from the alignment), administration, operations and training, and recreation and conservation. Construction in this segment would introduce structures visible between a coastal highway (Kam Highway) and the shoreline. The alignment is on man-made fill, volcanic tuff, and recent alluvium.

The D2/D2a segment runs along the makai side of Kam Highway. It lies on the boundary between U.S. Navy land and the right-of-way of Kam Highway owned by the State of Hawaii. It lies entirely within the SMA and, for the segment's entire 0.83-mile length, it is adjacent to the Pearl Harbor National Historic Landmark boundary. Military uses adjacent to the alignment include a fuel storage tank farm, housing, and administration. This segment is adjacent to bachelor officers' quarters (apartments) located on the makai side of Kam Highway just north of Radford Drive. The D2/D2a alignment is located on soil that is more suitable for foundations than the soils in Dl. The D2/D2a soils are primarily volcanic tuff with some recent alluvium and man-made fill.

Table 7.2-4
ALIGNMENT INVENTORY--SECTIONS D & E

Data Map and Evaluation Factors	Alignment Segment Alternatives			
	Segment D1	Segment D2/D2a	Segment D2/D2b	Segment E
ALTERNATIVE ALIGNMENTS MAP	I	I	I	I
Location	Makai	Mauka	Mauka	0
Segment length	1.04	0.85	0.85	0.24
Parallels existing 138 kV lines	0	0	0	0
Parallels existing 46 kV lines	0.74	0.85	0.85	0
Parallels public rights-of-way	0	0.85 (Kam Highway)	0.85 (Kam Highway)	0
Crosses public rights-of-way	North Road	Kam Highway	Kam Highway	Kam Highway, H-1
LAND JURISDICTION AND REGULATION MAP				
Jurisdiction				
U.S. Navy land	1.04	0.85(A)	0.85(A)	0.17
State of Hawaii lands	0	0.85(A)	0.85(A)	0.07
City and County of Honolulu lands	0	0	0	0
Hawaiian Electric lands	0.01	0	0	0
Other private parcels (<5 acres)	0	0	0	0
Other private parcels (>5 acres)	0	0	0	0
Regulation				
Special Management Area (SMA)	0.40(A), 0.40	0.09	0.09	0
Shoreline setback area	0	0	0	0
Conservation District lands	0	0	0	0
Resource subzone	0	0	0	0
General subzone	0	0	0	0
Energy corridor	0	0	0	Crosses
Historic Preservation				
National historic site or district	1.04	0.85(A)	0.47(A)	0
State historic site or district	0	0	0	0
Nominated state or national historic site	0	0	0	0
Hawaiian fishpond or historic settlement area	0	0	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Hwy).

Table 7.2-4
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives Segment D1	Segment D2/D2a	Segment D2/D2b	Segment E
EXISTING AND PROPOSED LAND USE MAP	I	I	I	I
Existing Uses				
Residential development	0	0	0	0
Agricultural	0	0	0	0
Commercial	0	0		0
Industrial	0	0		0
Parks, recreation, and preservation	0	0	0	0
Schools	0	0		0
Churches, hospitals, or medical facilities	0	0	0	0
Utilities	0.01	0		0
Parallels existing pipeline routes	0.33	0		0
Substations	Kuahua	0	0	0
Military housing	0.07(A)	0.17(A)	0.19(A)	0.05(A)
Military supply, storage, and maintenance	0.36	0.52(A)	0.52(A)	0
Military administration, community, and medical	0.19	0.09(A)	0	0.14(A)
Military operations and training	0.07(A), 0.21	0	0	0
Military recreation and conservation	0.19(A)	0	0	0.14(A)
Visual Resources				
Significant stationary views	0	0		0
Structure visible between coastal roadway and shoreline	Yes	Yes	Yes	0
Proposed Land Use				
Proposed linear facilities	Crosses alternate Rapid Transit System corridor	Crosses alternate Rapid Transit System corridor	Crosses alternate Rapid Transit System corridor	Crosses alternate Rapid Transit System corridor
Other Proposed developments	0	0		Proposed Rapid Transit Station
Projects under construction	0	0		0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Hwy).

Table 7.2-4
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives			
	Segment D1	Segment D2/D2a	Segment D2/D2b	Segment E
GEOLOGICAL AND BIOLOGICAL RESOURCES MAP	I	I	I	I
Geological				
Koolau basalt	0	0	0	0
Volcanic tuff	0.45	0.57	0.57	0.15
Older alluvium	0	0	0	0
Man-made fills	0.57	0.05	0.05	0.09
Recent alluvium	0.08	0.24	0.24	0
Stream	0	0		0
Open lined channel	0.02	0.02		0
Spring		0	0.02	0
Flood-prone area	0	0		0
Biological				
Koa-haole scrub	0	0	0	0
Mangrove swamp	0	0		0
Cultivated wetlands	0	0	0	0
Nonwoody wetlands	0	0		0
Rare, endangered, threatened wildlife species	0	0	0	0
Rare, endangered, threatened plant species	0	0	0	0

Notes:

I = Sections of new 138 kV alignment.

(A) = Data factor adjacent to alignment (i.e., adjacent to or separated by street or road other than Kam Hwy).

The D2/D2b segment is almost identical to the D2/D2a segment except that approximately 1,500 feet north of Radford Drive it cuts from the makai to the mauka side of Kam Highway to avoid the bachelor officers' quarters located along the makai side of the road. The 1,500-foot portion of this segment located on the mauka side of Kam Highway is also located adjacent to a housing area (single-family housing), but the houses are located farther back from Kam Highway than along the makai side. Construction in the D2/D2b segment would mean that fewer structures are visible between the coastal highway (Kam Highway) and the shoreline than in the D2/D2a segment. The portion of the D2/D2b segment on the mauka side of Kam Highway is on the SMA boundary (the rest of the segment is within the SMA).

Section E Inventory

This single segment follows the alignment of an existing 46 kV line along the north side of Radford Drive from the makai side of the Radford/Kam Highway intersection to the Radford/Bougainville Drive intersection (Figures 7.1-1 and 7.1-2, Map 2). The resources are summarized in Table 7.2-4. The entire length is within U.S. Navy land except where the alignment crosses the rights-of-way of Kam Highway and the H-1 freeway, owned by the State of Hawaii. The segment crosses the Energy Corridor at the makai side of the H-1 overpass. Adjacent military land uses include administration, community and medical buildings, recreation and conservation, and housing. The segment crosses an alternate corridor for the proposed RTS on the H-1 freeway and a proposed Rapid Transit Station at the intersection of the H-1 freeway and Radford Drive. The segment is located on volcanic tuff and man-made fill.

Section F Inventory

The four alignment segments in Section F (Table 7.2-5) form three alternative alignments, two of which involve rerouting substantial portions of the existing Makalapa-Iwilei 138 kV transmission line. Segment F1 is the northernmost alignment. Segment F2 is the alignment of the existing Makalapa-Iwilei 138 kV transmission line. If the new line is sited in the F2 segment, the Makalapa-Iwilei line could be relocated to either the F3 or F4 segments.

The F1 segment would be simplest and shortest alternative because it would require relocating only one pole of the Makalapa-Iwilei line. For 0.2 mile, the segment parallels the Makalapa-Iwilei line on the opposite side of Bougainville Drive (as close as 60 feet). The F1 segment

Table 7.2-5
ALIGNMENT INVENTORY--SECTION F

Data Map and Evaluation Factors	Segment F1 I	Segment F2/F3 II	Segment F2/F3 III	Segment F2/F3 IV	Segment F2/F4 II	Segment F2/F4 III	Segment F2/F4 IV
ALTERNATIVE ALIGNMENT MAP							
Location	-- North --	----------	Intermediate	----------	----------------	South	----------------
Segment length	0.57	0.66	0.59	0.09	1.09	0.59	0.28
Parallels existing 138 kV lines	0.19	0.66	0.59	0.09	0	0.59	0.28
Parallels existing 46 kV lines	0	0	0.19	0	0.28	0.19	0
Parallels public rights-of-way	0.48	0.38	0.59	0.09	1.09	0.59	0.28
Crosses public rights-of-way	Y	2 crossings	1 crossing	0	0	1 crossing	2 crossings
LAND JURISDICTION AND REGULATION MAP							
Jurisdiction							
U.S. Navy lands	0.05	0.57	0	0.09	1.09	0	0.28
State of Hawaii lands	0.19	0	0	0	0	0	0
City and County of Honolulu lands	0	0	0	0	0	0	0
Hawaiian Electric lands	0	0	0	0	0	0	0
Other private parcels (<5 acres)	0.28	0.09	0.59	0	0	0.59	0
Other private parcels (>5 acres)	0	0	0	0	0	0	0
Regulation							
Special Management Area (SMA)	0	0	0	0	0	0	0
Shoreline setback area	0	0	0	0	0	0	0
Conservation District lands	0	0	0	0	0	0	0
Resource subzone							
General subzone							
Energy corridor (A)	0.28 (A)	0	0	0	0	0	0.28(A)
Historic Preservation							
National historic site or district	0	0	0	0	0	0	0
State historic site or district	0	0	0	0	0	0	0
Nominated state or national historic site	0	0	0	0	0	0	0
Hawaiian fishpond or historic settlement area	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.
IV = Sections of existing 138 kV alignment that are vacated when the existing 138 kV line is relocated.

(A) = Data factor adjacent to alignment (other than Kam Highway).

Table 7.2-5
(continued)

Data Map and Evaluation Factors	Alignment Segment Alternatives						
	Segment F1	Segment F2/F3			Segment F2/F4		
	I	II	III	IV	II	III	IV
EXISTING AND PROPOSED LAND USE MAP							
Existing Uses							
Residential	0	0	0	0	0	0	0
Agricultural	0	0	0	0	0	0	0
Commercial	0.28	0.14	0.59	0	0.09	0.59	0
Industrial		0	0	0	0	0	0
Parks, recreation, and preservation, open space	0.24	0	0	0	0	0	0
Schools		0	0	0	0	0	0
Churches, hospitals, or medical facilities		0	0	0	0	0	0
Utilities		0	0	0	0	0	0
Parallels existing pipeline routes	0.28	0	0	0	0	0	0
Substations	------------------ 1 (Makalapa) ------------------						
Military housing	0	0	0	0	0.19	0	0
Military supply, storage, and maintenance	0	0.14	0	0	0.14	0	0
Military administration, community, and medical	0	0.14	0	0.09	0.33	0	0.28
Military operations and training	0	0.11	0	0	0	0	0
Military recreation and conservation	0.04	0.05	0	0	0.28	0	0
Visual Resources							
Significant stationary views	0	0	0	0	0	0	0
Structure visible between coastal roadway and shoreline	0	0	0	0	0	0	0
Proposed Land Use							
Proposed linear facilities	0	0	0	0	0.38 (Rapid Transit System)	0	0
Other proposed developments	0	0	0	0	0	0	0
Projects under construction	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.
IV = Sections of existing 138 kV alignment that are vacated when the existing 138 kV line is relocated.

(A) = Data factor adjacent to alignment (other than Kam Highway).

Table 7.2-5
(continued)

Data Map and Evaluation Factors	Segment F1	Segment F2/F3			Segment F2/F4		
	I	II	III	IV	II	III	IV
GEOLOGICAL AND BIOLOGICAL RESOURCES MAP							
Geological							
Koolau basalt	0	0	0	0	0	0	0
Volcanic tuff	0.38	0.66	0.59	0	1.09	0	0.28
Older alluvium	0	0	0	0	0	0	0
Man-made fills	0	0	0	0	0	0	0
Recent alluvium	0.19	0	0.07	0.09	0	0.09	0
Stream	0	0	0	0	0	0	0
Open lined channel	0	0	0	0	0	0	0
Spring	0	0	0	0	0	0	0
Flood-prone area	0	0	0	0	0	0	0
Biological							
Koa-haole scrub	0	0	0	0	0	0	0
Mangrove swamp	0	0	0	0	0	0	0
Cultivated wetlands	0	0	0	0	0	0	0
Nonwoody wetlands	0	0	0	0	0	0	0
Rare, endangered, threatened wildlife species	0	0	0	0	0	0	0
Rare, endangered, threatened plant species	0	0	0	0	0	0	0

Note:

I = Sections of new 138 kV alignment.
II = Sections of new alignment for relocated existing 138 kV alignment.
III = Sections of new 138 kV line sited on the former alignment of existing 138 kV line.
IV = Sections of existing 138 kV alignment that are vacated when the existing 138 kV line is relocated.

(A) = Data factor adjacent to alignment (other than Kam Highway).

crosses a small area (0.05 mile) of Navy land (open space) and 0.019 mile of land under the jurisdiction of the State Department of Transportation (part of the right-of-way for Bougainville Drive). Most of the segment crosses private land in commercial use. The alignment passes between Costco and Marsh Co. along Malaai Street. For 0.28 mile, the segment parallels the Energy Corridor. The segment is located primarily in volcanic tuff, and 0.2 mile is in recent alluvium.

The F2/F3 and F2/F4 alternatives involve 0.59 mile where the new line would be located in the alignment of the existing Makalapa-Iwilei line. That line would be relocated to either Segment F3 (in the case of the F2/F3 combination) or to Segment F4 (in the case of the F2/F4 combination).

Segment F3 is 0.66 mile long. Most of its length is located in Navy lands used for the Pearl Harbor Public Works Center (storage and supply), operations and training, and administration. Approximately 0.14 mile is private commercial land adjacent to Salt Lake Boulevard. The segment is largely in volcanic tuff (0.59 mile), with a portion (0.07 mile) in recent alluvium. If this segment were selected for the relocation of the Makalapa-Iwilei line, for a distance of 0.09 mile along Bougainville Drive, the existing line would be removed and no line would replace it as the Makalapa-Iwilei line is relocated along a more southerly alignment.

Segment F4 is 1.09 miles long. All of its length is located in Navy land, primarily used for housing, the Navy Exchange Commissary complex, and administration. For 0.38 mile of its length, the segment follows the makai side of Salt Lake Boulevard parallel to one alternative alignment for the proposed RTS (which would be located in the median of Salt Lake Boulevard). The segment is located entirely within volcanic tuff soils. If this segment were selected for the relocation of the Makalapa-Iwilei line, for a distance of 0.28 mile along Bougainville Drive, the existing line would be removed and no line would replace it as the Makalapa-Iwilei line is relocated along a more southerly alignment.

7.2.2 Alignment Comparison and Selection

The alignment segment alternatives identified in Subsection 7.1.1 were next compared, by segment, for permit requirements and environmental/land use and engineering considerations. The comparison built on the alignment inventory, which provided the data for comparison against siting criteria and a permits evaluation. Potential permit requirements for siting and constructing a new 138 kV line were identified through a review of applicable regulations and consultations with federal, state, and City and County of Honolulu agencies (Table 7.2-6).

Section A

Section A includes two alternatives located between Waiau Power Plant and McGrew Point--Segments A1 and A2 (Figures 7.1-1 and 7.1-2).

Environmental/Land Use Criteria: Segment A1 (the makai segment) crosses residential areas near Kaluamoi Drive and Lipoa Place and would pass through the center of a major county park, Pearl Harbor (Blaisdell) Park. Segment A2 passes along the mauka (Kam Highway) edge of Pearl Harbor (Blaisdell) Park and avoids most residential areas except for a few single-family houses and apartment buildings along Kam Highway. The proposed RTS route would run along the median of Kam Highway adjacent to the A2 segment. According to staff of RTS, conflicts between RTS and the proposed transmission line could be avoided along the A2 (Kam Highway) segment by coordinated planning and careful placement of poles in relationship to proposed Rapid Transit Stations.

The A1 segment crosses City and County of Honolulu land (Pearl Harbor [Blaisdell] Park) and runs adjacent to U.S. Navy land at McGrew Point, whereas the A2 segment runs adjacent to (not through) the county land. Both alternatives follow the alignments of existing 46 kV lines. The A2 segment, unlike the A1 segment, follows a major road (Kam Highway).

Engineering Criteria: Segment A1 is approximately 1.8 miles long, whereas Segment A2 is approximately 1.6 miles long. Segment A1 is located along recent alluvium soils for approximately 1.6 miles, while Segment A2 is located on recent alluvium for 1.4 miles. Segment A1 is located adjacent to a Chevron oil pipeline for approximately 1.6 miles. Both segments would have adequate separation from existing 138 kV lines.

Permit Comparison: Because it runs adjacent to the shoreline of Pearl Harbor, Segment A1, depending on the exact placement of the line and poles, could trigger a number of permit requirements related to work on or in shorewaters. These include the Corps of Engineers Section 401 and Section 10 permits (which, in turn, could trigger a federal Environmental Impact Statement and a state Coastal Zone Management federal consistency review) and a Shoreline Setback Variance (which could trigger a state EIS). Because

Table 7.2-6
POTENTIAL PERMITS AND APPROVALS BY ALIGNMENT SEGMENT

Authorizing Agency/Permit Name		Alignment Alternatives: Section A A1	A2	Section B B1/B1a	B1/B1b/B3/B4	B2/B3/B4	Section C C1	C2	Section D D1	D2/D2a	D2/D2b	Section E E	Section F F1	F2/F3	F2/F4
Federal															
USCOE:	General Permit/Section 10	P	-	P	-	-	P	P	P	P	P	-	-	-	-
USCOE:	Section 404	P	-	P	-	-	P	P	P	P	P	-	-	-	-
CEQ:	NEPA Compliance	P	-	P	-	-	-	-	-	-	-	-	-	-	-
U.S. Navy:	Approval for Easement	P	-	Y	Y	Y	Y	Y	Y	P	P	Y	Y	Y	Y
State															
DBED:	CZM Federal Consistency	P	-	P	-	-	-	-	-	-	-	-	-	-	-
DLNR:	Historic Site Review	-	-	P	-	-	P	P	P	P	P	-	-	-	-
DLNR:	Stream Channel Alteration Permit	P	P	P	P	P	P	P	P	P	P	-	-	-	-
DLNR:	Easement for Use of State Lands	-	-	P	Y	Y	-	-	-	-	-	-	-	-	-
DOT:	Use of Energy Corridor	-	-	-	-	-	-	-	-	-	-	P	P	-	-
DOT:	Work on State Highway	-	Y	Y	Y	Y	-	Y	-	Y	Y	P	Y	-	Y
EQC:	State EIS*	P	P	P	P	P	P	P	P	-	-	-	P	P	-
PUC:	Approval for Construction in a Residential Area	Y	P	-	P	-	-	-	P	P	P	P	-	-	Y
PUC:	Notice of Conflicting Lines	-	-	-	P	P	-	-	-	-	-	-	P	-	-
City and County of Honolulu															
DLU:	Shoreline Setback Variance	P	-	P	-	-	-	-	-	-	-	-	-	-	-
DLU:	SMA Use Permit	Y	Y	Y	P	P	Y	Y	Y	-	-	-	-	-	-
DLU:	Conditional Use Permit (Type 1)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
DOT:	Street Usage Permit	Y										Y	Y	Y	Y
DPW:	Easement for Use of County Lands	Y	P	-	-	-	-	-	-	-	-	-	-	-	-
DPW:	Permit for Construction on County Roads	Y											Y	Y	Y

Y = Yes, permit probably required.
P = Permit potentially required, depending on right-of-way and pole location.
* = According to HRS 343, actions or permits that could initiate the state EIS process include:

- Use of state lands
- Use within Shoreline Setback Area
- Use within historic site or district designated in National Register or Hawaii register

Other EIS triggers such as use of state or county funds, use within Waikiki Special District, or construction of helicopter facilities do not apply to this project.

the segment runs across Pearl Harbor (Blaisdell) Park, Segment A1 would require an easement for use of county lands.

Both segments A1 and A2 may require an SMA permit because the Waiau Power Plant (which forms their common beginning point) is within the SMA. Segment A1, however, falls entirely within the SMA, whereas Segment A2 lies on the SMA boundary along Kam Highway. Both Segments A1 and A2 would probably require PUC Approval for Construction in a Residential Area (although Segment A1 passes through a residential area while Segment A2 is adjacent to residential areas only at a few points). Segment A2 would require a state DOT Permit to Perform Work on State Highways, whereas A1 would require permits from the City and County Public Works Department and Department of Transportation Services for construction in a county right-of-way (the bike path).

Alignment Decision: The A2 alignment was selected because it follows a major road, it avoids more residential areas than Segment A1, it is shorter than Segment A1, and it runs along the edge rather than through the center of Pearl Harbor (Blaisdell) Park.

Unlike A1, Segment A2 would not trigger the requirement for a Shoreline Setback Variance (and, therefore, possibly the requirement for a state EIS as well). If the line can be sited entirely within the right-of-way of Kam Highway, Segment A2 may not require an SMA use permit except at Waiau Power Plant. Segment A2 is also located in recent alluvium soils for a slightly shorter distance than Segment A. Also, Segment A2 (unlike A1) is not adjacent to an oil pipeline for most of its length.

<u>Section B</u>

Section B includes three alignment configurations (B1/B1a, B1/B1b/B3/B4, and B2/B3/B4) between McGrew Point and the Salt Lake Boulevard/Kam Highway intersection. Alignment alternatives in this section are compressed into a narrow area between the Aloha Stadium grounds and Pearl Harbor. In order to avoid crossing the new 138 kV line over the existing Waiau-Makalapa No. 1 138 kV line and in order to observe adequate clearance between the two lines, two of the alternatives (B1/B1b/B3/B4 and B2/B3/B4) would require the existing line to be moved to the mauka side of Kam Highway.

Environmental/Land Use Criteria: The B2/B3/B4 segment would be adjacent (for almost 0.2 mile) to a residential area on the makai side of Kam Highway. On the other side of Kam Highway, the B1 segment follows the edge of the proposed

Aiea Bay State Recreation Area. The Bla segment traverses the Richardson Recreation Center.

The B3/B4 combinations would require realigning the existing Waiau-Makalapa No. 1 line along the ewa side of Aloha Stadium. One pole would be placed in the retaining wall of the parking lot adjacent to Kam Highway (the retaining wall will be rebuilt around the pole). The new line would be placed on the opposite (makai) side of Kam Highway adjacent to the Richardson Recreation Center.

All the alignments in the Aloha Stadium area would be adjacent to the proposed alignment of the RTS (located in the median of Kam Highway and across the Aloha Stadium parking lot). According to RTS staff, conflicts between the transmission line and the RTS can be avoided through coordination of plans and careful siting of individual poles.

Segment Bla is located on Navy land; Segments Bl, Blb, and B3 are adjacent to Navy land. As noted above, the B3/B4 combination would require realigning the Waiau-Makalapa No. 1 138 kV line to be adjacent to the state-owned Aloha Stadium grounds and would require placing one pole in the retaining wall of the stadium.

All of the segments in this section follow in large part the alignments of existing 46 kV lines. All but the Bla segment parallel public roads (Kam Highway).

Engineering Criteria: Because of special constraints imposed by the locations of the existing Waiau-Makalapa No. 1 138 kV line, the shoreline, and Aloha Stadium, maintaining adequate separation between the proposed line and the existing Waiau-Makalapa No. 1 line is difficult in this area. The alignments involving the B3/B4 segment would involve realigning the existing Waiau-Makalapa No. 1 line to the mauka side of Kam Highway. This would provide a minimum of 100 feet between the two lines--adequate separation. The Bl/Bla combination would be the simplest and shortest alignment because it would not require the realignment of any sections of existing line; however, the Bl/Bla combination has the longest distance located on recent alluvium soils, which can require pile foundations for adequate support. All of the B section segments would require construction adjacent to existing fuel, water, or sewer pipelines.

Permit Comparison: All of the alignments in this section require a Permit to Perform Work on State Highways because they involve alignments along Kam Highway. Alignment Bl/Bla could require an easement for use of state lands because it crosses state-owned land in the area of the proposed Aiea Bay State Recreation Area; alignment segment B3/B4 would require an easement from the state to place a pole in the retaining wall of the Aloha Stadium parking lot.

Because it crosses Aiea Stream close to its mouth and is adjacent to the shoreline, Segment B1/B1a has the greatest potential to require a Corps of Engineers Section 10 or Section 404 Permit, which could trigger federal NEPA review and state Coastal Zone Management federal consistency review. Segment B1/B1a might also require a Shoreline Setback Variance, which would trigger review under the state EIS requirements. A shoreline setback certification has not been made in this area and, therefore, the exact location of the shoreline setback area can be determined only by a survey certified by the state. However, the proposed alignment approaches the shoreline no closer than approximately 100 feet and thus appears to be entirely outside the shoreline setback area. Segment B1/B1a is also clearly within the SMA and would require an SMA permit; the other alignment alternatives are on the SMA boundary. Segment B1a is partially within the Pearl Harbor National Historic District and would probably require historic site review. Segment B1/B1b/B3/B4 would probably require PUC Approval for Construction in a Residential Area.

Alignment Decision: The B1/B1b/B3/B4 alignment was selected because it avoids most residential areas and (unlike the B1a segment) does not pass through the Richardson Recreation Area and the proposed Aiea Bay State Recreation Area. Although the alignment requires relocating the existing Waiau-Makalapa No. 1 138 kV Transmission Line to the mauka side of Kam Highway and requires placing one pole in the retaining wall of the Aloha Stadium parking lot, there should be no long-term disruption of parking or other activities in the Aloha Stadium grounds. Separating the Waiau-Makalapa No. 1 and No. 2 lines by the width of Kam Highway provides adequate separation.

<u>Section C</u>

Section C includes two segment alternatives (C1 and C2) between the intersection of Kam Highway and Salt Lake Boulevard and Halawa Stream.

Environmental/Land Use Criteria: Neither of the C alternatives crosses residential areas. The C1 segment traverses the Navy's Richardson Recreation Center and crosses the parking lot of the U.S.S. Arizona Memorial Visitor Center, while C2 follows Kam Highway adjacent to the Visitor Center parking lot.

The C1 alternative crosses Navy land (within the Pearl Harbor National Historic District) for its entire length (along the right-of-way of an existing 46 kV line); the C2 alternative is adjacent to Navy land (also along the right-of-way of an existing 46 kV line) along Kam Highway. The C2 alternative is adjacent to one alternative alignment of the proposed RTS in the median of Kam Highway, but according to staff of the RTS project, conflicts between a transmission line sited along the C2 segment and the RTS can be avoided by careful siting of the line and poles.

Engineering Criteria: Segment C1 is slightly longer than Segment C2 (0.6 mile versus 0.4 mile). Both provide adequate separation of existing 138 kV lines. Segment C1 crosses more recent alluvium (0.2 mile) than Segment C2 (0.05 mile). Segment C1 parallels pipelines for its entire length.

Permit Comparison: Both C segments would require an easement from the U.S. Navy and both are located within the SMA. Segment C1, which is entirely within the Pearl Harbor National Historic Landmark, is more likely to require Historic Site Review than Segment C2, which is located on the boundary of the historic landmark. Both segments terminate at Halawa Stream and thus have the potential to require a Corps of Engineers Section 10 or Section 404 Permit and/or a DLNR Stream Channel Alteration Permit (which could be avoided by siting pole footings outside the stream channel). Segment C2, located on Kam Highway, would require DOT Permit to Perform Work on a State Highway.

Alignment Decision: The C2 alignment was selected over the C1 alignment because it follows an existing 46 kV line along a major roadway, it avoids the Pearl Harbor National Historic Landmark and does not cross the parking lot of the U.S.S. Arizona Memorial, it is not adjacent to pipelines, and less of its length is located on recent alluvium soils.

Section D

Section D includes two segments along Kam Highway and a third on North Road and Radford Drive in the Pearl Harbor Naval Base.

Environmental/Land Use Criteria: The D2/D2a and D2/D2b segments are adjacent to residential areas along Kam Highway for part of their lengths; however, D2/D2b is more distant from housing than D2/D2a (which is located within 30 to

40 feet of a five-story bachelor officers' quarters building). Although Segments D2/D2a and D2/D2b are adjacent (and cross over) one alternative alignment for the RTS, according to staff of the RTS, conflicts between the transmission line and the RTS can be avoided by careful siting of the line and individual poles. Segment D1 is located entirely within Navy property within the Pearl Harbor Naval Base and the Pearl Harbor National Historic Landmark, whereas Segments D2/D2a and D2/D2b are adjacent to Navy property and might not require an easement from the Navy.

Engineering Criteria: Segment D1 is longer than the other two segments (1.04 miles versus 0.85 mile). The D1 segment is located on man-made fill or recent alluvium for about half its length, whereas the D2/D2a and D2/D2b segments are on recent alluvium and man-made fill for only about one-quarter of their lengths. The D1 segment is located adjacent to a Navy fuel pipeline for about one-third of a mile.

Permit Comparison: Segment D2/D2a is within the SMA; the D2b portion of D2/D2b is on the SMA boundary (which follows the mauka side of Kam Highway). All of the segments begin at the Halawa Stream and could require a Corps of Engineers Section 10 or Section 404 Permit for crossing the stream or a DLNR Stream Channel Alteration Permit; however, these permits can probably be avoided by siting pole footings outside the stream channel. All of the segments have portions adjacent to the Pearl Harbor National Historic Landmark, possibly requiring DLNR Historic Site Review, and all segments could possibly require PUC Approval for Construction in a Residential Area. The D2/D2a and D2/D2b segments are adjacent to Kam Highway and would require a Permit to Perform Work on a State Highway.

Alignment Decision: Segment D2/D2b was selected because, unlike segment D1, it avoids the Pearl Harbor National Historic District and the Navy lands within the Pearl Harbor Naval Base. Segment D2/D2b is also shorter than Segment D1, and it is located along a major road. Segment D2/D2b was selected over segment D2/D2a because it is farther from housing (a minimum of 50 feet) than D2/D2a, which is located within 30 to 40 feet of a five-story bachelors officers' quarters building on the makai side of Kam Highway.

Section E

Alignment Decision: As described above (Subsection 7.1.2), only a single alignment alternative could be identified in the vicinity of Radford Drive between Kam Highway and Bougainville Drive, because the areas north and south of

Radford Drive are highly developed in residential and administrative uses within Navy property. The E segment follows the north side of Radford Drive from its intersection with Kam Highway to the mauka side of the H-1 overpass.

Section F

Section F has three alternatives between the Radford/H-1 overpass and Makalapa Substation. Two of the alternatives require extensive relocation of the existing Makalapa-Iwilei 138 kV transmission line to make room for the Waiau-Makalapa No. 2 138 kV Transmission Line.

Environmental/Land Use Criteria: The F1 segment is located primarily in land in commercial use (with a small portion crossing open space land that is part of the Bougainville Drive right-of-way), while segment F2/F4 crosses substantial areas of military housing and the Navy Exchange Commissary Complex. Segment F2/F4 would be adjacent to the RTS alignment alternative along Salt Lake Boulevard. Road improvements are also planned for Salt Lake Boulevard in the vicinity of Segment F2/F4. Segment F1 is located largely on private lands, with only a short distance across Navy land (0.05 mile) and the rest of the segment located in the state-owned right-of-way of Bougainville Drive. Segments F3 and F4 are located entirely across Navy land. Portions of segments F2, F3, and F4 are on the alignments of existing 46 kV lines.

Engineering Criteria: The shortest and simplest alternative would follow the F1 segment. If the line is constructed in the F1 segment, it would parallel the existing Makalapa-Iwilei 138 kV transmission line for approximately 0.2 mile. In order to provide adequate separation, one pole of the Makalapa-Iwilei line would probably have to be relocated to the makai side of Bougainville Drive. Even so, use of this alignment would require an exemption from PUC's General Order No. 6 requirements relating to conflicting lines because the new line and the existing line will be as close as 60 feet on Bougainville Drive and 45 feet on Lawehana Street. The two other alternatives (F2/F3 and F2/F4) would require substantial relocation of the Makalapa-Iwilei line in order to provide adequate separation between the new line and existing lines. The F1 segment is located adjacent to the Energy Corridor, and construction in this segment may require installing cathodic protection to prevent increased corrosion to the Energy Corridor pipelines.

Permit Comparison: The F1 segment might require a Permit for Construction to Cross or Enter the State Energy Corridor, depending on the exact location of the line in relation to the Energy Corridor. Both F1 and F2/F4 would require a Permit to Perform Work on a State Highway. Segment F2/F4 would require PUC approval for Construction in a Residential Area.

Alignment Decision: The F1 alignment was selected because adequate separation from existing 138 kV transmission lines can generally be assured, except near the intersection of Bougainville Drive and Lawehana Streets, where one pole of the existing Makalapa-Iwilei 138 kV line must be relocated from the mauka to the makai side of Bougainville Drive. In addition, unlike segments F2/F3 and F2/F4, it does not cross extensive areas of Navy land. Unlike segment F2/F4, it is not located near the Navy Exchange Commissary Complex (a high-public-use area) and it avoids housing areas.

7.3 PREFERRED ALIGNMENT DESCRIPTION

The product of the alignment selection decisions for each segment is a single alignment running from the Waiau Power Plant to the Makalapa Substation (Figure 7.2-6). From the power plant, the alignment follows the alignment of an existing 46 kV line along the makai side of Kam Highway to McGrew Point. From McGrew Point to Aloha Stadium, the proposed alignment follows the makai side of Kam Highway rather than follow the alignment of the existing 46 kV line that crosses farther makai through the proposed Aiea Bay State Recreation Area. The new transmission line will continue to follow the makai side of Kam Highway as the highway turns south near the stadium. In order to provide adequate separation between the new line and the existing Waiau-Makalapa No. 1 line, the existing line will be relocated from the makai to the mauka side of Kam Highway from the Aiea interchange to the intersection of Kam Highway and Salt Lake Boulevard. This will require placing one transmission pole in the retaining wall of the Aloha Stadium parking lot (the retaining wall will be rebuilt around the pole).

South of Aloha Stadium, the new line will follow the makai side of Kam Highway to approximately 1,500 feet north of Radford Drive, where it will cross to the mauka side of the highway. The alignment follows the north side of Radford Drive and then turns north for approximately 1,250 feet along the makai side of Bougainville Drive (the mauka side of the H-1 freeway). It turns south to cross Bougainville Drive and follows the west side of Lawehana Street and the south side of Malaai Street to the Makalapa Substation. In order to provide adequate separation, one pole of the existing Makalapa-Iwilei 138 kV transmission line will be relocated from the mauka to the makai side of Bougainville Drive at Lawehana Street.

Chapter 8
Public and Agency Consultation

Chapter 8
PUBLIC AND AGENCY CONSULTATION

8.1 PUBLIC/AGENCY INVOLVEMENT SUMMARY

8.1.1 Public Involvement Plan

Public Involvement Planning Group

A public involvement program outlining the major public participation activities and schedule was prepared by the Public Involvement Planning Group for the Waiau-Makalapa No. 2 138 kV Transmission Line Project in June 1988. The Public Involvement Planning Group consisted of HECO personnel; the environmental consultant, CH2M HILL; and subconsultants who are experts in the field of public involvement. HECO participants represented transmission engineering, land acquisition, corporate communications, governmental affairs, and legal departments.

Public Involvement Plan

As stated in the plan, the purposes of the Waiau-Makalapa public involvement activities were to:

- Inform the public about the project and their opportunities to participate
- Ensure that affected agencies, interest groups, individuals, and elected officials are well informed about the project
- Ensure that public concerns are reflected in the study approach
- Provide timely information to the Project Team and to HECO's decision-makers about the public's opinions on the various corridor and alignment options
- Alert the planning team to potential conflicts and provide mechanisms for resolving them
- Meet implicit and explicit consultation requirements of permitting agencies

Key Public Targets

The Waiau-Makalapa Public Involvement Plan was designed to reach a number of different segments of the public. Plan elements were specifically directed toward:

- Elected officials
- Officers and members of neighborhood boards
- Offices of community and service organizations:
    - Business organizations
    - Environmental groups
    - Senior citizen groups
    - School organizations
- Community leaders
- Major landowners
- Federal, state, and local agency personnel
- Media
- General public

8.1.2 **Public Involvement Activities by Phase**

The public involvement activities included dissemination of information and opportunities for direct public involvement. The principal activities involved public meetings that corresponded with major project study milestones. Other focused public and agency meetings were held on an ongoing basis throughout the project such as project briefings and information meetings with neighborhood boards. All of the public involvement activities incorporated in the project are described below.

Phase I Regional Study and Corridor Identification

The major activities for the initial phase of the work (the regional study, corridor identification, and alternative corridor evaluation) included:

Mailing List **(January 1988)**

At the beginning of the project studies, a mailing list was prepared that included the key public groups and individuals in the study area. This mailing list initially included approximately 200 elected officials; community and service organizations; federal, state, and city and county agencies; major landowners; utilities; and interested persons. During the project, the mailing list was expanded to include those who contacted HECO or its consultants for project-related information, persons who attended the meetings and other organizations, and individuals who returned mail-back cards from the newsletters or otherwise requested that their name be added. The final project mailing list included more than 300 people.

Consolidated Application Process/Public Agency Meeting No. 1 (February 5, 1988)

Assistance was requested of the Office of State Planning and the Coastal Zone Management Office in arranging and coordinating a joint meeting of federal, state, and city and county agencies to review and provide comment on the project proposal.

Fact Sheet (February 15, 1988)

A fact sheet that briefly described the need for the project, the scope and schedule of the route selection study, the opportunities for public involvement, and a map of the study area was prepared. It served as the public announcement of the project.

Announcement Letter (February 19, 1988)

HECO mailed personal letters to key elected officials, affected neighborhood boards, and major landowners. These mailings included copies of the fact sheet and made the formal announcement of the project.

News Release (February 22, 1988)

HECO issued the fact sheets, a press release to the media, and conducted a media briefing session.

Announcement to Other Interested Groups/Individuals (February 1988)

Following the news release, HECO mailed letters and fact sheets to neighborhood board members, community leaders, community and service organizations, business organizations, school organizations, senior citizens groups, environmental groups, and major landowners/developers on the project mailing list.

Announcement to Public Agencies (February 1988)

A letter was mailed to federal, state, and city and county agencies announcing the project and requesting that they each designate a contact person.

Telephone Calls/In-person Interviews (February and March 1988)

HECO contacted key elected officials, chairpersons of affected neighborhood boards, and major landowners to ensure that the project information materials were received and to determine whether individual briefings were desired.

Newsletter No. 1 (May 1988)

Newsletters were mailed to all persons on the project mailing list, made available at HECO offices, and used as handouts at public and agency meetings and briefings.

The first project newsletter included a project description, statement of need, study area map showing alternative corridors, the route selection methodology, and identified a contact person at HECO. Newsletters were also used for public meeting handouts.

Meetings with Neighborhood Boards (March to May 1988)

HECO conducted project information meetings for neighborhood boards to acquaint them with the project, the study process, and to provide opportunities to participate and to receive comments and concerns about the transmission line location.

Individual Meetings with Landowners and the U.S. Navy (June 1988)

Key members of the project team met with major private land owners, and the U.S. Navy to discuss the project and obtain information about locational opportunities and constraints.

Phase II Corridor Evaluation and Alignment Selection

During the period June to September 1988, additional information on conditions within the preferred corridor was gathered through detailed field study. The information was mapped and analyzed and alternative alignments with the preferred corridor were identified. Using information received from neighborhood boards and consultation with agencies, a preferred alignment was selected. A brief chronology of the major public involvement during Phase II is presented below.

Newsletter No. 2 (October 1988)

Newsletter No. 2 contained a description of the preferred alignments and included a map insert showing the location of preferred and alternative alignments. It also included diagrams of the pole types, a summary of permitting considerations, and an updated project schedule. An announcement of the times and locations for the public meetings was also included.

Media Release (November 12 to 16, 1988)

A display advertisement that announced the times, locations, and purpose of the public meetings was placed in the Honolulu Advertiser for three consecutive days.

Public Meetings (November 16 to 17, 1988)

Two public meetings were held; in Pearl City on November 16 and in Aliamanu on November 17 to present and discuss the alternative and preferred alignments and the selection criteria and to answer questions and receive comments (see Section 8.4 and Appendix G).

Consolidated Application Process/Public Agency Meeting No. 2 (November 29, 1988)

A second joint meeting of federal, state, and city and county agencies was held. The purpose of the meeting was to present the location of the preferred alignment and to identify permits, approvals and reviews that would be required and determine the sequencing of the permits. Refer to Section 8.5 and Appendix G for discussion of the results of this meeting.

Presentations to Neighborhood Boards (August to September 1989

Neighborhood Boards were interested in having an update of the project following final alignment selection. The project team presented the preferred alignment and discussed community concerns.

8.2 NEIGHBORHOOD BOARD MEETINGS

8.2.1 Schedule, Format, and Attendance

After the formal announcement of the project (through letters and fact sheets to elected officials, community leaders, neighborhood boards, and the media), each organization was invited to have HECO present the Waiau-Makalapa No. 2 138 kV Transmission Line Project at a monthly meeting. The neighborhood boards in the study area accepted the invitation. The following presentations with question and answer periods were held:

- Pearl City Neighborhood Board Plan and Zoning Committee — March 17, 1988
- Aiea Neighborhood Board — April 11, 1988
- Aliamanu/Salt Lake/Foster Village Neighborhood Board — May 12, 1988

The format for each of the neighborhood board meetings was similar. HECO gave a slide presentation describing the project, the purpose and need for the project, the routing methodology, and the goals and objectives for the routing process. At the close of the presentation, HECO answered questions from neighborhood board members and the public. The presentation, questions, and responses were recorded and are summarized in Subsection 8.2.2 and are provided in meeting summaries in Appendix G.

Additional presentations were given by HECO to the neighborhood boards after the selection of the preferred alignment. The following meetings were attended by HECO:

- Pearl City Neighborhood Board — August 31, 1989
- Aiea Neighborhood Board — September 11, 1989
- Aliamanu/Salt Lake/Foster Village Neighborhood Board — September 14, 1989

The Aiea Board unanimously approved a motion that the Board go on record as supporting the undergrounding of 12 kV distribution lines along Kam Highway and supporting the 138 kV line construction.

The Aliamanu/Salt Lake/Foster Village Board also approved a motion to support the preferred alignment for the Waiau-Makalapa No. 2 Transmission Line.

8.2.2 Summary of Comments

Highlights of the major questions and concerns asked by board members during the meetings attended by HECO during March through May 1988 are summarized by topic. The major topics were:

- Transmission alternatives to the proposed overhead lines

- Effect of the project on the ratepayer
- Traffic disruption during construction of the new line
- Socioeconomic effects of the line: public health, radio and television interference, etc.
- EA or EIS requirements for the proposed project

Transmission Alternatives to the Proposed Overhead Lines

A common inquiry in all the meetings was the possibility of alternative technologies to the overhead transmission line. Participants in the meetings asked HECO to:

- Investigate options of undergrounding the line, routing overhead across Pearl Harbor, or using submarine cable to avoid land use and visual impacts
- Determine whether the new line could be routed along an existing transmission line corridor or highway

Effect on the Ratepayer

Financial impacts of the proposed project and financing for the new line were concerns raised in most meetings. The questions included:

- How much will the construction of the new line cost?
- How does HECO plan to pay for the project?
- Will there be rate reductions for customers who are directly affected by the new line (i.e., Pearl City)?
- Does the Navy use the power and, if so, shouldn't they pay for it?
- Will the new line increase our rates?

Traffic Disruption During Construction

Traffic congestion associated with lane closures during line construction was a major concern with most Boards. Traffic management procedures and construction during off-peak traffic hours were suggested as ways of alleviating the potential traffic congestion problems.

Socioeconomic Effects

Other concerns that were voiced during the meetings were related to the socioeconomic welfare of the community residents. Topics included:

- Possible effect of the new line on television and radio reception
- Potential health risks from electromagnetic fields (EMF)
- Safety of the new high-voltage line
- Visual appearance of the new line
- Proximity to residences or schools

EA or EIS Requirements

The public wanted to know how the environmental effects of the proposed project would be assessed. The questions that were asked included:

- Will an EA or an EIS be prepared for this project?
- What permits are required for HECO to build this line?
- What is the schedule for the preparation of the EA?

The principal questions raised in the Phase II neighborhood board meetings attended by HECO in August and September 1989 included such topics as:

- The availability of the Routing Report
- Agencies that will issue permits and approve the project
- Traffic disruption and management during project construction
- Whether the project would affect the Aiea Bay jogging and bike path

- The cost, size, and appearance of the line
- Undergrounding of the 12 kV distribution line
- Potential health effects from electromagnetic fields (EMF)

Meeting summaries are included in the Public and Agency Consultation Summaries, Appendix G. They provide a written record of the presentation, questions and answers, and HECO's responses.

8.3 ALIGNMENT PUBLIC MEETING SUMMARY

8.3.1 Schedule, Format, and Attendance

Two alignment public meetings were held in Pearl City and Aliamanu on November 16 and 17, 1988, respectively. The meetings provided a forum for public review of the preferred alignment(s), the alignment selection criteria, and HECO's proposal to underground the 12 kV distribution lines as part of the project.

The meetings opened with a slide presentation by HECO describing the purpose and need for the project, the routing methodology and description of the location of the preferred alignment and description of the 12 kV distribution line undergrounding proposal. A question and answer period followed the presentation. All questions were recorded on flip charts to ensure that the publics concerns were accurately documented.

A total of 13 people attended the two meetings. Most were people from the community with an interest in the project--one owned a business along the preferred alignment, one was an elected official, and two were from the neighborhood boards.

8.3.2 Summary of Comments

Generally, the comments involved four main issues: undergrounding (both transmission and distribution lines), electromagnetic field effects, reaction of the business community, and the proposed rapid transit system.

Undergrounding. In order to clean up the array of overhead lines along Kam Highway, HECO presented a proposal to underground the 12 kV distribution lines as part of the project. The construction and service connection costs of this option were discussed. Most of the questions that were asked were in reference to this underground option. A few questions arose concerning the possibility of undergrounding the transmission lines (i.e., 138 kV and 46 kV lines), and what the reliability (i.e., repair frequency/maintenance) would be on underground relative to overhead lines.

Electromagnetic Field Effects. One participant was interested in the findings of recent nationally prominent EMF studies and what the EMF values might be along the proposed route. Other participants expressed a general concern regarding EMF and health effects. Another participant asked whether HECO had standards for electromagnetic field strengths (even though no national or state standards exist).

Reaction of Business Community. Several attendees asked whether HECO knew the reaction of the business owners along Kam Highway to the proposal to undergrounding of the 12 kV distribution line. HECO asked whether a joint meeting with the neighborhood board and business owners would be useful to discuss the 12 kV underground proposal. There was support voiced for a joint meeting.

Rapid Transit System. The question was asked whether the preferred alignment of the Waiau-Makalapa No. 2 138 kV Transmission Line would conflict with the proposed Rapid Transit System alignments.

HECO responded that the preferred alignment for the Rapid Transit System is within the median of Salt Lake Boulevard and Kam Highway. As long as this is the case, there should be no conflict with the proposed transmission line because poles will be sited adjacent to the curb and the conductors (wires) will span the stations with adequate safe clearances. HECO noted that it has coordinated its routing study with DTS Rapid Transit System planning staff.

Detailed meeting summaries are included in the Public and Agency Consultation Summaries, Appendix G. They provide a written record of the presentations, questions and answers, public comments, and HECO's responses.

8.4 AGENCY CONSULTATION

8.4.1 Consolidated Application Process/Public Agency Meeting No. 1 (February 5, 1988)

On February 5, 1988, the first Consolidated Application Process (CAP) meeting was held at the State Office of Coastal Zone Management. Eighteen agency personnel participated in the meeting. Through a slide presentation, HECO provided an overview of the project, purpose and need, and routing study methodology and alternative corridors.

The objectives of the CAP meeting were to:

- Brief the agencies on the purpose and need for the Waiau-Makalapa No. 2 138 kV Transmission Line Project.

- Present the corridor alternatives and discuss the constraints and opportunities considered in identifying them.

- Identify specific agency issues and concerns:

  - Compatibility or conflict with jurisdiction or statute

  - Information or policies that could influence corridor acceptability

- Identify criteria or guidelines that agencies feel are important to consider in evaluating and selecting preferred corridors.

- Discuss agency jurisdiction, possible permits, and the permit process.

- Discuss the concept of joint use of existing transportation, utility, and energy corridors as a means of avoiding conflicts with existing and proposed land uses.

- Discuss corridor preferences and identify possible means for minimizing and resolving siting conflicts--land use jurisdiction and policy.

- Identify contact person(s) for followup discussion and additional data collection in later phases of the project.

A summary of agency comments is presented in Table 8.4-1.

8.4.2 Consolidated Application Process/Public Agency Meeting No. 2 (November 29, 1988)

On November 29, 1988, a second Consolidated Application Process meeting was held at the State Office of Coastal Zone Management. Seventeen agency personnel participated in the

Table 8.4-1
SUMMARY OF AGENCY RESPONSES
CAP MEETING FEBRUARY 5, 1988

Agency	Principal Concerns/Comments
Public Utilities Commission	Routing of the new 138 kV line through a residential area would require a public hearing in accordance with HRS 269-27.5.
State Land Use Commission	No action/concerns from LUC unless a land use district designation were to be amended.
Department of Land Utilization (City/County)	Conditional Use Permit (Type 1) would be required for any route selected. A Special Management Area Use Permit (SMA) would be required if the selected route passed through a Special Management Area.
Coastal Zone Management (State)	No action/concerns from CZM unless the project were constructed in the Coastal Zone.
U.S. Fish and Wildlife Service	Concerned with protection of wildlife resources and the National Wildlife Refuge Units in the project area.
U.S. Army Corps of Engineers	Actions that could trigger the Corps' involvement include any dredge or fill actions in wetlands or federal waters or the crossing of any navigable waters by the new line.
State Department of Transportation Highways Division	Avoid crossing or paralleling the H-1 Freeway. DOT policy states that no work would be permitted within freeway rights-of-way.
Harbors Division	Energy corridor may provide an opportunity for siting the line. Work within shoreline waters would require a Shore-waters Permit.
Department of Business and Economic Department	DBED would become involved only if the federal agencies were involved through the Federal Consistency Review Process.
Department of Health (City/County)	Concerned that the routing of the new line avoids schools, playgrounds, and nursery schools.
Department of General Planning (City/County)	Concerned with the necessity of including the proposed project on the Public Facilities Map of the development plan.
Department of Land and Natural Resources (State) (No representative present)	DLNR could become involved if the project crossed Conservation District Lands, historic sites, or any land owned by the state.

meeting. Through a slide presentation, HECO's project team described the preferred alignment. The objectives of the meeting were to:

- Solicit input from the agencies regarding the location of the preferred alignment
- Identify permits, approvals, and reviews that would be required if the line were built in the selected alignment
- Determine the sequencing of the permits
- Determine the necessity of a public hearing for any of the approval processes
- Investigate the possibility of joint public hearings if more than one hearing is required

Each agency representative was asked to provide its agency's concerns and identify required permits or approvals. A complete record of the comments is contained in the Public and Agency Consultation Summaries, Appendix G.

The major conclusions from the meeting were that an SMA Use Permit would be required by the City and County Department of Land Utilization (DLU) and, because the application for an SMA permit must precede all other permits, DLU would become the lead agency for environmental review. DLU would also be responsible for processing the Conditional Use Permit. Through their review, DLU would determine whether an EIS is required and, if so, they would be the lead agency.

Other comments were expressed by the State Department of Transportation, Highways Division, and the City/County Department of Transportation Services (DTS). These agencies stated that more detailed drawings of the project (i.e., pole locations and design specifications) would be required in order to address their specific concerns. The Highways Division expressed concern about adequate conductor/roadway clearances, safety, and the potential traffic congestion during construction at major roadway crossings in several locations along the alignment. DTS expressed a desire to coordinate with HECO to avoid siting conflicts with the proposed Rapid Transit System project.

References, List of Preparers, Glossary and Acronyms

References

REFERENCES

Advisory Council on Historic Preservation. "Memorandum of Agreement" between the U.S. Navy and the Advisory Council on Historic Preservation regarding Pearl Harbor National Historic Landmark. 4 September 1979.

American National Standards Institute. National Electrical Safety Code. ANSI C2-1987: 1987 edition.

Bath, Joyce. Oahu Specialist, Department of Land and Natural Resources. Historic Sites Section. Personal communication, February 1988.

Bauckham, Art. State of Hawaii, Department of Health, Environmental Health Services Division. July 18, 1988.

Bier, James A. Map of O'ahu, the Gathering Place. Reference Maps of the Islands of Hawaii (Revised Edition). University of Hawaii Press.

Bremer, D. The Waipio, Oahu, Christmas Bird Count: 1986. Results and a Review of the First Decade, 1977-1986. 'Elepaio 47(5): 53-58. 1987.

California Drafting Services, Inc. Trail Map for the Island of Oahu. 1975 (revised 1987).

California Public Utilities Commission. Potential Health Effects of Electric and Magnetic Fields from Electric Power Facilities. Report to the California State Legislature. September 1989.

Chevron USA Inc. Photo Map of Pipelines to Honolulu Plant 28. Hawaiian Refinery (14 sheets, scale 1"=800').
City and County of Honolulu, Department of General Planning. "Proposed Amendments to the Primary Urban Center Development Plan 1986-87." December 1986.

__________. "Proposed Amendments to the Primary Urban Center Development Plan, 1987 Annual Review," "Urban Center Development Plan, 1987 Annual Review." July 1987.

__________. "Requests for Amendments to the Land Use Map and Public Facilities Map." July 1987.

__________. "General Plan: Objectives and Policies." 1988.

City and County of Honolulu, Department of Land Utilization. "Land Use Ordinance." October 1986.

__________. Coastal View Study. 1987.

City and County of Honolulu. Revised Ordinances of Honolulu, as amended, Chapter 33: Special Management Area for the City and County of Honolulu.

__________. "Shoreline Setback Rules and Regulations of the City and County of Honolulu." June 1983.

Electric Power Research Institute. Study of Environmental Impact of Underground Electric Transmission systems. May 1975.

Federal Emergency Management Agency (FEMA). Flood Insurance Rate Maps. Revised September 4, 1987.

Harry, Brian. National Park Service, Historic Preservation Section. Personal communication, July 18, 1988.

Hawaiian Electric Company, Inc. Five Year Transmission System Analysis (1988-1992). HECO, Honolulu. March 1988.

__________. "Sales, Peak, and Purchase Power Forecasts," Interoffice Correspondence. HECO, Honolulu. April 18, 1988.

__________. Twenty Year Transmission Study 1988-2007. HECO, Honolulu. March 1988.

__________. Feasibility study of Tri-Island Electric Utility Integration (Maui-Molokai-Lanai). 1987.

__________. Existing Transmission System Map. 1987.

__________. Standard Practice Manual, Section IX Project Management Systems. Agreement with the State of Hawaii Public Utilities Commission for approval to construct a high voltage overhead transmission line through a residential area. 1985.

Hawaiian Independent Refinery, Inc. Hawaiian Independent Refinery, Inc. 10-inch and 12-inch Product Lines. Sheets 9-13 (scale 1"=400' and 1"=200'). 1982.

Historic Preservation Plan. Pearl Harbor Naval Complex Designation as National Historic Landmark. 1964.

Hommon, R., U.S. Navy Archaeologist. Personal communication. February 1988.

Lembeck, Jason. HIRI pipeline consultant. Personal communications. March, April, and May 1988.

McAllister, Gilbert. Archaeology of Oahu. BPBM Bulletin No. 104. 1933.

McCormick, Marshall. Pipeline engineer, Chevron USA, Inc. Personal communications. March and June 1988.

Mimura, Clayton. Engineer, Geolabs Hawaii. Personal communication. 1988.

Pacific Division, Naval Facilities Engineering Command 9PADNAVFACENGCOM). Pearl Harbor Naval Complex Master plan. February 1984.

Power Technologies, Inc. "Technical Appendix to Archer 138 kV Transmission Line Environmental Assessment (HECO)." August 1989.

Quinn, Daniel. State of Hawaii, Department of Land and Natural Resources, Division of State Parks, Outdoor Recreation, and Historic Sites. Personal communication. 3 May 1988.

Shiratori, Bernard. Department of Health, Noise Branch. Personal communication, July 18, 1988.

State of Hawaii, Department of Health, Title II Administrative Rules, Chapter 42, "Vehicular Noise Control for Oahu."

State of Hawaii, Department of Health, Title II Administrative Rules, Chapter 43, "Community Noise Control for Oahu."

State of Hawaii, Department of Health, Title II Administrative Rules, Chapter 59, "Ambient Air Quality Standards."

State of Hawaii, Department of Health, Title II Administrative Rules, Chapter 60, "Air Pollution Control."

State of Hawaii, Department of Land and Natural Resources. Oahu Wells Map. 1988.

__________. Historic Sites Records for Oahu. 1988.

__________. Aiea Bay State Recreation Area Conceptual Master Plan and Draft EIS. 1986.

__________. "State Conservation Lands Functional Plan." July 1984.

State of Hawaii, Department of Planning and Economic Development. Hawaii Coastal Zone Management Program Federal Consistency Procedures Guide. April 1985.

__________. "State Energy Functional Plan." October 1987.

State of Hawaii, Department of Regulatory Agencies. Title VI Public Utilities Commission. General Order No. 6, Rules for Overhead Electric Line Construction. 1969.

__________. Title VI Public Utilities Commission. General Order No. 6, Revised Rules for Overhead Electric Line Construction. 1969.

State of Hawaii, Department of Transportation. Rules Repealing Rules and Regulations Relating to the Accommodation and Installation of Utilities on State Highways and Federal Aid Secondary Highways, and Adopting Chapter 105, Title 19, Administrative Rules. 1981.

__________. "Administrative Rules of Hawaii Governing the Use of Traffic Control Devices at Work Sites on or Adjacent to Public Streets and Highways."

__________. "Specifications for Installation of Miscellaneous Improvements Within State Highways" and "General Notes for Traffic Control Plans." 1984.

__________. Federal-Aid Highway Systems Map. Island of Oahu. Maps 5 and 8 (scale 1:24,000). 1983.

__________. Establishment of Energy Corridor on Oahu, Modified Environmental Impact Statement and Preferred Corridor Alignment Map (scale: 1:48,000). 1971.

State of Hawaii (Territory of Hawaii). Revised Laws of Hawaii. Franchise Agreement Electric Light and Power Between Hawaiian Electric Company, Inc., and the Territory of Hawaii.

State of Hawaii. Hawaii Revised Statutes, Chapter 205, Land Use Commission. Revised 1975.

State of Hawaii. Hawaii Revised Statutes, Chapter 226, The Hawaii State Plan Revised. 1987.

State of Hawaii. Hawaii Revised Statutes, Chapter 343, Environmental Impact Statements. 1983.

Stone and Webster Management Consultants, Inc. "Hawaiian Electric Company Investigation of July 13, 1983 Blackout." February 1984.

Summers and Sterling. Sites of Oahu. 1978.

Tomlinson, M. J. Pile design and Construction Practice Viewpoint Publications: Cement and Concrete Association. London. 1981.

Toups Engineering, Inc. GASCO, Inc., and Hawaiian Independent Refinery, Inc. 16" Gas Pipeline and 10" Gas Pipeline Map. Pearl City to Iwilei (sheet 2). 1987.

United States Council on Environmental Quality, National Environmental Policy Act Regulations, 40 CFR Part 1408.27 (43 FR 55978, November 29, 1978).

U.S. Department of Labor. OSHA Occupational Safety and Health Standards. Federal Register Vol. 37, No. 202.

U.S. Department of Labor, Occupational Safety and Health Administration. "Safety and Health Regulations for Construction." 1972.

U.S. Department of Natural Resources. "State Recreation Functional Plan." December 1985.

U.S. Department of Transportation. "Moanalua Rd. from Pali Momi St. to Aiea Interchange." June 1985.

________. Accommodation and Installation of Utilities on State Highways and Federal Aid Secondary Highways. Title 19, Subtitle 4; Chapter 105. 1981.

U.S. Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways, Part VI--Traffic Control for Highway Construction and Maintenance Operations."

U.S. Fish and Wildlife Service. Hawaiian Waterbirds Recovery Plan. Prepared by the Hawaii Waterbirds Recovery Team, U.S. Fish and Wildlife Service Endangered Species Program, Portland, Oregon. 1978.

U.S. Geological Survey, Water Supply Paper 2300-Hawaii Surface Water Resources. 1984.

U.S. Geological Survey, Water Supply Paper 2300-Hawaii Ground Water Resources. 1984.

List of Preparers

LIST OF PREPARERS

Hawaiian Electric Company Team

Charles Ane, Land Agent, Land and Rights of Way

Patrick A. Calizar, Senior Civil/Structural Engineer, Structural Section, Transmission Systems Division

Andrew Chang, Manager, Government Relations

Kevin Doyle, Director, Government Relations

Jackie M. Erickson, Corporate Counsel

Francis K. Hirakami, Senior Electrical Engineer, Transmission Section

Fred K. Karimoto, Principal Engineer Standards and Applications Division

Nicholas Kashiwabara, Principal Engineer, Transmission Systems Division

Keith K. Kobuke, Project Engineer, Transmission Section, Transmission Systems Division

Harvey Y. C. Lee, Electrical Engineer, Substations and Communications Section, Transmission Systems Division

Ralph H. Moltzau, Jr., Environmental Scientist, Air Monitoring/Noise

Brenner Munger, Manager, Engineering Department

David J. Nagata, Electrical Engineer, System Planning Division

Mary Ellen Nordyke-Grace, Project Manager, Project Management Division, Facilities and Project Management Department

Gary N. Okura, General Superintendent, Distribution Department

Paul N. Oshiro, Senior Electrical Engineer, Transmission, HECO Planning Division, System Planning

Scott Shirai, Senior Communications Representative

Eugene K. Yoshimi, Senior Electrical Engineer, Substation Section, Transmission Systems Division

Robert Young, Electrical Engineer, System Operations

CH2M HILL Team

John M. Everingham, Senior Project Manager, CH2M HILL: Project Manager

Winona Char, President and Principal Biologist, Char and Associates: Biological assessment

Clyde Kanehiro, Cartographer, CH2M HILL: Mapping and graphics

Joseph Kennedy, President, Senior Archaeologist, Archaeological Consultants of Hawaii, Inc.: Cultural resource analysis

Herbert M. Lee, Principal, Lee Communications: Community and government relations, public involvement

Andrew O. Linehan, Environmental Planner, CH2M HILL: Environmental analysis, land use and regulation, environmental permits and policies, principal author

Al Lono Lyman, Planner, CH2M HILL: Regulatory review

Nancy E. Olmstead, Environmental Planner, CH2M HILL: Air, noise, water quality analysis, vegetation and wildlife, principal author

Tom Packard, Planner, EDAW: Visual simulations

Brent Schulz, Planner, CH2M HILL: Land use analysis, mapping and graphics

Marcy S. Schwartz, Senior Planner, CH2M HILL: Public involvement program design, newsletter author

Mike Silva, P.E., Principal, Enertech Consultants: Electric and magnetic field measurements and analysis

Tamara West Smith, Senior Editor, CH2M HILL: Project editor

Bob Wong, P.E., Geolabs, Hawaii, Inc.: Geotechnical analysis

Eric Zigas, Senior Planner, EDAW: Visual simulations and visual impacts analysis

Glossary and Acronyms

GLOSSARY

Access Road	Road extending across private or governmental land from a public road to utility facilities.
Ahupua'a	Land division in traditional Hawaiian culture, usually extending from the uplands to the sea.
Alignment	A strip of land of varying width up to 100 feet in which a transmission line right-of-way could be located; one or more alignments could be located within a single corridor.
Alii	Hawaiian royalty.
Alluvium	Clay, silt, sand, or gravel deposited and/or landforms originated by flowing water courses.
Alternating Current (ac)	An electric current that reverses its direction of flow periodically, as contrasted with direct current (dc).
Aquifer	A water-bearing stratum of permeable rock, sand, or gravel.
Arcing	A discharge of electric current crossing a gap between two electrodes.
Backfill	Earth or other material that has been used to refill a ditch or trench; also, the act of refilling a ditch or trench.
Boring	A hole made by sinking a shaft or tunneling underground.
British Thermal Unit (Btu)	The standard unit for measuring a quantity of heat energy, such as the heat content of fuel; the amount of heat energy necessary to raise the temperature of 1 pound of water 1°F.
Bundled	An assembly of two or more conductors operating in a single phase used as a single conductor.

Cable	Used for underground transmission, consists of an insulated conductor; conductor and insulation are electrostatically shielded and encased in an overall protective jacket.
Cathodic Protection Equipment	Electrical equipment designed to supply a negative voltage to buried cable systems and other lines for protection against corrosion.
Circuit	A configuration of electrically connected devices permitting the flow of an electric current. The term "single circuit" in this report means one 3-phase circuit composed of three conductors, each corresponding to a different phase. Double circuit means two 3-phase circuits. Most often, circuits operate independently of one another.
Combined Cycle Plant	An electric generating plant using one source of energy to drive two types of turbines: a combustion turbine and a steam turbine.
Conductor	A wire or combination of wires suitable for carrying an electric current; the metal employed is usually copper or aluminum.
Dielectric	Material with electrical insulating properties.
Direct Current (dc)	Electricity that flows continuously in one direction, as contrasted with alternating current.
Distribution	The delivery of electrical energy to customers on the distribution system.
Easement	An interest in land owned by another that entitles its holder to a specific limited use or enjoyment. A right to make limited use of another's property.
Electric Fields	An electric field is produced in the area surrounding a conductor (such as a transmission line or cable) when voltage is applied to the conductor. Any electrical

	device, including household appliances and transmission lines, creates electrical fields.
Fluid-Filled Self-Contained Cable	An fluid-impregnated, paper-insulated cable that is encased in a moisture-impervious jacket at the factory and maintained under oil pressure through a hollow core in the conductor (the cable as it comes from the factory needs no additional protective jacket; hence the name self-contained).
Forbs	Vegetative communities consisting of both grasses and herbs, usually low-growing.
Gauss	The most common unit of magnetic field intensity is the Gauss (G), which is a measure of the magnetic flux density (intensity of magnetic field attraction per unit area).
Heiau	Hawaiian temple.
High-Pressure Fluid-Filled (HPFF) Cable	High-pressure, fluid-filled, pipe-type cable system in which three paper-insulated cables are placed in a pipe and pressurized with insulating oil.
Insulation	Material having a high resistance to the flow of electric current; used to prevent leakage of current from a conductor.
Insulator	The device connecting conductors to transmission towers that also insulates the conductors from one another, the tower, or other grounded surfaces. Generally, insulators are porcelain discs that hang in a string and support one or more conductors.
Intermittent	In this document, refers to streams that are dry during nonrainy seasons.
Kilovolt (kV)	1,000 volts.
Kilowatt (kW)	1,000 watts.
Load	The amount of service (e.g., electrical power) delivered to or required at any specified point or points in a system.

	Load originates primarily at customers' energy-consuming equipment.
Magnetic Fields	Magnetic fields occur when electric current flows through a conductor. All electrical devices, including household appliances, create magnetic fields when operated.
Makai	Direction toward the sea.
Manhole	A subsurface structure large enough for a man to enter. Manholes provide an underground location for cable installation and for joining cables. Manholes are usually made of concrete and may be either cast and lowered into an excavation provided in advance. Sometimes called splice vaults.
Mauka	Direction toward the mountains.
Megawatt (MW)	1,000,000 watts.
Peak Load	The maximum demand for electric power that determines the generating capacity required by a utility. More generally, it is the maximum load consumed or produced over a stated period of time.
Perennial	In this document, refers to streams that flow with water throughout the year.
Power (Electric)	The time rate of generating, transferring, or using electric energy, usually expressed in kilowatts.
Pumping Plant	A device used to maintain pressure and sometimes circulate oil in cable systems that use oil as the pressure medium. The plant usually consists of one or more oil pumps (usually driven by an electric motor), oil storage tank, nitrogen storage cylinder, plumbing, control equipment, and housing for the above equipment.
Right-of-Way	A strip of land within which the user has permission to construct and maintain transmission lines as authorized by a written agreement with the property owner.

Splice	The physical connection of two or more conductors to provide electrical continuity.
Splice Vault	See definition for manhole.
Splice, Insulated	A splice with a dielectric medium applied over the connected conductors and adjacent cable insulation.
Substation	An assemblage of equipment for the purpose of switching and/or changing or regulating the voltage of electricity.
Termination	A cable termination is located at the terminal ends of an underground cable system and is usually located above ground. The termination serves to prevent entrance of the external environment into the cable and to maintain the pressure, if any, within the cable system. It also controls, by design, the electrical stresses so that external overhead connections may be made to the cable system, such as at substations and generating plants. Formerly called "pothead." This latter term is being dropped from usage by the latest proposed IEEE standard.
Transition Station	An aboveground installation where a transition is made from an underground or submarine transmission line to an overhead transmission line or vice versa.
Transmission Systems	As distinguished from distribution systems, transmission systems are the backbone or main arteries of a utility's electrical system. Usually, the transmission line between generator plants and substations or between substations does not serve customers. Distribution systems, on the other hand, distribute electrical power to customers, either directly or via stepdown transformers. HECO's transmission lines are 138-kV lines.
VAR Losses	Volt-Ampere Reactive is the basic measure of reactive power. Reactive power is used to maintain system voltage.

Visual Impact	A change in the perception of the visual quality of a landscape resulting from a visible change or modification in the landscape. Visual impact can result from natural ecological changes, such as erosion; development activities, such as buildings or transmission lines; and land management activities, such as timber harvesting and fire breaks.
Volt	The unit of electromotive force or electrical pressure analogous to water pressure in pounds per square inch. It is the electromotive force that, if steadily applied to a circuit having a resistance of 1 ohm, will produce a current of 1 ampere.
Voltage	The electric pressure of a circuit in an electric system measured in volts.

ACRONYMS AND ABBREVIATIONS

ac	Alternating current
AES-BP	Applied Energy Services-Barbers Point
Btu	British Thermal Unit
CEQ	Council on Environmental Quality
CIP	Campbell Industrial Park
CZM	Coastal Zone Management
DBED	Department of Business and Economic Development
dc	Direct current
DLNR	Department of Land and Natural Resources
DLU	Department of Land Utilities
DOT	Department of Transportation
EPRI	Electric Power Research Institute
EQC	Environmental Quality Commission
G	Gauss
H-Power	Honolulu Resource Recovery Venture
HECO	Hawaiian Electric Company, Inc.
HERS	Hawaiian Electric Renewable System
HPFF	High-pressure fluid-filled
Hwy	Highway
KP	Kalaeloa Partners Limited Partnership
kV	Kilovolt
kW	Kilowatt
LPFF	Low-pressure fluid-filled
LUD	Land Use District

MW	Megawatt
NESC	National Electrical Safety Code
OEQC	Office of Environmental Quality Control
PUC	Public Utilities Commission
PWD	Public Works Department
SMA	Special Management Area
USACOE	U.S. Army Corps of Engineers
USDL	U.S. Department of Labor
VAR	Volt-ampere reactive

Appendices

Appendix A
Data Factor Definitions

APPENDIX A

DATA FACTOR DEFINITIONS

HAWAIIAN ELECTRIC COMPANY

CH2M HILL

CONTENTS

1.0 LAND JURISDICTION

1.1 Regional Study

Military Lands - Federally owned lands designated for military operations or reserve. Branches of the military that have jurisdiction over federal land in the Makalapa project area include:

U.S. Navy - U.S. Department of Defense

U.S. Army - U.S. Department of Defense

U.S. Coast Guard - This group is included in this category because of its association with the military. It is, however, a division of the U.S. Department of Transportation.

State, City/County, and Private Lands

State of Hawaii --Lands owned by the State of Hawaii, and administered by the Department of Land and Natural Resources, or the Department of Transportation.

City/County of Honolulu--Lands owned by the City and County of Honolulu.

Private Lands--Lands owned by private individuals, families, businesses, or other non-governmental entities.

1.2 Alignment Evaluation Additional Factors

Hawaiian Electric Company--Land owned by Hawaiian Electric Company (does not include Hawaiian Electric easements).

Bishop Estate--Land owned by Bernice Pauahi Bishop Estate, as determined from the Real Estate Atlas of Hawaii (1988 edition).

Other Private Parcels Less than 5 Acres--Private parcels less than 5 acres in size, as determined from the Real Estate Atlas of Hawaii (1988 Edition).

Other Private Parcels Greater than or Equal to 5 Acres-Parcels each 5 acres or more in size, other than Bishop Estate as determined from the Real Estate Atlas of Hawaii (1988 edition).

2.0 LAND REGULATION

2.1 Regional Study

Conservation--Land designated as Conservation Land Use District by the State of Hawaii Land Use Commission as shown on State Land Use District maps. Conservation Land Use Districts are further divided into General or Resource subzones.

Urban--Land designated as Urban Land Use District by the State of Hawaii, Land Use Commission.

Agriculture--Land designated as Agriculture Land Use District by the State of Hawaii, Land Use Commission.

Special Management Area--Lands designated as the Special Management Area by the City/County Department of Land Utilization pursuant to the State of Hawaii Coastal Zone Management policies.

2.2 Alignment Evaluation Additional Factors

Energy Corridor--Land designated by the State of Hawaii Department of Transportation for the transport of sources of energy by pipelines or other means, pursuant to H.R.S. Chapter 277. The Energy Corridor designated by the State is generally 40 feet wide and runs from the Campbell Industrial Park to central Honolulu. The Energy Corridor was mapped from Energy Corridor Maps of the Department of Transportation, Harbors Division.

National Historic Landmark Boundary--The mauka boundary of Pearl Harbor Naval Base, an historic landmark as established by the State Historic Preservation Office pursuant to the Historic Preservation Act.

3.0 EXISTING LAND USE

3.1 Regional Study

The following definitions draw, in some cases, from the language of the City/County of Honolulu Land Use Ordinance. However, it should be noted that data factors were mapped from actual surface features and therefore do not always conform with City zoning districts.

Residential--Single-family detached residence, duplexes, and other types of low-density cluster or common wall housing apartments. Low density apartment areas for low-rise, low density multi-family residential structures. Medium density apartment areas for mid-rise, medium density multi-family residential structures. High-density apartment areas for high-rise, high-density multi-family residential structures.

Commercial--Commercial areas are principally for business or commercial activities in contrast to other types of economic activities. Limited accessory uses directly related to the principal uses may also be permitted but only on the same lot and not as a principal use.

Industrial--Industrial areas are principally for processing, construction, manufacturing, transportation, wholesaling, storage and similar activities. Accessory or supporting activities that directly enhance the viability of the principal activities may also be included.

Agricultural--Agricultural areas are those areas suitable for crop growing, grazing, and the raising of livestock, flower gardening, nurseries, or similar activities.

Public and Semi-public Facilities--Public and semi-public facilities include those areas designated for general governmental activities; airports, harbors, bus yards, and other terminals; major health care facilities; corporation yards and maintenance yards of public agencies; religious, social and social service institutions; and other public facilities such as fire stations and police stations or training facilities. Some religious facilities may not be included in this category if they are not obvious from local maps or aerial photographs.

Hospitals--These include major health care facilities, including hospitals, clinics and other private or public medical facilities.

Schools--Schools include preschools, kindergartens, elementary, middle, and high schools both private and public. Also included are colleges and university facilities and grounds. Playgrounds and playing fields adjacent to the school yards area also part of this land use category. There are ten schools within the Waiau-Makalapa project area:

- Waimalu Elementary School
- Pearlridge Elementary School
- Our Savior Lutheran School
- Alvah Scott Elementary School
- St. Elizabeth School
- Aiea Elementary SChool
- Makalapa Elementary School
- Radford High School
- Hale Keiki School
- Pearl Harbor Kai Elementary School

Parks and Recreation--These areas include all cemeteries, public parks, and recreational facilities. Beach parks, neighborhood and district parks, botanical gardens, golf courses and pedestrian malls as well as privately owned or operated park and recreational facilities which are provided as integral parts of the development. There are seven parks or recreational areas within the Waiau-Makalapa project area:

- Waimalu Playground
- Blaisdell Park
- Pearlridge Community Park
- Aiea Field Park
- Makalapa Park
- Aloha Stadium
- Bloch Arena

Highway Interchanges--The land required for intersections of major roadways, interstates or highways, including the shoulder and right-of-ways.

Stationary View--Refers to specific locations, such as scenic lookouts or coastal parks, where significant views can be seen by the pedestrian. While pedestrian views can be found from most shoreline areas, stationary views in this study are reserved for long established and recognized viewing points such as the Diamond Head Lookouts, Heeia State Park and Magic Island (Department of Land Utilization, 1987).

Housing (Military)--Military housing includes unaccompanied personnel housing with unit dining, administration, and supply attached. Also includes residential dwellings with detached storage, garages, and laundry buildings.

Supply, Training and Operations/Maintenance (Military)-Training areas include small arms ranges, classrooms and open areas set aside for troop training.

Operational facilities include airfield pavements, helicopter landing pads, liquid fuel and dispensing, airfield communications/navigational aids, land operations facilities, waterfront operations facilities, harbor and coastal facilities.

Maintenance includes vehicle, procured item, and engineering maintenance; ammunition rework and overhaul shops; and other machine and carpentry shops required for operational activities.

Administrative and Community Facilities (Military)--Administrative facilities and community support include post headquarters, Army Headquarters, engineer administration, provost marshal administration, exchange and organizational administration offices, and associated facilities. The community support areas are services that involve commercial activity such as retail shops, commissary, and exchange facilities. Other community services that principally involve personnel support and morale and welfare are the fire station, chapels, drug and alcohol abuse center, post office, child support service center, library, and medical and dental clinics.

Recreation and Conservation Buffer (Military)--Land areas within military lands that provide recreational amenities, scenic qualities, and natural resource value.

3.2 Alignment Evaluation Additional Factors

Energy Corridor--A 40-foot right-of-way administered by the State Department of Transportation for transport of sources of energy by pipelines or by other means pursuant to H.R.S. Chapter 277.

4.0 PROPOSED LAND USE

<u>Planned/Proposed</u>--Refers to the early stages of project planning and development. Projects in this category include those in any stages of planning prior to approval from City Council and other permitting agencies involved in the approval process.

<u>Approved</u>--Projects in this category refer to those that have been through all the necessary environmental and land use approval processes. These projects have been brought before the City Council and approved and most of the permits for construction are in place.

<u>Under Construction</u>--Refers to those projects where groundbreaking has occurred, the construction contracts for all or portions of the project have been negotiated and the contractors have begun construction.

5.0 BIOLOGICAL, GEOLOGICAL, AND WATER RESOURCES

5.1 Regional Study

<u>Koa Haole Scrub</u>--One of the most common vegetation types on undeveloped portions of the project area, koa-haole along with a number of other grass and shrub species forms a closed to open scrub cover.

<u>Wetlands</u>--Found primarily in the Pearl Harbor area, wetlands are characterized by the presence of hydrophytes (i.e. water-loving plant species) such as mangrove, cattails, and bulrush.

<u>Urban - Complex</u>--Includes all those lands under sugar cane and pineapple cultivation, residential, and urban areas, and military lands.

<u>Flood Prone Areas</u>--Any area surrounding the mouth or upper reaches of a stream or waterway that is subject to inundation by a 100-year flood. These areas are identified as special flood hazard areas inundated by 100-year flood on the Flood Insurance Rate Maps, (FEMA).

<u>Open Lined Channel</u>--An artificial watercourse with a definite bed and banks which periodically or continuously contains flowing water. The channel is usually comprised of concrete and serves the purpose of containing any flow to prevent spillage or flooding onto nearby land during high flows.

Springs--Fresh water flows that originate from groundwater deposits. These groundwater sources in the Pearl Harbor area are lens-shaped basal aquifers of fresh water floating on salt water, usually confined by coastal caprock under artisan pressure. This artisan pressure causes the springs to rise when the caprock is cracked or broken.

5.2 Alignment Evaluation Additional Factors

Streams--Any river, creek, slough, or natural watercourse in which water usually flows in a defined bed or channel.

Koolau Basalt (Tkb)--The oldest geologic unit within the project area. It generally consists of interbeded pahoehoe and a'a flows of basaltic lavas and may have a mantle of cobbles and boulders, or residual soil overlying the top of the rock. Various types of volcanic rock sub-components, such as clinker layers and lava tubes, could also be encountered.

Volcanic Tuff (Qht)--This is rock from the vents of the Honolulu Volcanic Series and the second youngest of the natural materials in the project area. The rock consists of volcanic ash which has consolidated or hardened to form medium hard rock called tuff that resembles siltstone or sandstone, locally called "mudrock".

Older Alluvium (Qa)--This geologic formation is the second oldest unit in the stratigraphic column of the project. It consists of terrigenous sediments which have been transported by stream action from the upper reaches of the streams. The materials consist mainly of very stiff to hard brown clayey silts and silty clays.

Man-made Fills (Rf)--Fill materials range from clays to gravels and intermediate mixtures of soils. These consistencies range from soft or loose to hard or very dense. Generally, these fills have been placed over soft sediments in order to make shoreline areas developable.

Recent Alluvium (Ra)--This unit consists mainly of very soft to medium stiff brown to dark gray clayey silt and organic silt with varying amounts of sand and infrequent pockets of gravel and cobbles. These soils are generally a result of sedimentation in a very low energy environment such as a lake or marsh, they accumulate quickly and have a tendency to be unconsolidated. Other soils assigned to this unit include localize thin layers of lagoonal marine sediment.

Mangrove Swamp--Areas of dense stands of mangrove trees (*Rhizophora mangle*).

Non-woody Wetlands--Wetlands areas with various grass and sedge species, cattails, and pickleweed.

Cultivated Wetlands--Wetland areas cultivated for watercress, taro, ung-choi, as well as recently abandoned cultivated wetlands.

6.0 CULTURAL RESOURCES

Unsurveyed Areas with Good Cultural Resources Potential--Areas where there is a good chance that archaeological remains could be found if subsurface investigations were conducted. These areas are determined by the following criteria:

- similar environmental settings in Hawaii have contained a high number of sites and other types of archaeological data
- known ethnographic and ethnohistoric data support the potential for locating subsurface archaeological remains
- shorelines and river/stream beds often have a high frequency of archaeological sites

Unsurveyed Areas with Moderate Cultural Resources Potential-Areas that have not been surveyed; however, previous surveys in similar settings have resulted in a moderate to low frequency of archaeological recovery.

Unsurveyed Areas with Poor Cultural Resources Potential--Areas with a poor likelihood of archaeological recovery. These are areas that have been previously disturbed, or previously surveyed.

National Historic Landmark Boundary--Refers to the mauka limit of the land designated as a National Historic Landmark. In this case, it is the Pearl Harbor Naval Base including most of the waters of Pearl Harbor.

7.0 UTILITIES AND TRANSPORTATION SYSTEMS

Utility System

Power Plant--Refers to one of three fossil fuel fired power generating plants on the island of Oahu: Waiau Power Plant, a 502 MW plant, Kahe Power Plant with 659 MW capacity, and Honolulu Power Plant with 116 MW capacity.

Substation--An assemblage of equipment designed for switching, changing, or regulating the voltage of electricity. This definition does not include service equipment, line transformers, line-transformer installations, or minor distribution or transmission equipment.

138 kV Transmission Lines--The major element of Hawaiian Electric Company's transmission system. These lines have the capacity to transfer 138,000 volts of electricity from the generating source to the substations where the voltage is stepped down to the subtransmission voltage of 46 kV.

46 kV Transmission Lines--The major elements of Hawaiian Electric Company's subtransmission system. These lines carry 46,000 volts of electricity and they are the middle link in the power delivery system between 138 kV transmission lines and 12 kV distribution lines.

Roads and Pipelines

Interstate Routes and Proposed Interstate Route--Multilane freeways that fall under the regulation and administration of the State Department of Transportation and were partially funded by the Federal government. The program of Interstate Highway development was originally established for the purpose of connecting U.S. military bases. For Oahu, they are the Interstate H-1 which runs from Honolulu proper through the Hickam Air Force Base to near the Barber's Point Naval Air Station and H-2, which starts at H-1 near Pearl City and heads mauka to connect the Wheeler Air Force Base. A third route, H-3, is "proposed" to connect the Windward side near Kaneohe Marine Corps Air Station with Honolulu.

State Routes-- Roadways under State of Hawaii Department of Transportation jurisdiction, generally with greater than 50-foot wide rights-of-way.

Major Local Routes--Roadways under the jurisdiction of the City and County of Honolulu, usually with less than a 50-foot wide right-of-way.

Oil/Gas Pipelines--Corridors where existing oil, gas, and other fuel pipelines are buried, generally with 15-to 30-foot wide rights-of-way.

Appendix B
Geotechnical Resources Technical Report

APPENDIX B

INTERIM REPORT
GEOTECHNICAL AND GEOLOGICAL RECONNAISSANCE
WAIAU TO MAKALAPA TRANSMISSION LINE
EWA AND PEARL HARBOR AREAS, OAHU, HAWAII

W.O. 2054-00 MAY 13, 1988

PREPARED FOR

CH2M HILL

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII
2006 KALIHI STREET
HONOLULU, HAWAII 96819

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

May 13, 1988
W.O. 2054-00

CH2M Hill
1585 Kapiolani Blvd., #1312
Honolulu, Hawaii 96814

Attention: Mr. John Everingham
Project Manager

Gentlemen:

INTERIM REPORT
GEOTECHNICAL AND GEOLOGICAL RECONNAISSANCE
WAIAU TO MAKALAPA TRANSMISSION LINE
EWA AND PEARL HARBOR AREAS, OAHU, HAWAII

In accordance with your request, we are submitting herewith our preliminary report on our geotechnical and geological reconnaissance of the subject portion of the Campbell Industrial Park to Waiau and Waiau to Makalapa Transmission Line Project.

PROJECT CONSIDERATIONS

It is proposed to construct new transmission lines from the Campbell Industrial Park Substation to the Waiau Generating Station and continue on to the Makalapa Substation. Preferred corridors for the transmission lines were defined by others in the initial planning stages of the project.

The transmission lines will be a single and/or double circuit 138 kV above-ground system with the transmission cables supported by and suspended between metal poles. Due to the relatively large moments on the poles, it is anticipated that some form of pier or pile foundation will be required.

This preliminary report is solely for the Waiau to Makalapa portion of the project and will be incorporated into the overall project report when the routing of the Campbell Industrial Park to Waiau portion is resolved.

PURPOSE AND SCOPE

The purpose of our reconnaissance was to map and provide a preliminary assessment of geologic and near-surface soil conditions within the proposed transmission line corridors to provide preliminary geotechnical data for the foundation design and evaluation of the feasibility of power line construction. Special emphasis was placed on potential geotechnical hazards which may impact the transmission line siting and design including but not limited to:

1. soft ground conditions;
2. artesian groundwater conditions and/or seepage; and
3. preliminary foundation bearing conditions.

To date, the scope of our work on this portion of the project has included the following work efforts:

1. A review of the available soils and geological literature, maps and soils reports (published and unpublished) pertinent to the proposed corridors and their vicinity.
2. Preliminary interpretation of the anticipated soils conditions as they may affect the proposed transmission line foundation design and foundation construction.
3. Preparation of this interim report.

General Site Description

The preferred corridor for the Waiau to Makalapa portion is a band paralleling Kamehameha Highway between the Waiau generating station and the Hickam-Pearl Harbor Interchange of Interstate Route H-1. From the Waiau station to the vicinity of Aloha Stadium, this band may be roughly defined as the area between the shoreline of the East Loch of Pearl Harbor and about 750 feet mauka of Kamehameha Highway. At Aloha Stadium, the corridor splits into two routes which encircle the naval reservation in Makalapa Crater. The eastern route is a relatively narrow band along Salt Lake Boulevard. The western route is a broader band along Kamehameha Highway which circles around the southern side of Makalapa Crater.

The topographic relief along the proposed corridor generally is low and gentle with a few sharp changes of relief. Most of the land along the proposed corridor is urban and/or suburban and has been developed for recreational, residential, commercial and military uses.

Regional Geology

The island of Oahu is composed largely of the weathered remnants of two extinct shield volcanoes - Waianae and Koolau. The older volcano, Waianae, forms the bulk of the western third of the island while the younger shield, Koolau, forms the majority of the eastern two-thirds of the island. Waianae became extinct while Koolau was still active and its eastern flank is partially buried below Koolau lavas in central Oahu.

The Waiau to Makalapa corridor is located on the southwest flank of Koolau and its geomorphology and subsurface conditions are directly related to the genesis of Pearl Harbor. The stratigraphic history of Pearl Harbor is quite complex due to its large areal extent, the number of streams, drainageways and springs entering it and a complex series of sea level fluctuations influencing erosional and depositional processes in the area. The base of the stratigraphic profile along the Waiau to Makalapa corridor is Koolau Basalt.

The Koolau volcanic shield was built during the late Pliocene and early Pleistocene by thin bedded basaltic lava flows. The main shield-building activity ceased approximately 2.5 million years ago. Evidence from drilled wells indicates that the island of Oahu has subsided as much as 1200 feet since the cessation of this early volcanic activity (Macdonald and Abbott, 1970).

During that period of subsidence, coral-algal reefs began to grow on the southern coast of Oahu forming a broad bay with a barrier reef across its mouth. The growth of the reef essentially kept pace with the rate of subsidence. A series of lagoons formed behind the barrier reef and both terrigenous and marine sediments accumulated in the lagoons (Macdonald and Abbott, 1970).

During the Pleistocene (Ice Age), there were many sea level changes as a result of widespread glaciation in the continental areas of the world. As the great continental glaciers accumulated, the level of the ocean fell since there was less water available to fill the oceanic basins. Conversely, as the glaciers receded, or melted, global sea levels rose because more water was available. The land mass of Oahu remained essentially stable during these changes and the fluctuations were eustatic in nature. These glacio-eustatic fluctuations resulted in stands of the sea which were both higher and lower relative to present sea level on Oahu.

The higher sea level stands caused the accumulation of deltas and fans of terrigenous sediments in the head of the old bay, accumulation of reef deposits at corresponding higher elevations and lagoonal/marine sediments in the quiet waters protected by fringing reefs.

The concurrent growth of reefs and lagoonal sediments may have also resulted in deposits of coral/algal limestone and marls within the predominantly lagoonal sedimentary unit.

The lower sea stands caused streams to carve valleys in the sediments and reef deposits. Subaerial exposure of the sediments and calcareous materials caused consolidation of the soft deltaic materials and lagoonal deposits and induration of the calcareous reef materials. In addition, renewed subaerial erosion of upper areas of the volcanic dome deposited terrigenous alluvial soils under relatively high energy conditions.

During periods of no significant sea level changes, continued stream action extended the alluvial deltas and fans seaward and deposited alluvium over the lagoonal sediments.

The geologic history of the Pearl Harbor area has been further complicated by the deposition of recent pyroclastic materials from explosive eruptions of the vents of the Aliamanu-Salt Lake-Makalapa members of the Honolulu Volcanic Series. These post-erosional, i.e., following the cessation of shield building, events were contemporaneous with the Pleistocene sea level fluctuations.

The eruptions were rather explosive in nature owing to the interaction of groundwater with the rising magma resulting in steam explosions which expelled large quantities of pyroclastic material - predominantly ash and cinder. These deposits of pyroclastics have consolidated to form volcanic tuff, locally referred to as "mudrock". The oldest of these eruptions, Aliamanu, caused a diversion of Halawa Stream to the north of its original location into the area of what are now the Southeast and Magazine Lochs of Pearl Harbor during the Kaena (+95 feet) high stand of the sea.

The remaining two events, Salt Lake and Makalapa, were essentially simultaneous and have been assigned to the stand of the sea which was at between 40 and 60 feet below the present sea level.

Those last two eruptions caused further diversion of Halawa Stream to its current location and deposited a mantle of tuff over much of the eastern and southeastern parts of the Waiau to Makalapa portion of the project.

About 15,000 years ago, a relatively rapid rise in sea level occurred. During that rise, the deep valleys in the Pearl Harbor area were drowned. In the last 10,000 years or so, sea level has adjusted to its present stand. Terrigenous and marine sediments have continued to accumulate in the low-energy estuarine or lagoonal environment of Pearl Harbor resulting in thick deposits of soft harbor sediments along the coast in the areas which were formerly valleys and drainageways.

Land development and reclamation projects within the last 100 years have brought the Pearl Harbor area to its present form. A great many of those projects were done for agricultural, residential and/or military development. Many of the resulting fills are of poor quality in terms of supporting large structural loads.

Subsurface Conditions

The research conducted for the project indicates that the subsurface materials consisted mainly of thick alluvial and lagoonal soil deposits that are underlain by Koolau basalt rock.

These alluvial and lagoonal soils can be grouped into several major stratigraphic units. The engineering characteristics of these units appear to be reasonably consistent for design purposes. These soil units were used on the maps and the body of this report and are identified as follows:

1. Koolau Basalt (Tkb)
2. Older Alluvium (Qa)

3. Coral-Algal Deposits (Qls)

4. Volcanic Tuff (Qht)

5. Recent Alluvium (Ra)

6. Man-Made Fills (Rf)

Detailed descriptions and discussions of the major stratigraphic units are presented in the following sections.

1. Koolau Basalt (Tkb)

The Koolau basalt is the oldest geologic unit within the project area. It generally consists of interbedded pahoehoe and a'a flows of basaltic lavas and may have a mantle of cobbles and boulders, or residual soil overlying the top of the rock.

It is anticipated that various types of volcanic rock sub-components, such as clinker layers and lava tubes, could also be encountered.

The Koolau basalt is the aquifer material of the Pearl Harbor Artesian Basin, which is one of the major developed groundwater bodies supplying fresh water for the island of Oahu.

The aquifer is the permeable lava rock while the upper confining member (caprock) is the relatively impermeable alluvial and lagoonal deposits. There is no lower confining member as is the usual case in most aquifer. At the bottom, the fresh water level is confined by salt water according to the Ghyben-Herzberg Principle which is based on observations that fresh groundwater floats on saline groundwater in coastal regions. The ratio of densities between fresh and salt water causes the salt water to be displaced downward about 40 feet below sea level for every foot that the fresh basal water table or potentiometric head rises above sea level.

Structurally, the Koolau basalt and its residual soils is the strongest of all the units encountered within the study area. However, its use for foundation support in many parts of the project area is severely limited by the considerable depths to reach the top of the basalt and the artesian conditions expected where the basalt is encountered at relatively low elevations. These conditions could increase the difficulty in construction and consequently project costs. Although the potential impact of breaching the caprock seal may only be a temporary condition, the long-term effects would have to be studied further.

2. <u>Older Alluvium (Oa)</u>

The older alluvium is assigned the position of being the second oldest unit in the stratigraphic column of the project area even though some of the coral-algal reef deposits may be intercalated with the alluvial deposits.

This unit generally overlies the Koolau basalt and consists of terrigenous sediments which have been transported by stream action from the upper reaches of the streams. The materials consist mainly of very stiff to hard brown clayey silts and silty clays. Gravel lenses representing buried stream channels are sometimes encountered. Portions of the older alluvium unit contain some weathered basalt boulders and cobbles. These coarse grained parts of the unit may also contain artesian water of the basal fresh water system or as a sub-aquifer.

The old lagoonal deposits of the older alluvium unit consist of marine or lagoonal sediments which have been desiccated and consolidated into very stiff to hard gray clayey silts.

The old lagoonal deposits consist almost exclusively of clayey silts of rather uniform texture and grain size, with occasional shell fragments.

Structurally, the older alluvium materials are considered to be sufficiently competent to support relatively large structural loads with proper design.

3. <u>Coral-Algal Deposits (Qls)</u>
This unit consists of fossil remnants of coral-algal reefs and their related detrital debris deposits. In Hawaii, the detrital deposits tend to be the dominant portion of any coral rock assemblage.

The detrital deposits are weakly to strongly cemented coral debris consisting of gravel, sand and silt sized clastic fragments. Some of the coral fragments were dissolved and the solution cavities filled with cemented and/or uncemented fine sands and silts.

Structurally, the coral-algal reef deposits are capable of supporting heavy foundation loads.

4. <u>Volcanic Tuff (Qht)</u>
Rocks from vents of the Honolulu Volcanic Series are the second youngest of the natural materials in the project area. They consist of volcanic ash which has consolidated or hardened to form a medium hard rock called tuff that resembles siltstone or sandstone, locally called "mudrock". As previously discussed, the tuff originated from volcanic vents in the Salt Lake-Aliamanu-Makalapa area; and, its occurrence is generally limited to that area. The tuff is usually found overlying coralline deposits or alluvium units.

Structurally, the tuff is very competent and capable of supporting heavy foundation loads on either spread foundations or end-bearing piles. However, the tuff tends to thin out towards the west, from the Salt Lake-Foster Village area towards Aiea Bay and the Northeast Loch of Pearl Harbor. Therefore, the tuff may be relatively thin or missing in portions of the project area in the vicinity of Aloha Stadium and the Arizona Memorial.

5. Recent Alluvium (Ra)

The recent alluvium consists mainly of very soft to medium stiff, brown to dark gray clayey silt and organic silt with varying amounts of sand and infrequent pockets of gravel and cobbles.

These soils are generally the result of sedimentation in a very low energy environment such as a lake or marsh. Frequently, these soils assigned to this unit accumulated very rapidly under water and have never been exposed. Therefore, there is a tendency to encounter underconsolidated sediments which are settling under their own weight or the weight of a minimal overburden.

Included in this unit are subunits of localized thin layers (about 10 feet) of lagoonal marine sediments consisting mostly of very soft to medium stiff gray clayey silts. These gray silts are identified as lagoonal facies subunits of the young alluvial unit. It is also possible that these lagoonal facies reflect a brief stand of the sea at each corresponding level.

The soils assigned to this unit are generally considered to be poorly to very poorly suited for use as support for foundation loads.

6. Man-Made Fills (Rf)
These fills were generally placed over the soft sediments for development along the shoreline areas. The fill materials range from clays to gravels and intermediate mixtures of soils. The consistencies range from soft or loose to hard or very dense.

The capability of these man-made fills to support structural loads is largely dependent upon the design and quality of the fill and its placement. Quite frequently, these fills were only intended to support very lightly loaded structures on shallow spread footings; and, therefore, only form a thin crust over the soft Recent Alluvium materials.

Foundation Support

Pier Foundation

In general, we anticipate that conventional pier foundations may be used to support the proposed transmission line poles in the areas mapped as Koolau Basalt, Older Alluvium, Coralline Deposits and Volcanic Tuff. Depending upon site-specific conditions, it may be possible to reduce the size and embedment of the piers in some locations where very competent basalt, coral or tuff is encountered at shallow depths.

Due to high lateral load and overturning moment requirements anticipated for the design of the proposed transmission line poles, we generally believe that large diameter drilled piers should be used.

The vertical load capacity of the drilled pier would be derived mainly from end bearing on the generally competent soil or rock, and partly from the frictional resistance between the shaft of the pier and the soils or rocks.

Lateral resistance of the drilled pier would be derived from the horizontal subgrade resistance of the generally competent soils or rocks.

Based on this general assumption of subsurface soil or rock conditions, we estimate that drilled piers of 2 to 4 feet diameter may be used and the piers should generally penetrate a minimum of about 20 feet into the existing ground in order to generate sufficient resistance to fulfill the above mentioned loading requirements with an adequate factor of safety.

In light of the inherent uncertainty in actual subsoil conditions for this project without field exploration, the drilled pier construction should be closely monitored by the geotechnical engineer in order to see that adequate foundation support is achieved. Additionally, detailed field exploration should be performed to better define subsoil conditions and parameters.

Since a significant portion of the load capacity would come from the frictional resistance between the shaft and the in-situ soils or rocks, extra care should be applied to the drilling of the pier hole, selection of concrete mix design and the placement of concrete.

Drilling fluids should be avoided as much as practical, as they may saturate and weaken the subsoil or rock. The holes should be advanced by auger drilling or bit chopping or cutting.

Prompt placement of concrete in the prepared hole, as soon as it is completed, is recommended to reduce probable caving in of the hole in occasional soft or loose areas. The concrete mix should be designed to minimize shrinkage in order to maintain high frictional contact value between the in-situ soil/rock and pier concrete. The concrete should be placed in a suitable manner to avoid segregation of the aggregates.

Pile Foundation

In the areas mapped as Recent Alluvium and in most areas mapped as Man-made Fill, we anticipate that deep pile foundation systems will be required to support the transmission line poles. Based upon our research, we anticipate that in many of these areas, bearing strata will be encountered at depths ranging from about 50 to 150 feet below the existing ground surface. It is our opinion that the depths to bearing are generally the greatest on the makai side of Kamehameha Highway.

To resist the anticipated high loading requirements with pile foundations, we believe that piles should be used in a group. The piles should be spaced apart adequately to minimize reduction in soil strength due to pile group effect and a rigid pile cap should be provided to reduce the lateral movement of the pile group under the design lateral load.

Ideally, the piles would develop their vertical load capacity primarily from end bearing on the competent bearing strata generally at great depths. However, it is our opinion that, where the bearing strata is very deep, the piles may be driven to a sufficient depth and would derive their vertical load capacity primarily from adhesion between the piles and the loose/or soft subsoils.

Lateral capacity of the piles would be derived from the horizontal subgrade resistance of the loose or soft upper subsoils.

Based on this general assumption of subsoil conditions, we estimate that a minimum of four (4) to six (6) pile group of sixteen-and-a-half-inch octagonal prestressed concrete piles may be used at each bore location. It is our opinion that the piles should penetrate to the bearing strata or extend to a minimum depth of about 100 feet below the existing ground surface in order to generate sufficient resistance to fulfill the above-mentioned loading requirements with an adequate factor of safety.

A detailed field exploration should be performed to define subsoil conditions and parameters on a site specific basis prior to final pile foundation design.

Anticipated Surface Conditions

Critical surface conditions are identified as those areas where the surface soils may have insufficient strength to support the loads of heavy construction equipment such as pile driving cranes or caisson drilling rigs. In these areas, it may be necessary to construct a stable working platform for such equipment. This platform may be temporary for construction only or may be a permanent improvement for maintenance purposes.

The construction of the working platform will have a significant effect on the design and cost of the project. The construction of the working platform will include a filter fabric and gravel stabilization layer over the soft ground (see Plate 2). Additionally, the weight of the new fill will cause ground settlements which may induce downdrag forces on the piles, thereby reducing the allowable load carrying capacity.

Stabilization of the ground surface may be needed in these areas to allow access for heavy equipment. If stabilization is required, existing underground utilities should be located. It should be determined whether the stabilization may have potential impacts on any of these buried utilities.

Based on our research, most of the areas along the Waiau to Makalapa corridor are relatively well developed for urban or military use. In these developed areas, we do not anticipate the occurrence of weak surface soils. However, the following areas may have weak surface soils:

1. The coastline proper, and a zone extending about 100 to 200 feet mauka of the water edge running from Waiau Power to McGrew Point.

2. The area makai of Kamehameha Highway at the mouth of Aiea Stream.

Design Review

Plans and specifications for the proposed construction should be forwarded to the geotechnical engineer for review and written comment prior to construction. This review is needed to determine adherence to the earth work and foundation recommendations given herein. If this review is not made, the geotechnical engineer can assume no responsibility for misinterpretation of the recommendations.

Additional Exploration

This reconnaissance was performed on the basis of a literature search and review of available soils/geologic data information relevant to the proposed transmission line alignment. The discussions and recommendations presented in this report are general in nature and as such should not be considered adequate for final design.

We strongly recommend that a full-scale geotechnical exploration, including borings, field and laboratory testing, be developed and implemented prior to the final design stage of the subject project. The recommendations presented herein are contingent upon the performance of such an exploration by the geotechnical engineer.

LIMITATIONS

The analyses and recommendations submitted in this report are based in part upon information obtained from research of available literature and data. Variations of conditions may occur; and the nature and extent of these variations may not become evident until construction or until a detailed field exploration is performed. If variations then appear evident, it will be necessary to re-evaluate the recommendations given in this report.

This report has been prepared for the exclusive use of CH2M Hill, Inc. for specific application to the Campbell Industrial Park to Waiau and Waiau to Makalapa Transmission Line Project in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

This report has been prepared solely for the purpose of assisting the architect/engineer in the preliminary design evaluation of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, for use in contract bid estimation. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers or cavities, may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, sufficient contingency fund is thus recommended to accommodate these possible extra costs.

The following plates and appendices are attached and complete this report:

Plate 1	-	Project Location Map
Plate 2	-	Stabilization Detail
Plates 3 and 4	-	Soils/Geologic Maps

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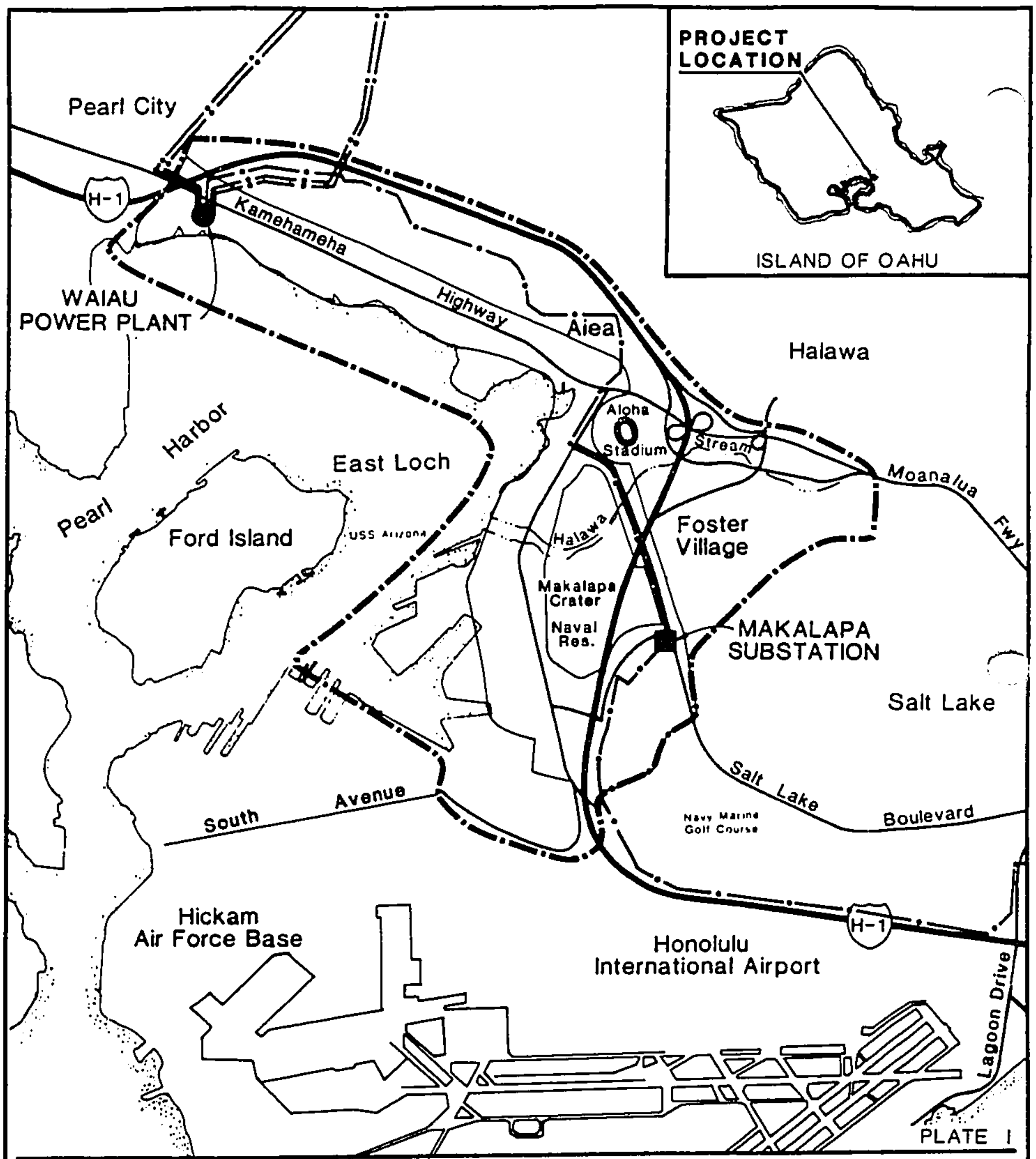
Respectfully submitted,

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII

By Clayton S. Mimura
Clayton S. Mimura, P.E.

CSM:DEF:lf

CLAYTON S. MIMURA
REGISTERED PROFESSIONAL ENGINEER
No. 4176
HAWAII, U.S.A.



LEGEND

Study Area Boundary — Existing 138kV Transmission Line — Power Plant — Substation

STUDY AREA LOCATION

0 1/4 1/2
MILES

Waiau – Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
CH2M HILL

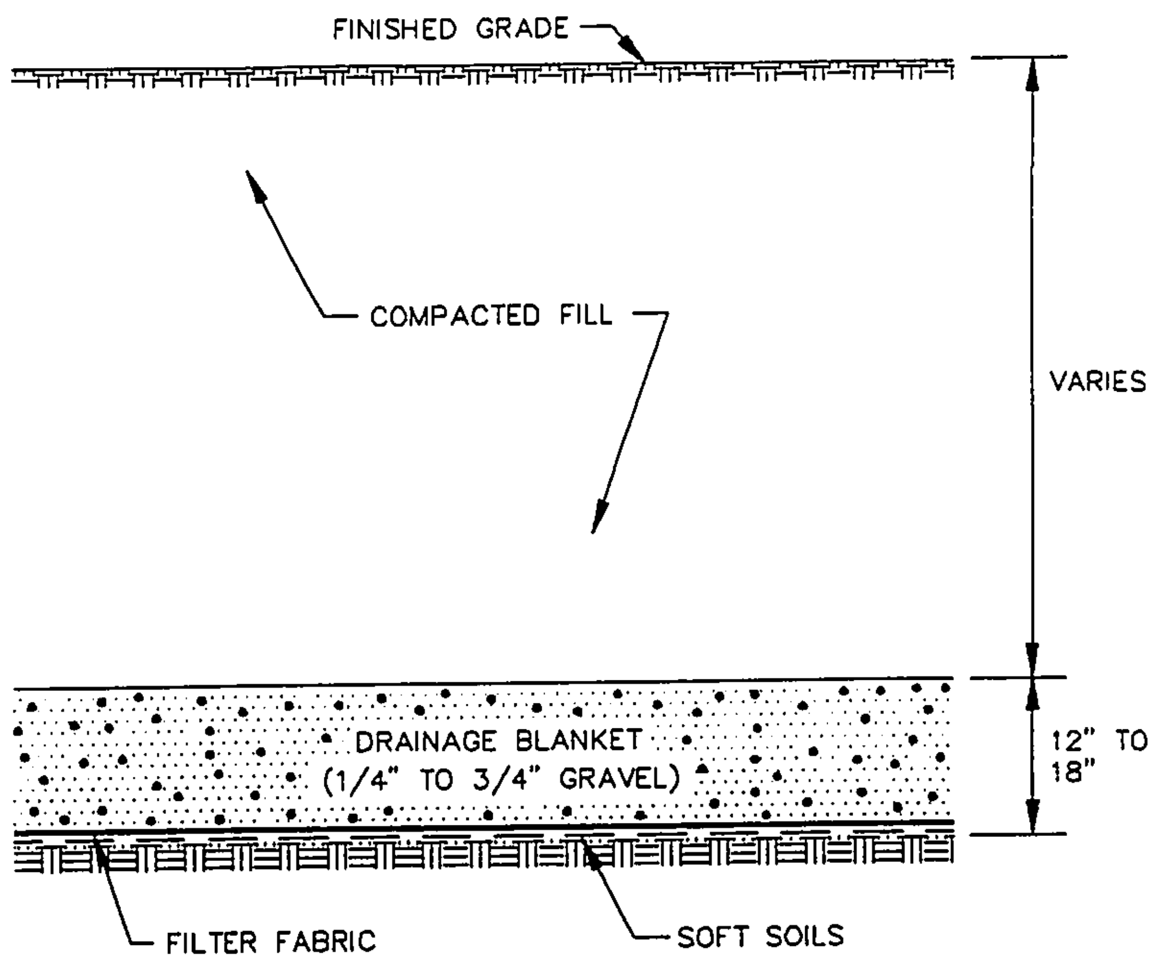


PLATE 2

TYPICAL STABILIZATION LAYER

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DATE JUNE 1988 | W.O. 2054-00

NOT TO SCALE

Appendix C
Effects of Electric and Magnetic Fields Technical Report

Appendix C
EFFECTS OF ELECTRIC AND MAGNETIC FIELDS

TECHNICAL REPORT

for

WAIAU-MAKALAPA NO. 2
138 kV TRANSMISSION LINE PROJECT

Prepared for
HAWAIIAN ELECTRIC COMPANY, INC.

Prepared by
ENERTECH CONSULTANTS

November 1989

PDX396.059.50

ELECTRIC AND MAGNETIC FIELDS
WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE

1. Introduction

Overhead transmission lines are a vital part of the system that provides electric service to homes and businesses in Hawaii. In recent years, interest has grown concerning potential environmental effects that may be associated with transmission lines--in particular, potential health effects of electric and magnetic fields (EMF). Because the issues are technically complex, the following information paper has been prepared to explain the issues in less technical terms.

Transmission line classification and electric and magnetic field generation and calculation are described. Predicted fields from the Waiau-Makalapa No. 2 138 kV Transmission Line are compared with fields from other transmission lines and sources. Current knowledge about EMF health effects is reviewed. Regulatory standards that have been developed in other states are described as they apply to field strengths at the edges of powerline rights-of-way. Finally, potential effects of transmission lines on radio and television reception, cardiac pacemakers, and ozone levels are discussed.

2. Transmission Line Voltage Classifications

The high-voltage transmission or bulk power lines form the backbone of the electric energy distribution system. The first long transmission line in the U.S. was built in Colorado to serve the Gold King Mine. The line operated at 40 kilovolts (kV) (or, 40,000 volts) and was placed in service in 1891. As the demand for power has increased, so has the transmission line operating voltage. Higher operating voltages are used to reduce electric losses and thereby provide more economical delivery of power.

Today, a network of about 332,000 circuit miles of transmission lines are in service in the United States. All transmission lines in the HECO system are operated at 138 kV, which is the highest voltage classification used in Hawaii. The proposed Waiau-Makalapa No. 2 line will also be operated at 138 kV. This voltage is in the lowest voltage classification for transmission lines in operation in the mainland United States, where lines range up to 765 kV.

Table 1 summarizes the circuit-miles of electric transmission lines of different voltage classifications in service in the United States. On Oahu, HECO operates 170 circuit-

Table 1
TRANSMISSION LINE CIRCUIT MILES
IN SERVICE IN THE UNITED STATES

Voltage Classification (kV)	Circuit Miles in Service
115 to 161	190,548
230	69,706
345	46,680
500	23,279
765	2,428
Total	332,641

Sources: North America Reliability Council (1988) and National Electrical Manufacturers Association (1986).

miles of 138 kV lines, 665 circuit-miles of 46 kV subtransmission lines, and 3,000 miles of 12 kV and 4 kV lines and feeders.

3. Electric Fields

Definition and Description

Electric fields are a result of the voltage or potential (electrical pressure) on an object. Any object with an electric charge on it has a voltage at its surface caused by the accumulation of more electrons on that surface compared with another object or surface. The voltage effect is not limited to the surface but exists in the space surrounding the object. The change in voltage over distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). This means that a difference in electrical potential or voltage exists between two points one meter apart. The electric field becomes stronger near a charged object and decreases rapidly with distance from an object.

Electric fields are a common phenomenon. Static electric fields can result from taking off a sweater or walking across a carpet. Body voltages have been measured as high as 16,000 volts as a result of walking on a carpet (Chakravarti and Pontrelli, 1976). The earth creates a natural static field in fair weather of about 150 V/m at ground level because of the 300 to 400,000-volt potential between the ionosphere and the earth (Veimeister, 1972; and National Research Council [NRC], 1986). This means that a 6-foot-tall person would have a static potential of about 275 volts between the top and bottom of the body.

The normal fair weather static electric field of the earth varies from month to month, reaching a maximum of about 20 percent above normal in January, when the earth is closest to the sun, and falling to about 20 percent below normal by July, when the earth is farthest from the sun. Much stronger static electric potentials can exist underneath clouds in thunderstorms, where the electric potential with respect to earth can reach 10 to 100 million volts before being discharged as lightning. Natural static electric fields under clouds and in dust storms can reach 3 to 10 kV/m (NRC, 1986; and CRC Press, 1981).

Most household appliances and other devices that operate on electricity create electric fields. The electric field is a result of the voltage on the appliance and decreases rapidly with distance. The fields that result from point source household appliances generally decrease more rapidly with distance than fields from line sources such as power lines. Appliances need not be in operation to create an electric field. An electric field occurs whenever an appliance is connected to an electrical outlet. Typical values measured 1 foot from some common appliances are shown in Table 2.

Table 2
TYPICAL ELECTRIC FIELD VALUES FOR HOUSEHOLD APPLIANCES
(at 12 inches)

Appliance	Electric Field Kilovolts/meter
Electric blanket	0.25*
Broiler	0.13
Stereo	0.09
Refrigerator	0.06
Iron	0.06
Hand mixer	0.05
Phonograph	0.04
Coffee pot	0.03

*1 to 10 kV/m next to blanket wires (Enertech Consultants, 1985).

Source: Carstensen, 1985.

Electric field values were calculated for normal, everyday line loadings for both existing conditions (i.e., existing 46 kV and/or 12 kV lines) and for the proposed line. Because the configuration of the proposed line differs somewhat along the route (as illustrated in diagrams at the end of this technical report), three sets of field values were calculated (Figures 1 to 3). Between the Waiau Power Plant and McGrew Point, there will be a vertical array of three

138 kV conductors above a vertical array of three 46 kV conductors. Between Aloha Stadium and Radford Drive, the configuration will be similar, except that below the 46 kV conductors there will be a horizontal array of 12 kV distribution line conductors. Between Radford Drive and Makalapa Substation, the new line will consist of a vertical array of three 138 kV conductors only. These different line configurations will produce different field strengths. Figures 1 and 2 show typical existing field strengths for two locations along the existing 46 kV and/or 12 kV lines. The figures also show two sets of field values for the proposed line. The graphic depiction of "Proposed: Standard Phasing" in these figures illustrates the estimated field values near the proposed line if standard conductor installation were used.

Where 138 kV lines are installed on the same pole as lower voltage lines, some arrangements of conductors ("low-reactance phasing") can reduce field strengths because the interaction of the different phases can reduce some field strengths (Figure 4 illustrates low-reactance phasing). In Figures 1 and 2, "Proposed: Low Reactance Phasing" illustrates estimated electric field values for the proposed line using low-reactance phasing. HECO proposes to use low-reactance phasing where possible in locations where the 138 kV line will share poles with lower voltage conductors.

Figure 3 illustrates the electric field at a location between Radford Drive and Makalapa Substation where there is not currently a lower voltage line and, therefore, there is no opportunity to use low-reactance phasing.

As Figures 1 to 3 illustrate, the electric field for the proposed Waiau-Makalapa No. 2 138 kV transmission line will be about 0.4 to 1.8 kV/m directly under the conductors near midspan (assuming standard phasing). Field strengths would decline to about 0.07 to 1.2 kV/m within 20 feet to the right or left of the centerline (as defined by pole placement). The maximum electric field reported in the lateral profiles occurs in a relatively small area (about 5 percent of total area) near midspan, and near the location where the conductors sag closest to the ground.

If, as proposed, low-reactance phasing is employed for the alignments along Kam Highway (where both existing 46 kV conductors and the proposed 138 kV conductors will share the same poles), electric field strengths under the conductors near midspan would be approximately 0.05 to 0.15 kV/m, and

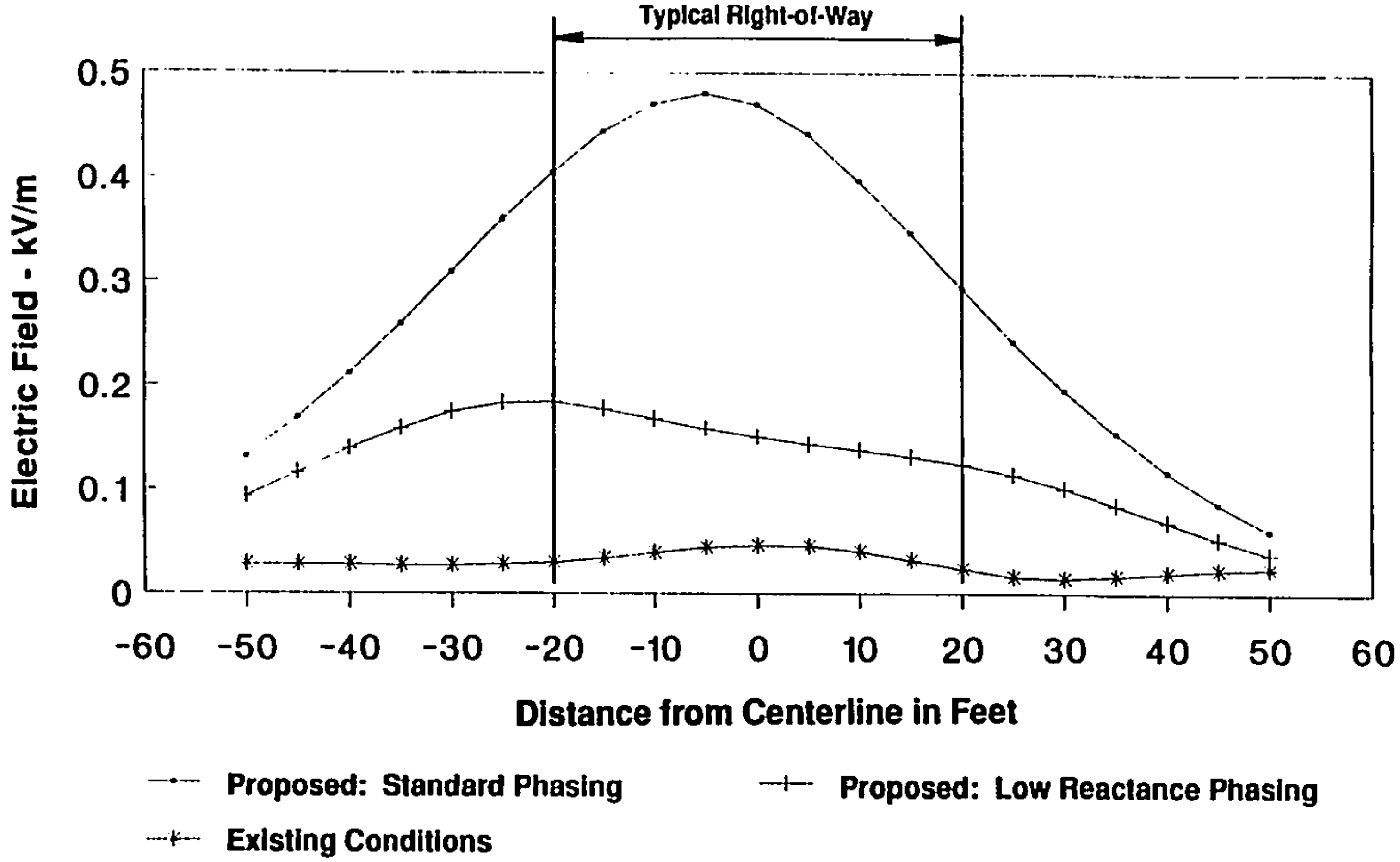


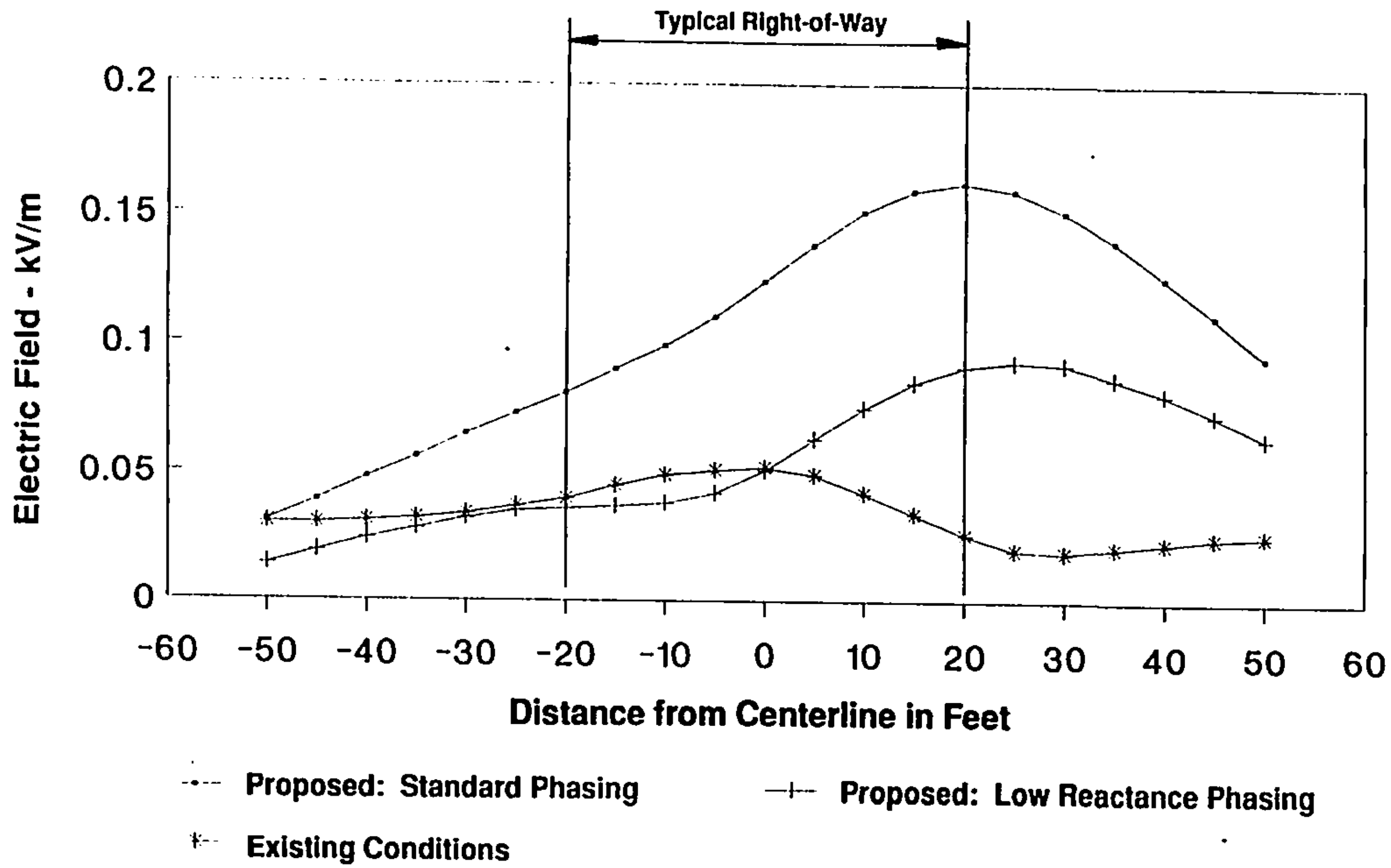
FIGURE 1

ELECTRIC FIELD LATERAL PROFILE CASE NO. 1: WAIAU-MCGREW POINT

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL



NOTE: Existing configuration is 46 kV and 12 kV
Proposed configuration is 138 kV, 46 kV, and 12 kV

FIGURE 2

ELECTRIC FIELD LATERAL PROFILE CASE NO. 2: ALOHA STADIUM-RADFORD DR.

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

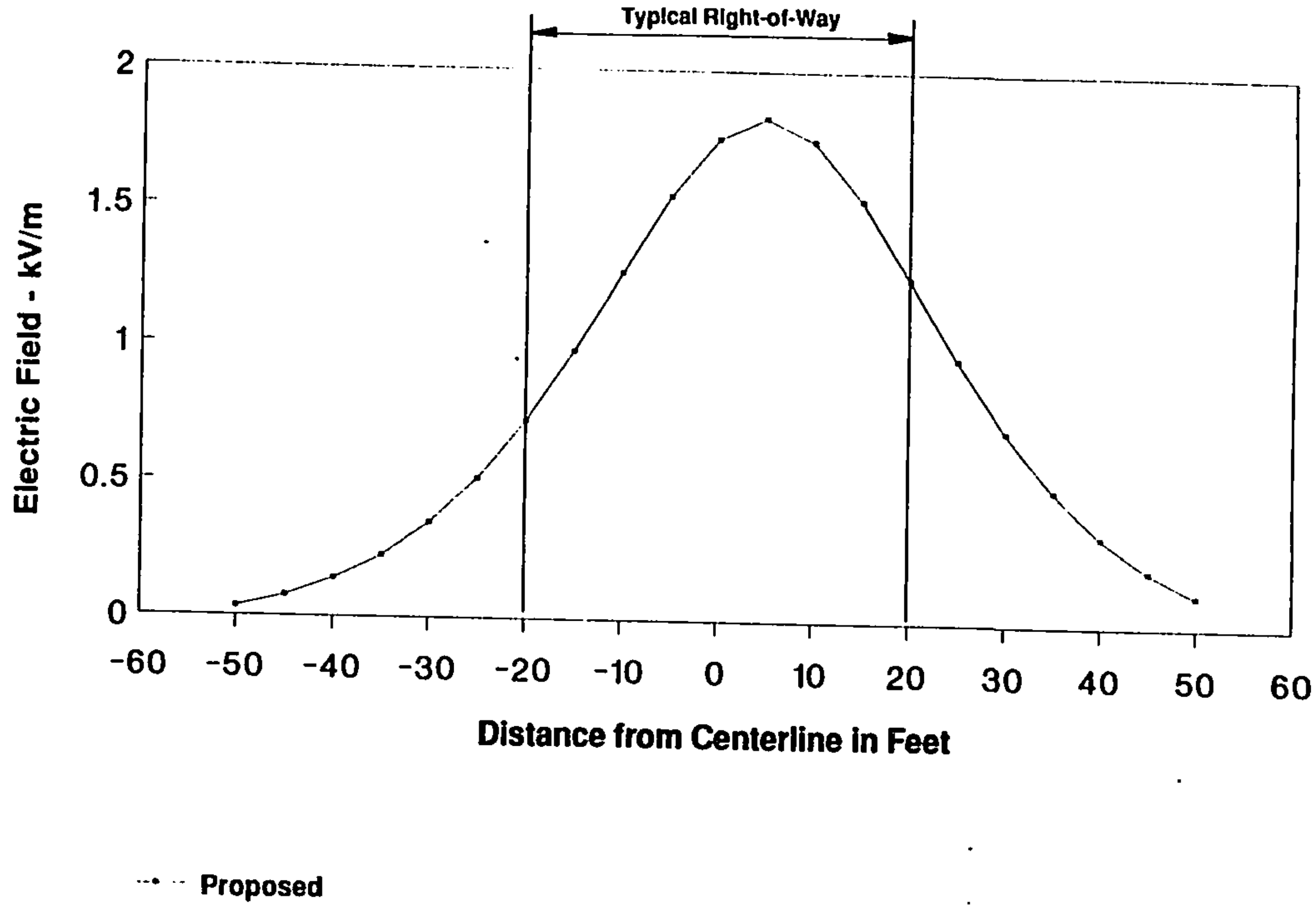
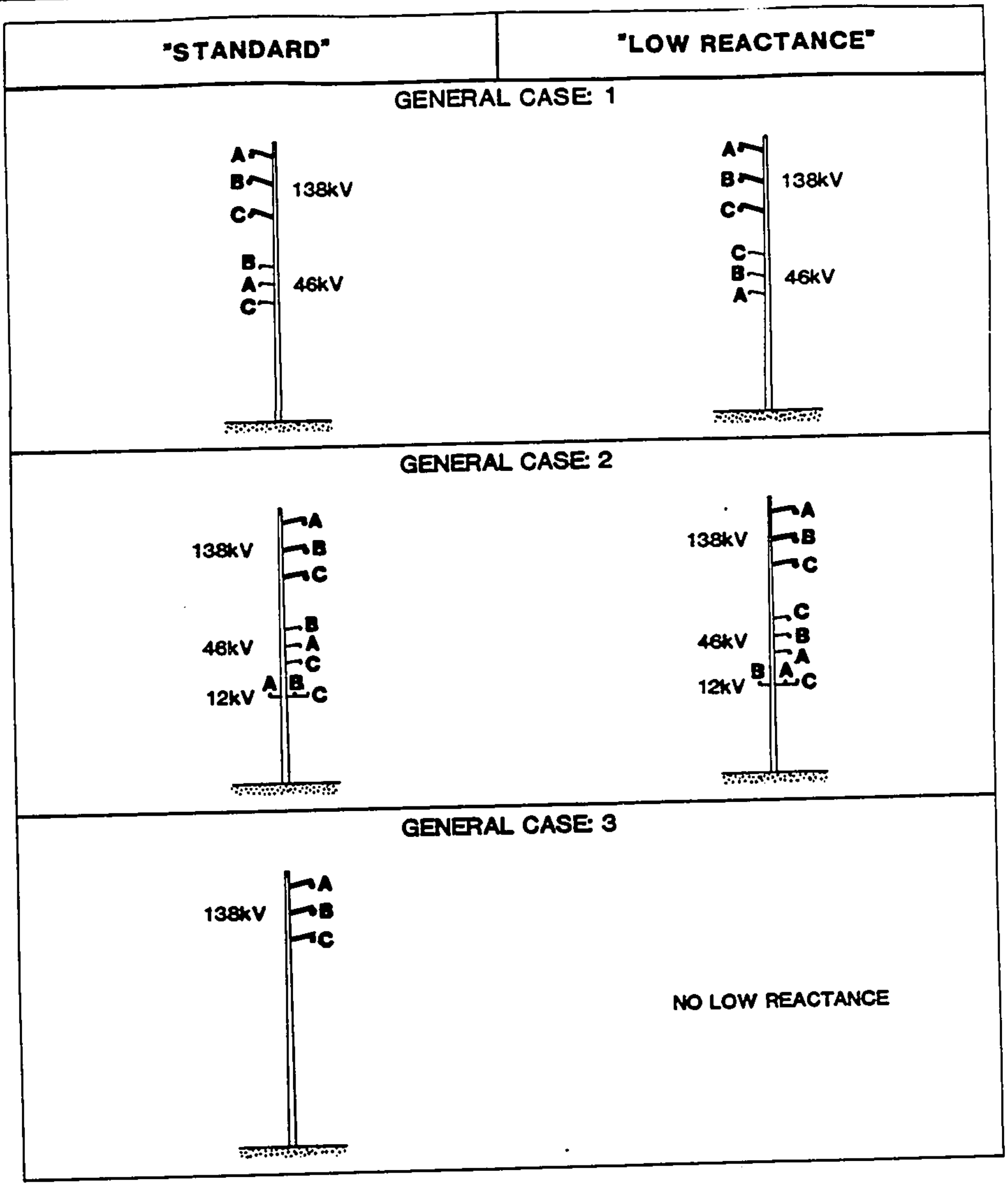


FIGURE 3

ELECTRIC FIELD LATERAL PROFILE CASE NO. 3: RADFORD DR.-MAKALAPA SUBSTATION

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
CH2M HILL



Source: ENERTECH Consultants

FIGURE 4

PROPOSED STANDARD AND LOW REACTANCE ELECTRICAL PHASING

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

would be approximately 0.03 to 0.18 kV/m 20 feet from the centerline.

4. Magnetic Fields

Definition and Description

An electric current flowing in any conductor (electric equipment, household appliance, or other) creates a magnetic field. The most commonly used unit for measuring magnetic fields is the Gauss (mG is equal to one-thousandth of a Gauss), which is a measure of the magnetic flux density (intensity of magnetic field attraction per unit area). As an example, the earth has a natural static magnetic field of about 360 mG near the Hawaiian Islands (Merrill and McElhinny, 1983).

The magnetic field under transmission lines is relatively low in comparison with measurements near many household appliances and other equipment. The magnetic field near an appliance decreases rapidly with distance from the device. The magnetic field also decreases with distance from line sources, such as powerlines, but not as rapidly as from appliances. Because the magnetic field is caused by the flow of an electric current, a device must be in operation to create a magnetic field. The magnetic fields of a large number of typical household appliances were recently measured by the Illinois Institute of Technology Research Institute (IITRI) for the U.S. Navy (Gauger, 1985) and by Enertech Consultants (Silva, 1988) for the Electric Power Research Institute (EPRI). Typical values of magnetic fields associated with household appliances are shown in Table 3.

Magnetic field values were calculated for normal, everyday line loadings for existing conditions (i.e., existing 46 kV and/or 12 kV lines) and the Waiau-Makalapa No. 2 138 kV Transmission Line at three locations along the preferred alignment (Figures 5 to 7). As was done for the electric field calculations, projected field values are shown for the proposed line for both standard phasing and low-reactance phasing.

The lateral plots for normal line loading show the magnetic field to be approximately 12 to 48 mG directly under the conductors near midspan (assuming standard phasing). Field strengths would decline to approximately 9 to 40 mG within 20 feet to the right or left of the centerline. If, as proposed, low-reactance phasing is employed for the alignments along Kam Highway (where the new line will have both 46 and

Table 3
TYPICAL MAGNETIC FIELD VALUES FOR HOUSEHOLD APPLIANCES

Appliance	Magnetic Field in milliGauss 12" Away	Maximum
Electric range	3-30	100-1,200
Electric oven	2-5	10-50
Garbage disposal	10-20	850-1,250
Refrigerator	0.3-3	4-15
Clothes washer	2-30	10-400
Clothes dryer	1-3	3-80
Coffee maker	0.8-1	15-250
Toaster	0.6-8	70-150
Crock pot	0.8-1	15-80
Iron	1-3	90-300
Can opener	35-250	10,000-20,000
Mixer	6-100	500-7,000
Blender, popper, processor	6-20	250-1,050
Vacuum cleaner	20-200	2,000-8,000
Portable heater	1-40	100-1,100
Fans/blowers	0.4-40	20-300
Hair dryer	1-70	60-20,000
Electric shaver	1-100	150-15,000
Color television	9-20	150-500
Fluorescent fixture	2-40	140-2,000
Fluorescent desk lamp	6-20	400-3,500
Circular saws	10-250	2,000-10,000
Electric drill	25-35	4,000-8,000

Source: Gauger, 1985.

138 kV conductors on the same poles), magnetic field strengths under the conductors near midspan would be approximately 7 to 12 mG. Field strengths near these sections of the line would be 4 to 8 mG at a distance of 20 feet from the centerline.

Under emergency conditions, the proposed 138 kV line could operate under a maximum loading that would temporarily increase magnetic field values directly beneath the conductors to the range of about 25 to 170 mG (depending on line configuration and location). At a distance of 20 feet from the centerline, the magnetic field would measure 14 to 143 mG. It should be noted that these conditions would be very rare and of short duration.

5. Health Effects of Electric Fields and Magnetic Fields

Overview

Although most studies in the 1960s and 1970s found no obvious harmful effects from typical transmission line electric and magnetic fields, some recent reports have suggested an

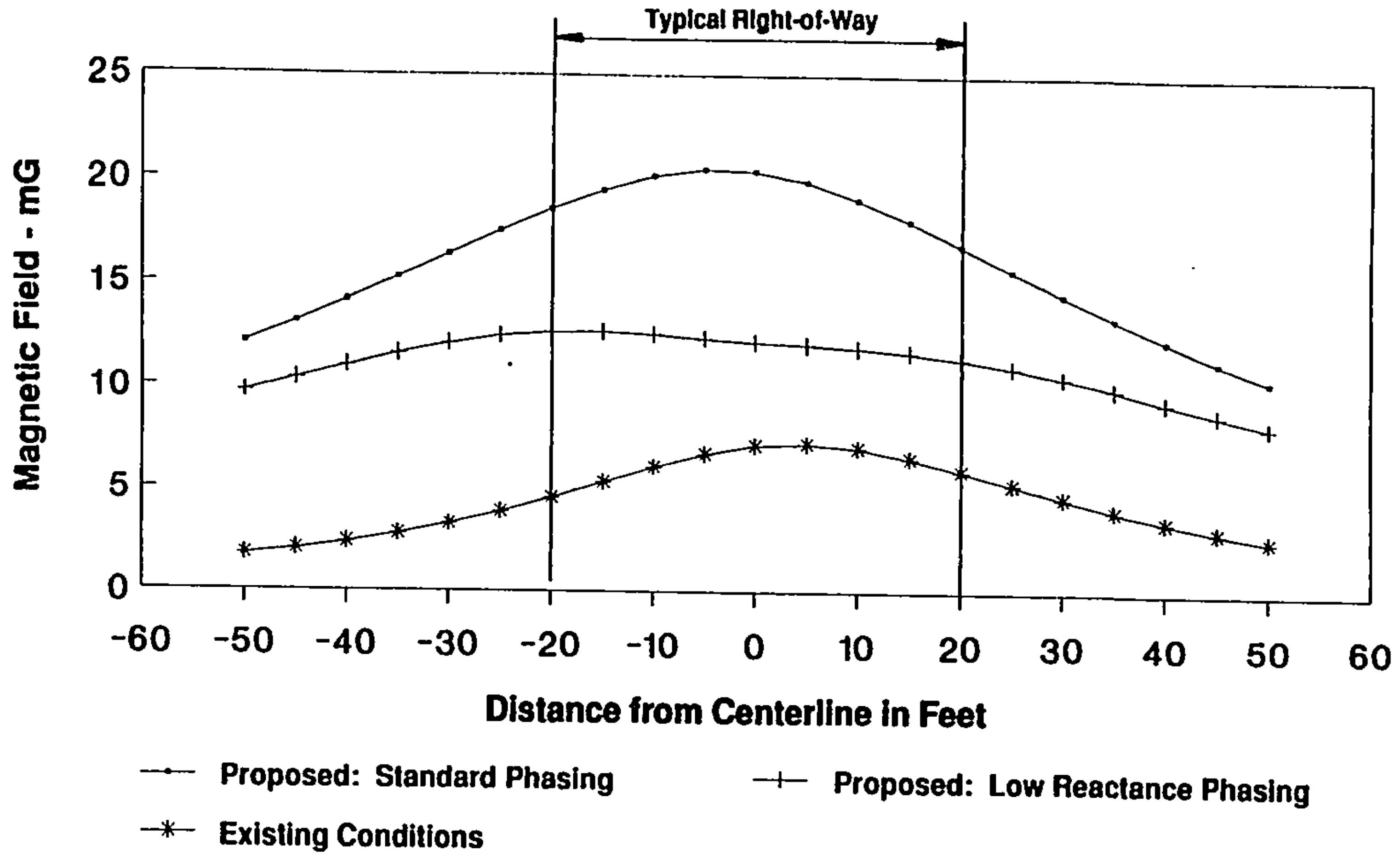


FIGURE 5

MAGNETIC FIELD LATERAL PROFILE CASE NO. 1: WAIAU-MCGREW POINT

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

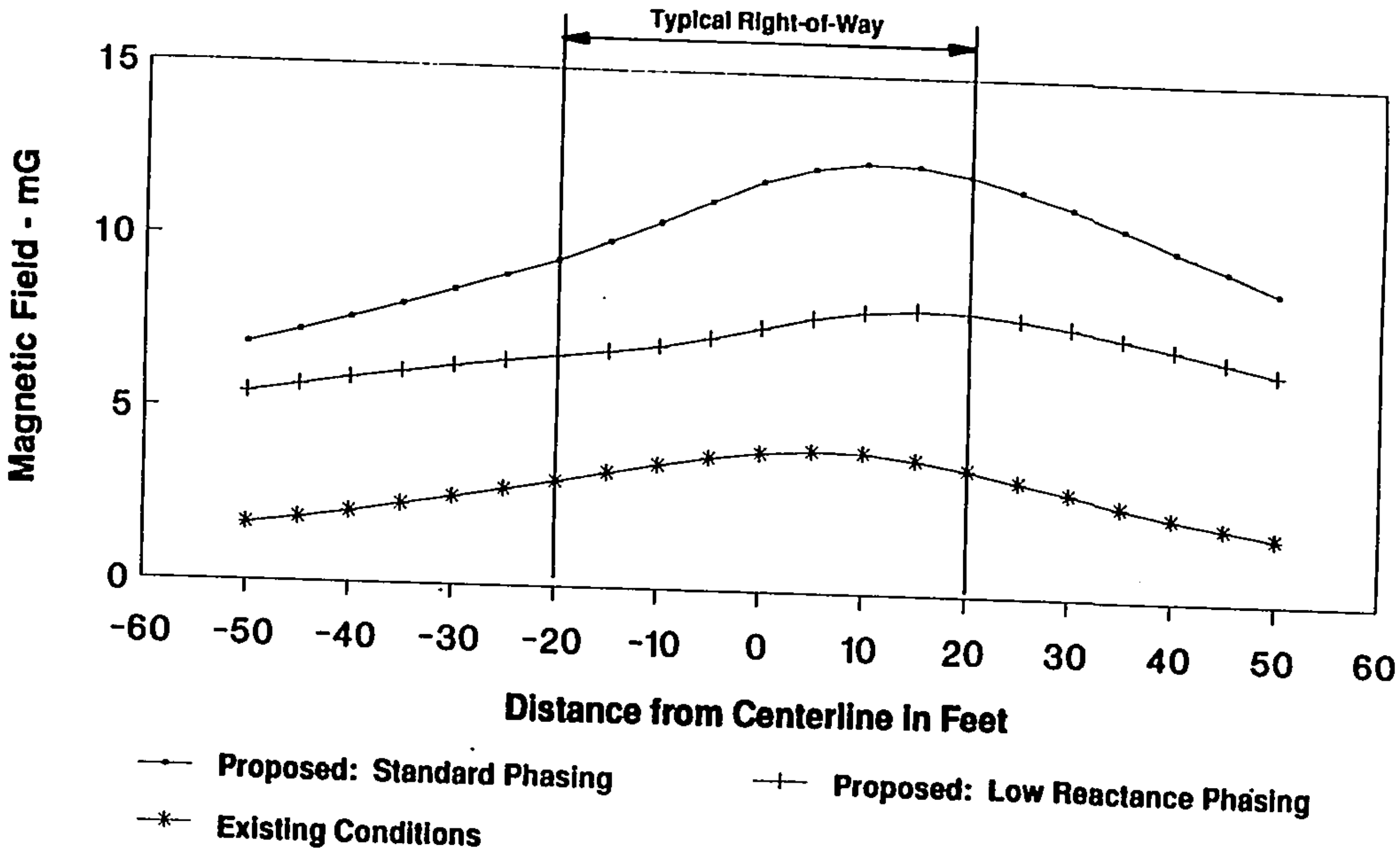
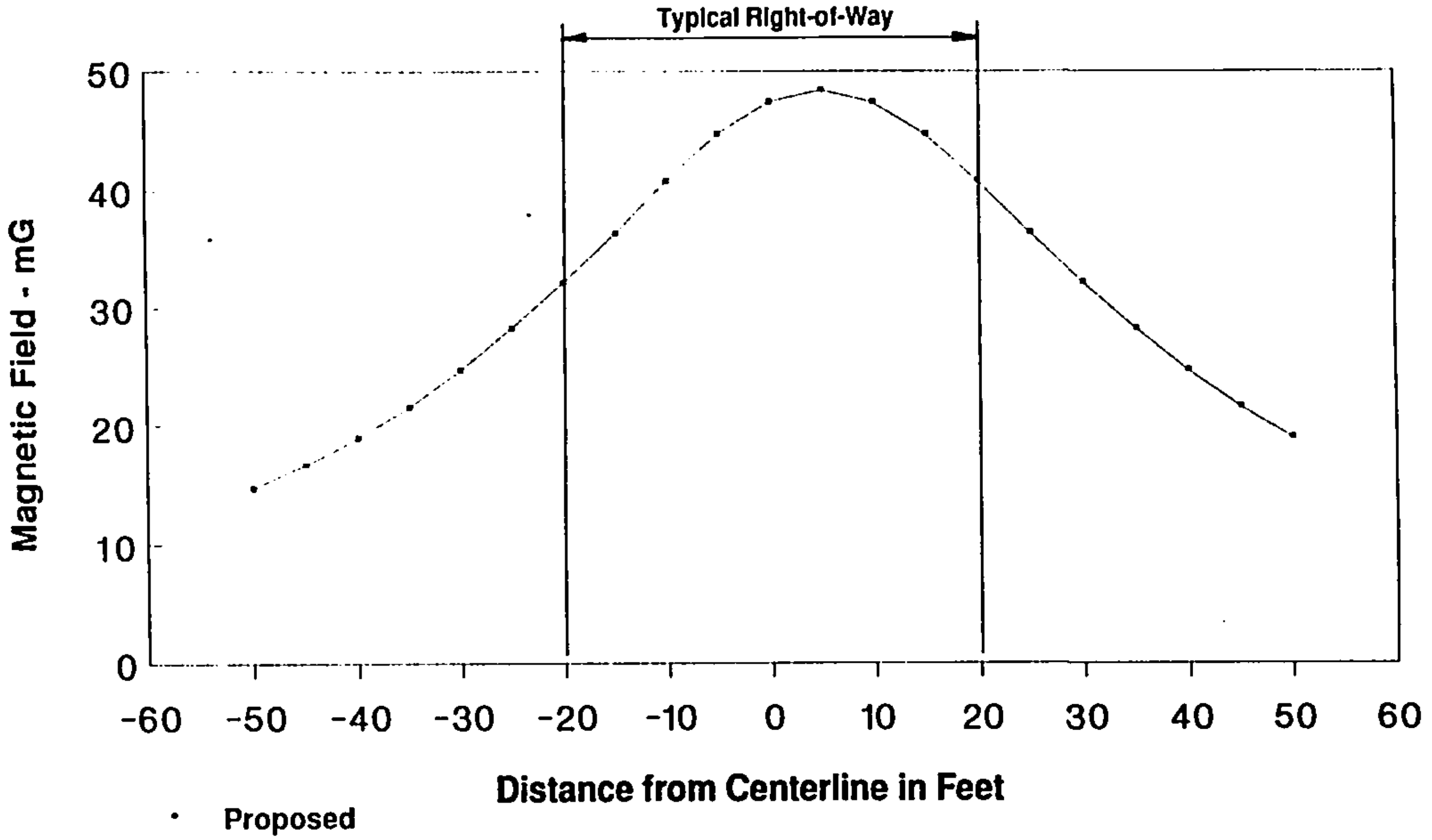


FIGURE 6

MAGNETIC FIELD LATERAL
PROFILE CASE NO. 2:
ALOHA STADIUM-RADFORD DR.

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

CH2M HILL



NOTE: Proposed configuration is 138 kV

FIGURE 7

MAGNETIC FIELD LATERAL PROFILE CASE NO. 3: RADFORD DR.- MAKALAPA SUBSTATION

Waiau-Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

association between exposure to magnetic fields and adverse health effects, including cancer. However, no association between electric fields and health effects has been found by any of the studies. The overall evidence for effects caused by magnetic fields is inconclusive, and studies are under way to obtain more definitive information. Although most of the research has been provoked by concern about the effects of the large (extra high voltage--EHV) 765 kV transmission lines, some of the recent research results are of interest in assessing potential health concerns for 138 kV lines.

The most recent research consists of sixteen studies and two follow-on projects conducted during the period from 1985 through 1987. These studies, administered by the New York State Power Lines Project (1987), were undertaken "to determine whether there are health hazards associated with electric and magnetic fields produced by 60-Hz power transmission lines (especially 765 kV lines)." The $5 million research effort was funded by electric utilities that serve New York State and supervised by a Scientific Advisory Panel reporting to the New York State Health Department. In general, the field strengths used in the laboratory studies were designed to be many times stronger than fields caused by the large 765 kV lines.

The studies generally fall into the broad areas of epidemiology, laboratory animal, and cellular research. None of the studies showed significant adverse effects on reproduction, growth, or development resulting from exposure to the laboratory-created electric or magnetic fields. The studies also showed no significant evidence of genetic or chromosomal damage that might lead to inherited effects or that might cause cancer. Two of the project's epidemiological studies, however, also examined the effects of generally lower voltage distribution lines. These two studies, of childhood cancer in Denver and adult cancer in Seattle, have generated much public interest.

The Denver Study

The Denver study (Savitz, 1987) was designed to repeat and improve upon an earlier (1979) study by Wertheimer and Leeper (also in Denver) that had shown an association between residences near distribution lines and the incidence of childhood cancer. Savitz evaluated the incidence of cancer among children living in homes near electric distribution lines. Both direct measurements and distribution "wiring codes" were used to characterize field strengths within houses. Measurements were taken with appliances turned on ("high power condition") and with appliances turned off ("low power condition"). The distribution wiring codes were used as a surrogate for the exposure over time to magnetic fields within the home caused by external power lines near the home. The wiring codes were based in general on the types, numbers, and diameters of conductors, the distance from house to powerline, and the number of nearby service drops.

The New York Scientific Advisory Panel interpreted Savitz' Denver study to imply a positive correlation between the incidence of childhood cancer, especially leukemia, and magnetic field exposure when low power condition magnetic fields measurements or wire codes were used as indicators of exposure. The correlation was stronger for the wiring code indicator than for the field measurements indicator. The evidence suggested a possible increase in the incidence of childhood cancers from about 1 in 10,000 children to about 2 in 10,000. However, no correlation was found with measured high power condition magnetic fields, or with the fields that were estimated to have occurred at the residences of birth of the sample group.

The Seattle Study

The other epidemiological cancer study funded by the New York State Power Lines Project (Stevens, 1987) was conducted in the Seattle area. The design of this study shared many features with the Denver study. Exposure to magnetic fields was assessed by field measurements and by the same wire coding system; however, the Seattle study focused on a possible correlation with adult, rather than childhood, cancers. In the Seattle study, the New York Scientific Panel found that "regardless of how exposure was characterized, no relationship with leukemia incidence was disclosed" (New York Power Lines Project, 1987). In other words, this study found no association between adult cancer and magnetic field exposure.

In evaluating the research results, the New York Scientific Advisory Panel cautioned that research has not found any biological mechanisms that could explain the role of magnetic fields in the development of cancer. The panel also noted that methodological uncertainties exist in quantifying magnetic field exposure levels. The panel concluded that the findings to date could not and should not be translated into specific recommendations for regulating right-of-way widths, line heights, or the location of lines near homes.

Office of Technology Assessment Background Paper

A comprehensive background paper on the biological effects of electric and magnetic fields (Office of Technology Assessment [OTA], 1989) was recently prepared for the U.S. Congress' Office of Technology Assessment. This paper discusses the present state of knowledge about the health effects of extremely low frequency (ELF) electric and magnetic fields. A brochure (Carnegie Mellon University, 1989) was also prepared that summarizes the OTA paper and various policy options.

The OTA paper provides a good overview of the sources and nature of electric and magnetic field exposure. It points out that we do not yet know what field attribute, or combination of attributes (if any), could produce public health effects. The assumption that "more is worse" may not be true. Therefore, field strength standards "can not be adequately supported by the science that is now available."

The OTA paper also provides a summary of the basic areas of research: cellular experiments, whole animal experiments, exposure assessment, and epidemiological studies. Using the review of the scientific literature, the paper states that:

> "As recently as a few years ago, scientist were making categorical statements that on the basis of all available evidence there are no health risks from human exposure to power-frequency fields. In our view, the emerging evidence no longer allows one to categorically assert that there are no risks. But it does not provide a basis for asserting that there is a significant risk.
>
> If exposure to fields does turn out to pose a health risk, it is unlikely that high voltage transmission lines will be the only sources of concern. Power-frequency fields are also produced by distribution lines, wall wiring, appliances, and lighting fixtures. These nontransmission sources are much more common than transmission lines and could play a far greater role than transmission lines in any public health problems."

The OTA paper and brochure also consider the public policy question of what should be done, given our present knowledge. Three basic approaches are suggested (Carnegie Mellon University, 1989):

1. "DO NOTHING"--Conclude that there is not yet enough evidence to warrant any action.

2. "PRUDENT AVOIDANCE"--Adopt strategies that can limit field exposures with small investments of money and effort. Don't do anything drastic or expensive until research provides a clearer picture of whether there is any risk at all.

3. "AGGRESSIVE REGULATION"--Conclude that there is a problem and spend time and money on an aggressive program to limit field exposure, while recognizing that we may eventually learn that some or all of this effort and money has been wasted. This would be either because it wasn't needed or we spent it the wrong way because we did not understand the science well enough to spend it effectively.

HECO has adopted the second approach in routing and designing the Waiau-Makalapa No. 2 138 kV Transmission Line. It has studied field levels and land use along the various line route options and it has studied various engineering design options (such as low reactance phasing).

Continuing Research

Researchers are careful to point out that it is very difficult to identify health hazards that may be subtle to detect or evident only after long periods of time. The converse is also true: no experiment, no matter how well designed, can prove <u>no</u> health hazards at all from any source studied. The studies that do suggest a health effect are often based on somewhat tentative positive findings. Results must be replicated before one can reach any conclusion about health hazards.

Based on the difficulty of reaching any meaningful conclusions about health hazards from the current studies, most researchers (including the New York Scientific Advisory Panel) recommend carrying out additional research. Several areas in particular merit further research.

- So far, research has not been able to discover the biological mechanism by which the effects of electric or magnetic fields observed at the cellular level might be linked to the limited epidemiological evidence suggesting possible health effects. Additional basic laboratory research is needed to determine whether physiological changes result from exposure to electric or magnetic fields, and how such changes might affect health.

- Another subject deserving further research is the effect of the fields typically experienced in homes--fields caused by televisions, electric blankets, other appliances, and electric wiring in house walls. As noted earlier in this paper, although field strengths near some of the larger transmission lines may be higher than field strengths near home appliances, most people experience significant exposure to electric and magnetic fields at home. The Denver study found some evidence of a weak association between the incidence of childhood cancer and the configuration of electric distribution line wiring; other studies, however, found no such link. Further study will help clarify the relative risk (if any) resulting from fields at home and near transmission lines.

As part of its expanding research on electric and magnetic field effects, EPRI is sponsoring more research, conducted by a number of distinguished researchers, on these and related subjects. EPRI has studied electric and magnetic field effects for 15 years. Currently, it provides 42 percent of worldwide funding for the subject. HECO financially supports EPRI's studies through HECO's membership in EPRI.

6. Electric Field and Magnetic Field Standards

General transmission line safety standards are imposed by the State of Hawaii Public Utilities Commission General Order No. 6 (Rules for Overhead Electric Line Construction) and the National Electrical Safety Code (NESC). The Waiau-Makalapa No. 2 138 kV Transmission Line will comply with these codes and standards. However, these standards are currently not written to address concerns about health effects of electric and magnetic fields.

There are no national standards in the United States for electric or magnetic field exposure. A few states have some form of electric field standard, and one state (Florida) has a magnetic field standard. These standards (summarized in Table 4) are all based on field strengths within or at the edge of transmission line rights-of-way. The widths of these rights-of-way vary greatly, according to the voltage of the lines and the regulatory requirements of each state.

Comparing the standards with the field strengths predicted for the Waiau-Makalapa No. 2 line is problematic. The

Table 4
STATE REGULATIONS THAT LIMIT FIELD STRENGTHS ON TRANSMISSION LINE RIGHT-OF-WAY (ROW)

	Field Limit
Electric Fields	
Montana	1 kV/m at edge of ROW in residential areas
Minnesota	8 kV/m maximum in ROW
New Jersey	3 kV/m at edge of ROW
New York	1.6 kV/m at edge of ROW
North Dakota	9 kV/m maximum in ROW
Oregon	9 kV/m maximum in ROW
Florida	10 kV/m maximum for 500 kV lines in ROW 2 kV/m maximum for 500 kV line at edge of ROW 8 kV/m maximum for 230 kV and smaller lines in ROW 3 kV/m maximum for 230 kV and smaller lines at edge of ROW
Magnetic Fields	
Florida	200 mG for 500 kV lines at edge of ROW 250 mG for double-circuit 500 kV lines at edge of ROW 150 mG for 230 kV and smaller lines at edge of ROW

Source: OTA (1989) and Carnegie Mellon University (1989).

proposed line will largely be sited along existing roadways (where HECO's franchise entitles it to site utility lines). In most locations, no right-of-way easement will need to be acquired and, therefore, no edge-of-right-of-way values can be predicted to compare with the standards. As an illustration of predicted values for normal line loadings, electric field strengths 20 feet from the centerline will be 0.03 to 1.7 kV/m, and magnetic field strengths will be 7 to 41 mG under normal operating conditions.

The standards listed in Table 4 are generally acknowledged not to be health-based standards because the existing body of knowledge does not support the establishment of health-based standards. Where states have set standards, they have generally done so for equity reasons, with the intent of keeping future conditions about the same as past conditions. In this way, no radically new conditions are created until more is known about the health effects of electric and magnetic fields.

The Public Utilities Commission of the State of California recently addressed the issue of electric and magnetic field standards (California PUC, 1989). In 1988, the California State Legislature passed Senate Bill 2519, that called for the California Public Utilities Commission and the State

Department of Health Services to conduct a study of potential health effects related to electric and magnetic fields and to make recommendations regarding further study and regulation. The report to the California legislature concludes:

> It is recommended that California take no action at the present to regulate electric and magnetic fields around electric power facilities.. Any such actions are premature given current scientific understanding of this health issue. Too little is known presently to be able to determine where or what rules would provide useful protection.

7. Other Transmission Line Electrical Factors

Corona

One of the more interesting phenomena associated with all energized devices, including high-voltage transmission lines, is corona. Corona is the physical manifestation of energy loss, and can transform energy into very small amounts of light, sound, radio noise, chemical reaction, and heat. Because energy loss is uneconomical, corona has been studied since the early part of this century. Consequently, it is well understood by engineers and steps to minimize it are major factors in line design. The line designer can control corona with good design practices, and it is usually not a problem for lines rated at 230 kV and lower.

When corona occurs on transmission lines it is usually on high voltage lines of 345 kV and above, and then mostly during foul weather. The effects are local and should be considered a nuisance rather than a serious problem or a hazard. For example, although radio noise in the AM range can be generated by corona discharge, it is usually of such small intensity that it could not be detected outside of the right-of-way. The same is true of television interference and audible noise. The engineering design of the proposed Waiau-Makalapa No. 2 138 kV Transmission Line produces very low conductor surface gradients (because of the lower 138 kV line voltage and use of larger conductors). The corona performance of the HECO 138 kV-line will be as good as, or better than other lines in this voltage classification (IEEE, 1972, 1971; Chartier, 1976; and EPRI, 1982). It is expected that the proposed 138 kV line will have little or no corona activity under most operating conditions.

Audible Noise

During corona activity, transmission lines (mainly 345 kV and above) generate a small amount of sound energy. This audible noise from the line can barely be heard in fair weather conditions on the higher-voltage lines and usually not at all on lines at 138 kV. During foul weather, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops. Audible noise decreases rapidly with distance from the line. Noise levels on the HECO system are low and have not been a problem. This is to be expected since audible noise is almost never reported on 138 kV transmission lines. Calculated audible noise levels in foul weather for the Makalapa No. 2 Transmission Line are about 10 to 12 dBA, a very low level that is comparable to levels in a typical soundproofed radio or television broadcast studio.

Radio and Television Interference

Overhead transmission lines do not, as a general rule, interfere with normal radio or TV reception. As described in the corona section, corona discharges can sometimes generate unwanted electrical signals. There are two potential sources of interference--corona and gap discharges. Corona may affect AM radios, while gap discharge can affect television, as well as radio reception. Corona activity is minimized because of proper line design and is, therefore, almost never a source of interference especially on lines smaller than 230 kV. Corona-generated interference decreases very rapidly with distance and, beyond the edge of the right-of-way, it decreases to very low values. For the proposed 138 kV line design, the calculated radio noise level at the right-of-way edge for foul weather is about 24 to 32 dBμV/m (decibels above a one microvolt reference value). This level will meet a level given by the Federal Communications Commission for satisfactory service (EPRI, 1982). The design of the 138 kV line is such that television interference levels will be extremely low (lower than on many previous 138 kV lines on the mainland where television interference has not been a problem).

Gap discharges are a very different problem. They are caused by electrical discharges between broken or poorly fitting hardware (i.e., insulators, clamps, brackets, etc.). Hardware is designed and installed to be problem-free, but gunshot damage, wind motion, corrosion damage, etc., sometimes can create a gap discharge condition. When this condition develops, intermittent gaps at connection points between hardware items allow small electrical discharges to occur between the gaps. This phenomenon is not limited to transmission lines and can often be found on distribution lines. The discharges act as small "transmitters" at frequencies that may be received on some radio and television receivers. Gap discharge sources can be located by HECO engineers and repaired. The severity of any interference depends upon the strength and quality of the transmitted radio or television signal, the quality of the radio or television set and antenna system, and the distance between the set and interference source. It should be obvious that radio and TV sets are influenced more by interference sources in the home itself than from transmission lines because of proximity. The large majority of interference complaints are found to be attributable to other sources than to transmission lines such as poor signal, poor antenna, heating pad, door bell, sewing machine, freezer, ignition system, aquarium thermostat, appliances, and fluorescent lights (IEEE, 1976).

HECO engineers design all transmission lines to be as free as possible from corona and other sources of interference. Radio/television interference complaints are recorded, evaluated, and investigated when necessary; corrective measures are taken as required.

Ozone

Ozone is another possible by-product of the higher voltage transmission lines that has raised some concern. Ozone (O_3) can be formed from charged air molecules through the combination of three oxygen atoms. Ambient ozone levels in rural areas are typically around 10 to 30 parts per billion (ppb) at night and may peak during the day at around 100 ppb. In urban areas, concentrations greater than 100 ppb are common. Cities like Los Angeles may peak at 500 ppb. The National Ambient Air Quality Standard for Oxidants (of which ozone is usually 90 to 95 percent) is 120 ppb, not to be exceeded as a peak concentration on more than 1 day a year.

What kind of ozone level increase can be expected in the vicinity of a transmission line? A theoretical "worst case" would be provided by the following conditions: heavy rains, light winds blowing exactly parallel to the line, and 10 or more continuous hours of these conditions. Close to the Waiau-Makalapa 138 kV line, calculated ozone levels would be about 0.003 ppb. Concentrations below about 1.0 ppb are impossible to measure with even the most sensitive instrumentation. Nitrogen oxides can also be generated by transmission lines but on a scale much smaller than ozone, and therefore the problem is even less significant. Therefore, ozone and nitrogen oxide are not problems for 138 kV transmission lines.

Cardiac Pacemakers

One electric field concern for the 345 kV and larger lines has been the possibility of interference with cardiac pacemakers. There are two general types of pacemakers: asynchronous and synchronous. The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference since it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker only pulses when its sensing circuitry determines pacing is necessary. Interference may result from the transmission line electric field causing a spurious signal on the pacemaker's sensing circuitry. However, when these pacemakers detect a spurious signal, such as a 60-Hz signal, they are programmed to revert to an asynchronous or fixed pacing mode of operation. Cardiovascular specialists do not consider prolonged asynchronous pacing a problem. Some pacemakers are designed to operate that way. Periods of operation in this mode are commonly induced by cardiologists to check on pacemaker performance. So, while the transmission line electric field may interfere with the normal operation of some pacemakers, the result of the interference is both not harmful and of short duration.

In any event, the electric fields associated with the Waiau-Makalapa 138 kV line are far below levels that are reported as capable of affecting pacemaker operation (about 2 to 9 kV/m) and would, therefore, pose no hazards for pacemaker operation (University of Rochester, 1985, and IITRI, 1979).

8. Conclusions

Research to date has not demonstrated evidence of health hazards caused by 138 kV transmission lines similar to the line that HECO is proposing to construct for the Waiau-Makalapa No. 2 Transmission Line Project. HECO continues to review and evaluate all scientific research on the health effects of transmission lines, and will consider the results of that research in its transmission line decisions. HECO also continues to support the scientific research on the health effects of transmission lines sponsored by EPRI. HECO's goal is to provide electric power to the people of Oahu while maintaining the highest safety standards for its employees and the public.

9. References

Electrical Supply and Demand For 1988-1997, North American Electric Reliability Council, New Jersey. 1988.

Tenth Biennial Survey of Power Equipment Requirements of the U.S. Electric Utility Industry 1985-1994, NEMA, March. 1986.

"The Measurement of Carpet Static", K. Chakravarti and G. J. Pontrelli, Textile Research Journal. February 1976.

The Lightning Book, Peter E. Veimeister, MIT Press. 1972.

The Earth's Electrical Environment, National Research Council, National Academy Press, Washington, D.C. 1986.

CRC Handbook of Chemistry and Physics--Atmospheric Electricity, CRC Press. 1981.

Carstensen, E. L. Biological Effects of Transmission Line Fields. New York: Elsevier Press. 1985.

"AC Field Exposure Study: Human Exposure to 60 Hz Electric Fields," EPRI Report EA-3993, Enertech Consultants. 1985.

The Earth's Magnetic Field, International Geophysics Series Vol. 32, R. T. Merrill and M. W. McElhinny, Academic Press, New York. 1983.

Gauger, J. R. "Household Appliance Magnetic Field Survey," IEEE Transactions on Power Apparatus and Systems. Vol. PAS-104, No. 9:2436-44. 1985.

Silva, J. M. "Power Frequency Magnetic Fields in the Home." Paper No. 88WM101-8: Presented at the 1988 IEEE/PES Winter Power Meeting. New York.

New York State Power Lines Project. Biological Effects of Power Line Fields: Scientific Advisory Panel Final Report. 1987.

"Biological Effects of Power Frequency Electric and Magnetic Fields--Background Paper," Office of Technology Assessment, U.S. Congress, prepared by Carnegie Mellon University, Washington, D.C. 1989.

"Electric and Magnetic Fields from 60 Hertz Electric Power: What Do We Know About Possible Health Risks?" Carnegie Mellon University, Pittsburgh, Pennsylvania. 1989.

EHV Transmission Line Corona Effects--IEEE Tutorial Course, 72CH0644-5PWR. 1972.

Radio Interference Limits That Exist in Five Countries, a Contribution to IEEE Task Force by V. L. Chartier, BPA, Vancouver, Washington. 1976.

Radio Noise Design Guide for High-Voltage Transmission Lines IEEE Radio Noise Subcommittee Report--Working Group No. 3, Paper 70TP631-PWR. 1971.

Transmission Line Reference Book-345 kV and Above, (Second Edition) Electric Power Research Institute. 1982.

IEEE Tutorial Course: The Location, Correction, and Prevention of RI and TVI Sources from Overhead Power Lines, IEEE, 76-CH1163-5-PWR, Interference Sources, Complaints Statistics, and Limits. 1976.

"Evaluation of the Effects of Electric Fields on Implanted Cardiac Pacemakers," EPRI Report EA-3917, University of Rochester. 1985.

"The Effects of 60 Hz Electric and Magnetic Fields on Implanted Cardiac Pacemakers," EPRI Report EA-1174, IITRI. 1979.

LINE GEOMETRY INFORMATION SHEETS AND DIAGRAMS: EXISTING CONDITIONS

The following information sheets and diagrams indicate the assumptions about conductor type, spacing, sag, and loadings used to calculate the electric and magnetic field lateral profiles for existing conditions.

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - WAIAU TO MCGREW PT.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: DAHLIA (556.5 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.856"

Subconductor Spacing: N/A **Phasing Spacing:** 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 46,000 VOLTS

Normal Loading - Average: 143 AMPS/PHASE
Maximum Continuous Loading: 715 AMPS/PHASE

Emergency Loading: 820 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 300' **Ruling Span:** 300'

Other/Special Information: ______________________________

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - WAIAU TO MCGREW PT.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: DAHLIA (556.5 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.856"

Subconductor Spacing: N/A **Phasing Spacing:** 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 12,000 VOLTS

Normal Loading - Average: 206 AMPS/PHASE
- Maximum: 715 AMPS/PHASE

Emergency Loading: 820 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 300' **Ruling Span:** 300'

Other/Special Information: ______________________________

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - ALOHA STADIUM TO RADFORD DR.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: DAHLIA (556.5 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.856"

Subconductor Spacing: N/A **Phasing Spacing:** 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 46,000 VOLTS

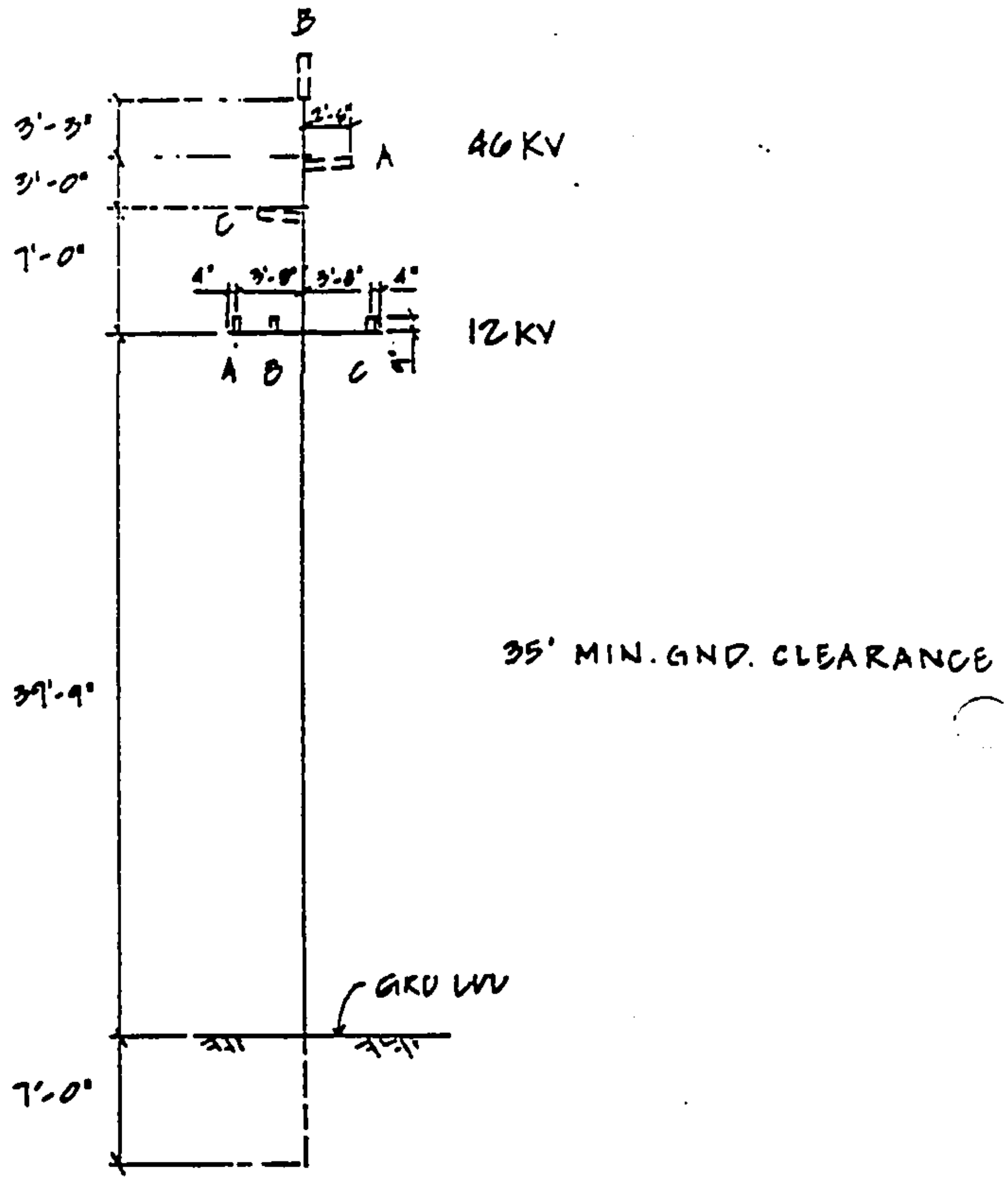
Normal Loading - Average: 159 AMPS/PHASE
Maximum Continuous Loading: 715 AMPS/PHASE

Emergency Loading: 820 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 300' **Ruling Span:** 300'

Other/Special Information: ______________________________



60' WOOD POLE FRAMING

FIG. 1

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - ALOHA STADIUM TO RADFORD DR.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: #4 COPPER

# of Subconductors: 1 **Subconductor Diameter:** 0.2043"

Subconductor Spacing: N/A **Phasing Spacing:** 2' TO 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 12,000 VOLTS

Normal Loading - Average: 77 AMPS/PHASE
Maximum Continuous Loading: 170 AMPS/PHASE

Emergency Loading: 190 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 300' **Ruling Span:** 300'

Other/Special Information: ______________________________

LINE GEOMETRY INFORMATION SHEETS AND DIAGRAMS: PROPOSED CONDITIONS

The following information sheets and diagrams indicate the assumptions about conductor type, spacing, sag, and loadings used to calculate the electric and magnetic field lateral profiles for the proposed line configuration.

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - WAIAU TO MCGREW PT.

In-Service Date: 1991 Number of Circuits: 1

AC/DC: AC Compliance with General Order #6 (Y/N): Y

Conductor Name: ARBUTUS (795 KCMIL AAC)

# of Subconductors: 2 Subconductor Diameter: 1.026"

Subconductor Spacing: 1' Phasing Spacing: 12'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL Voltage: 138,000 VOLTS

Normal Loading - Average: 502 AMPS/PHASE
Maximum Continuous Loading: 1800 AMPS/PHASE

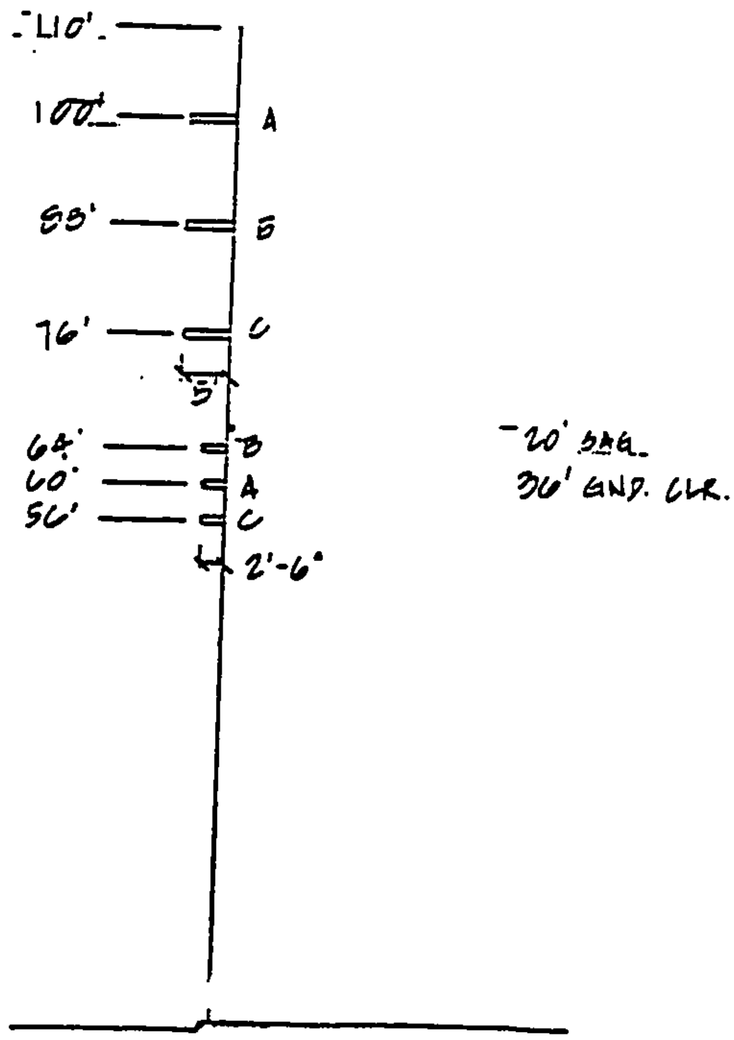
Emergency Loading: 2000 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 600' Ruling Span: 600'

Other/Special Information: ______________________

GENERAL CASE #7:
WAIALU TO MCGREW PT.



TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - WAIAU TO MCGREW PT.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: DAHLIA (556.5 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.856"

Subconductor Spacing: N/A **Phasing Spacing:** 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 46,000 VOLTS

Normal Loading - Average: 143 AMPS/PHASE
Maximum Continuous Loading: 715 AMPS/PHASE

Emergency Loading: 820 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 600' **Ruling Span:** 600'

Other/Special Information: ______________________________

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - ALOHA STADIUM TO RADFORD DR.

In-Service Date: 1991 Number of Circuits: 1

AC/DC: AC Compliance with General Order #6 (Y/N): Y

Conductor Name: ARBUTUS (795 KCMIL AAC)

# of Subconductors: 2 Subconductor Diameter: 1.026"

Subconductor Spacing: 1' Phasing Spacing: 12'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL Voltage: 138,000 VOLTS

Normal Loading - Average: 502 AMPS/PHASE
Maximum Continuous Loading: 1800 AMPS/PHASE

Emergency Loading: 2000 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 600' Ruling Span: 600'

Other/Special Information: ______________________________

TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - ALOHA STADIUM TO RADFORD DR.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: DAHLIA (556.5 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.856"

Subconductor Spacing: N/A **Phasing Spacing:** 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 46,000 VOLTS

Normal Loading - Average: 159 AMPS/PHASE
Maximum Continuous Loading: 715 AMPS/PHASE

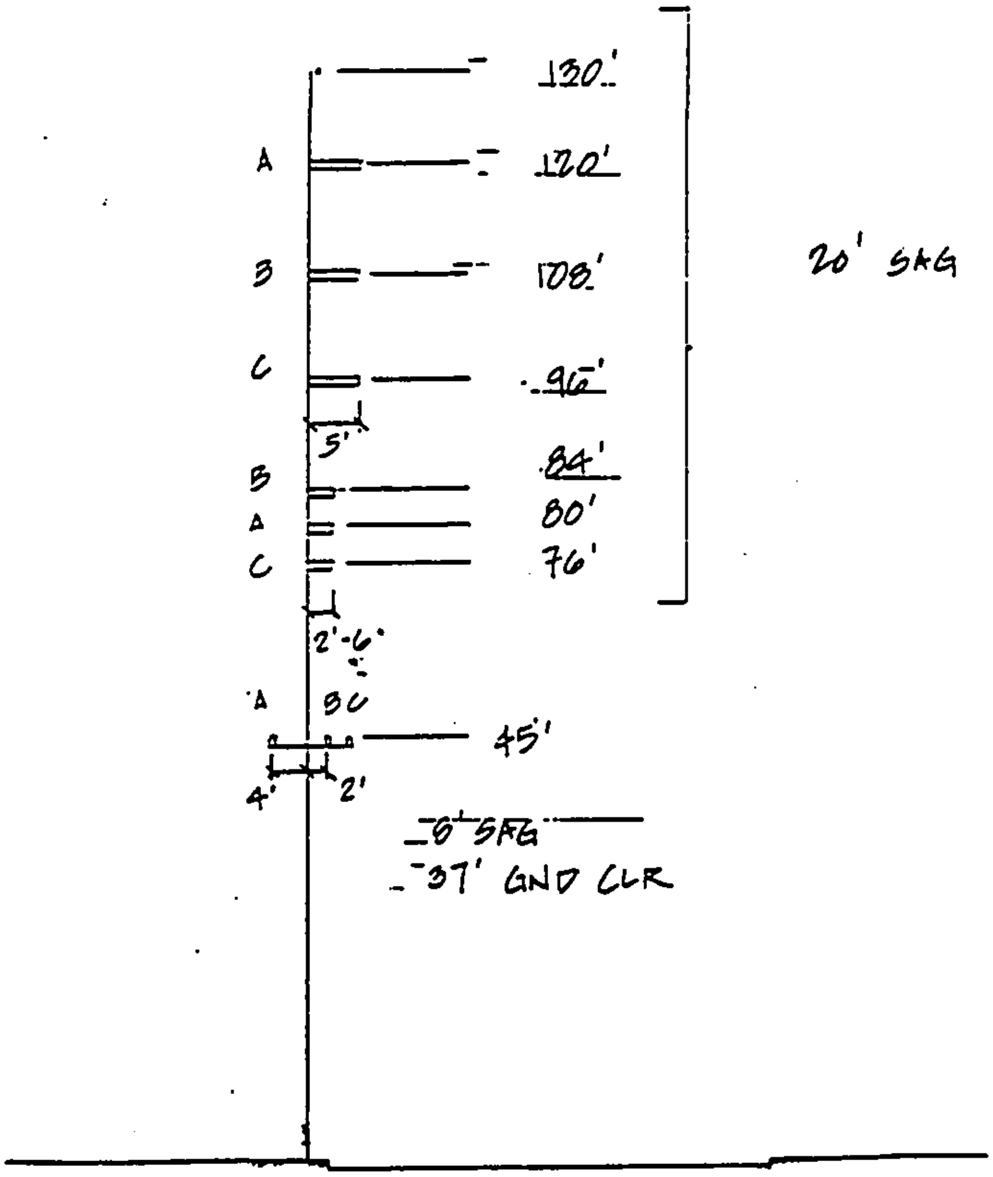
Emergency Loading: 820 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 600' **Ruling Span:** 600'

Other/Special Information: ______________________________

GENERAL CASE # 2
ALOHA STADIUM TO RADFORD DR.



TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
KAM HWY. - ALOHA STADIUM TO RADFORD DR.

In-Service Date: EXISTING **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: TULIP (336.4 KCMIL AAC)

# of Subconductors: 1 **Subconductor Diameter:** 0.666"

Subconductor Spacing: N/A **Phasing Spacing:** 2' TO 4'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 12,000 VOLTS

Normal Loading - Average: 77 AMPS/PHASE
Maximum Continuous Loading: 515 AMPS/PHASE

Emergency Loading: 595 AMPS/PHASE

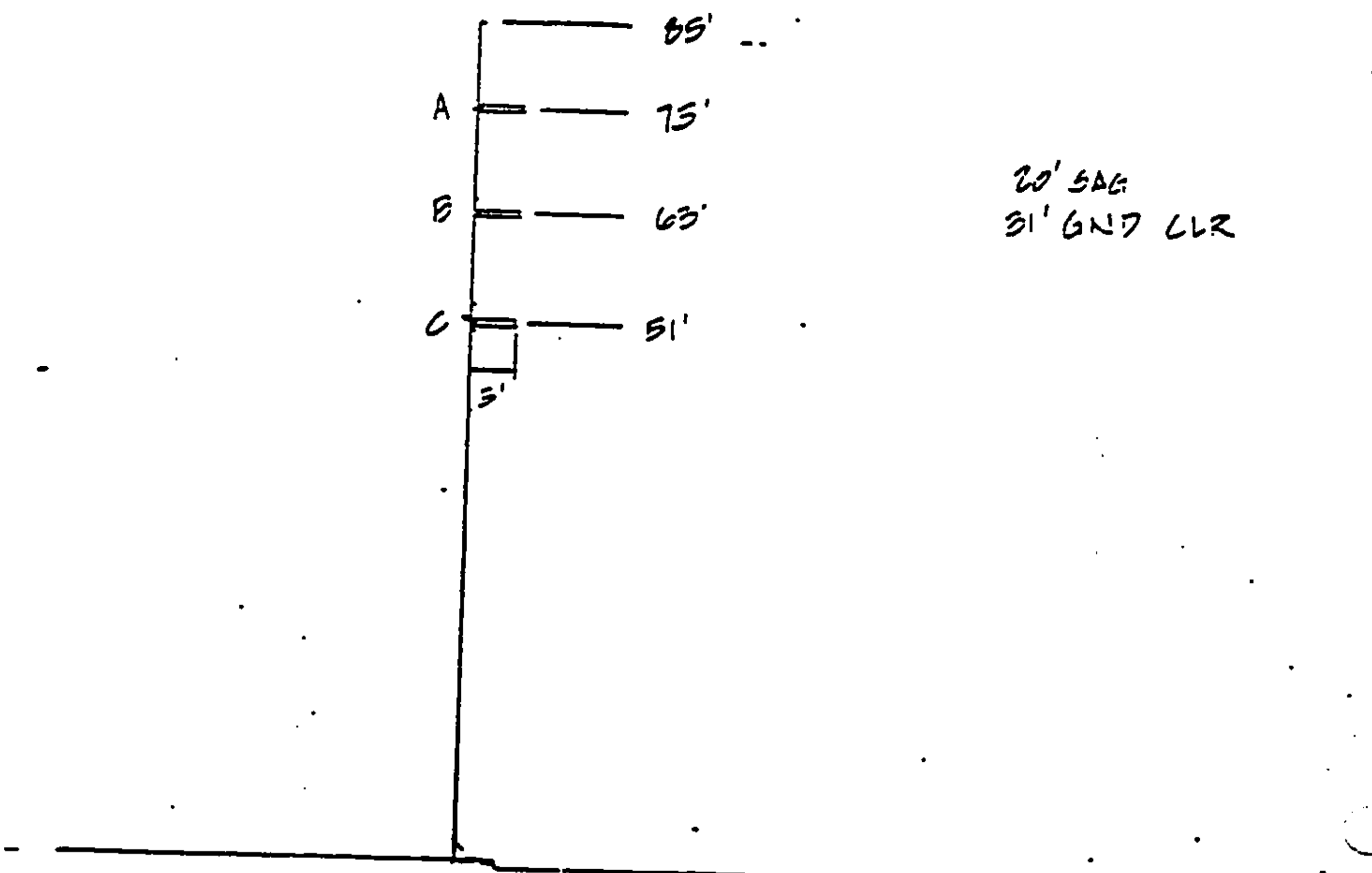
Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 300' **Ruling Span:** 300'

Other/Special Information: ____________________________

GENERAL CASE #3:

RADFORD DR. TO MAKALAPA SUBSTATION



TRANSMISSION LINE GEOMETRY INFORMATION

Circuit Name: WAIAU-MAKALAPA #2 138KV
RADFORD DR. TO MAKALAPA SUBSTATION

In-Service Date: 1991 **Number of Circuits:** 1

AC/DC: AC **Compliance with General Order #6 (Y/N):** Y

Conductor Name: ARBUTUS (795 KCMIL AAC)

# of Subconductors: 2 **Subconductor Diameter:** 1.026"

Subconductor Spacing: 1' **Phasing Spacing:** 12'

Phasing Arrangement: REFER TO SKETCH

Attachment Height: REFER TO SKETCH

Minimum Ground Clearance: REFER TO SKETCH

Altitude: 50' MSL **Voltage:** 138,000 VOLTS

Normal Loading - Average: 502 AMPS/PHASE
Maximum Continuous Loading: 1800 AMPS/PHASE

Emergency Loading: 2000 AMPS/PHASE

Tower/Pole Height (Typical): REFER TO SKETCH

Span Length: 600' **Ruling Span:** 600'

Other/Special Information: ____________________

Appendix D
Biological Resources Survey

APPENDIX D

BIOLOGICAL RESOURCES SURVEY
WAIAU-MAKALAPA NO. 2 TRANSMISSION PROJECT

HAWAIIAN ELECTRIC COMPANY

Char & Associates
in association with
CH2M HILL

June 1988

Table of Contents

BIOLOGICAL RESOURCES
WAIAU-MAKALAPA TRANSMISSION PROJECT

1.0 INTRODUCTION

Hawaiian Electric Company (HECO) proposes to construct a second 138,000 volt transmission line between its Waiau Power Plant and Makalapa Substation. This second line is needed by 1995 to avoid overloads on the existing Waiau-Makalapa No. 1 line. Two corridors have been identified for the siting of the second transmission line. One corridor runs between Kamehameha Highway and the shoreline from the power plant to North Road; it then follows Bougainville Drive to the substation. The second corridor follows Salt Lake Boulevard, crossing makai of Aloha Stadium to the substation.

Field studies to assess the biological resources found along the two corridors were conducted in May 1988. The objectives of the biological survey were to 1) search for threatened and endangered plant and animal species protected by Federal and State laws and regulations; 2) describe the major vegetation types and wildlife habitats; and 3) inventory the biological resources found within the corridors.

2.0 VEGETATION

The area between the Waiau Power Plant and the Makalapa Substation contains dense residential and commercial developments (Urban/ Developed Lands). Areas containing more or less undeveloped lands with natural vegetation are generally small in size and fragmented. Scrub vegetation composed of koa-haole occurs on steeply, sloping areas and along drainageways. Wetlands dominated by mangrove are found scattered along the shores of East Loch, Pearl Harbor, from the power plant site to Aiea Bay. Cultivated wetlands occur mauka of Kamehameha Highway near Waiau and Kalauao Springs.

Introduced species are the primary constituents of the vegetation types recognized along the two corridors. No rare, threatened or endangered plant species or sensitive native plant communities were found during the course of the field studies.

2.1 Survey Methods

Prior to the field survey, a review was made of the pertinent literature to familiarize the principal investigator with other biological studies conducted in the general area.

Existing topographic maps, as well as recent aerial photographs, were examined to determine access, terrain characteristics, reference points, and potential technical and logistical problems. Recent aerial photographs were used in delineating undeveloped areas and vegetation types. Field verification was made in May 1988. The field studies included the areas within the corridors as well as a buffer zone area, about one-quarter mile wide, along both sides of the corridors.

A walk-through survey method was used. Plants were identified in the field; plants which could not be positively identified were collected for later determination in the herbarium and for comparison with the botanical literature. Notes were made of the species present in each of the major vegetation types. The species recorded are indicative of the season ("rainy" vs. "dry") and environmental conditions under which the survey was made. Surveys conducted at different times of the year and under varying environmental conditions, would no doubt yield slight variations in the kinds of plants recorded, especially of the weedy, annual taxa.

2.2 Vegetation Types

The major vegetation types recognized on the study area are described in detail below. All are dominated by introduced plant species.

A list of those plant species inventoried on undeveloped or cultivated lands is presented in Section 2.4, Species Checklist. Vegetation types have been mapped and are presented in Figure 1. In places, delineation of vegetation types is not precise and there is often a transition zone where the vegetation types may intergrade.

Scrub

This vegetation type occurs on the slopes above A. Scott School and Radford High School; on the inner slopes and bottom of Makalapa Crater; and along the Halawa Stream drainage channel and the adjacent slopes. It is dominated by the introduced koa-haole, which in many places has been severely affected by recent infestations of the jumping plant louse (*Heteropsylla* sp.).

Koa-haole Scrub -- In general, this community consists of dense stands of koa-haole shrubs (*Leucaena leucocephala*), 6 to 18 ft. tall. Scattered trees of kiawe (*Prosopis pallida*), 'opiuma (*Pithecellobium dulce*), Chinese banyan (*Ficus microcarpa*), and African tulip tree (*Spathodea campanulata*) are frequently associated with this scrub community. Depending on such physical features as slope, soil depth and soil type, drainage, etc., the composition of the ground cover species will vary considerably. In drainage areas, bottoms of small gulches, and the Makalapa Crater floor, Guinea grass (*Panicum maximum*), or its more diminutive variety, green panic grass (Panicum maximum var. trichoglume), forms denes ground cover. On slopes where the soil is often shallow and rocky or boulder-strewn, the koa-haole cover is less dense and the ground cover consists of a mixture of grasses and smaller shrubs (subshrubs). These include sour grass (Tricachne insularis), bristly foxtail (Setaria verticillatà), Guinea grass, swollen finger grass (Chloris inflata), pitted beard grass (Andropogon pertusus), false mallow (Malvastrum coromandelianum), hairy abutilon (Abutilon grandifolium), and asystasia (Asystasia gangetica). Vines of wild bittermelon (Momordica charantia), koali-'ai (Ipomoea cairica), and koali-'awania (Ipomoea indica) are occasional features of this plant community especially along the margins of the scrub.

Wetlands

Wetlands are defined as areas which are inundated or saturated by surface or ground water so that hydric soils are formed and the vegetation is dominated by obligate wetland species. Obligate wetland species or obligate hydrophytes are plants which are generally found (99% or more of the time) only in wetlands under natural conditions. Morphological features such as prop roots; pneumatophores; floating leaves; spongy stems, roots, and leaves; vivipary; etc., often characterize these obligate species. Obligate wetland plants and the larger wetland areas along Pearl Harbor have been inventoried (Elliott and Hall 1977). In this report, three wetland communities are recognized. Wetlands dominated by mangrove occur as scattered pockets along the shoreline, primarily at the mouths of streams. The fishpond on the Navy's McGrew Point housing area is almost completely overgrown by mangrove. Small patches of pickleweed are often associated with the mangrove, however, these were too small to map at the scale used in this study. A rather distinct expanse of pickleweed can be found in Makalapa Crater in a highly saline situation. Two cultivated wetlands can be found mauka of Kamehameha Highway.

Mangrove Forest -- This wetland community is composed of dense stands of mangrove treees (Rhizophora mangle), 25 to 40 ft. tall. In other less disturbed shoreline areas along Pearl Harbor, outside the study site, the mangrove forest (or mangrove swamp) may attain heights of 50 to 75 ft. In places, such as the McGrew Point Park, the mangrove has been thinned out and/or cut back.

Occasionally other trees such as hau (Hibiscus tiliaceus), milo (Thespesia populnea), and kiawe (Prosopis pallida) are found as associates, especially along the mouths of streams.

Non-woody Wetlands -- Pickleweed (Batis maritima) is the primary component of this plant community within the project area. Although it forms a woody, low-statured scrub, up to 3 ft. tall, its photographic signature is similiar to that of wetlands composed of cattails or various sedges and grasses and it has been placed in this wetland community type in the report.

Small patches of pickleweed are often found on the mudflats adjacent to mangrove forests. On the Makalapa Crater floor, in a low-lying area, the damp, dark-black organic soil is very saline; salt accumulation on the surface of the soil can be found in places. In this area, the vegetation is composed almost entirely of pickleweed.

Cultivated Wetlands -- Two areas used for wetland farming are found mauka of Kamehameha Highway. Almost all the wetland area below the Pearl Ridge Shopping Center fed by Kalauao Stream is under active watercress (Nasturtium microphyllum) cultivation by Sumida Farm, Inc. Adjacent to the Zippy's restaurant (450 Kamehameha Highway), the Waiau Spring feeds an area once under wetland cultivation. Old farm equipment, dikes, several wooden structures, etc., can still be seen. Dense mats of California grass (Brachiaria mutica) covers most of the formerly cultivated areas. Water hyacinth (Eichornia crassipes) is found in the deeper, open water areas.

Urban/Developed Lands

Dense residential and commercial developments are the primary features along the two corridors. No inventory was made of the plants in these areas as the vegetation consists of ornamental and landscaped species which are maintained in this urban setting; less well-maintained areas support an assortment of weedy (or ruderal) species. These lands have been greatly modified by humans so that no native plant communities remain.

2.3 Special Status Plants and Sensitive Plant Communities

Special status plants are officially listed, proposed or candidate species which have been identified by the U. S. Fish and Wildlife Service as Threatened or Endangered (USFWS 1985; Herbst 1987). Special status plants also include rare plants which have been identified by Fosberg and Herbst (1975). Sensitive native plant communities have been described and their occurrences noted by The Nature Conservancy of Hawaii in their Hawaii Heritage Program.

Almost all the lands along the two corridors has been developed or at least disturbed to some extent. The few areas which contain more or less natural vegetation types are dominated by introduced plant species. No special status species or sensitive native plant communities exist on or adjacent to the corridors.

2.4 Species Checklist

Following is a list of the terrestrial, vascular plant species found on the study site during the course of the field studies. The plants are divided into three groups: Ferns, Monocots, and Dicots. Within each of these groups, the plants are arranged alphabetically by family, genus, and species. Taxonomy and nomenclature of the Ferns are in accordance with Lamoureux (1984); flowering plants (Monocots and Dicots) follow Wagner et al. (in press). Common English names given follow St. John (1973), in most cases; Hawaiian names are in accordance with Porter (1972).

For each species, 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:
   - I = indigenous = native to the Hawaiian Islands but also native to one or more other geographic area(s)
   - P = Polynesian = plants of Polynesian introduction prior to Western contact (1778)
   - X = introduced or alien = brought to the islands intentionally or accidentally by humans after Western contact.
4. Vegetation type. Presence (+) or absence (-) of a species within each of two major vegetation types recognized on the study site (see text for discussion). No inventory was made for the Urban/Developed Lands.
   - s = Koa-haole Scrub
   - w = Wetlands

Scientific Name	Common Name	Status	Vegetation Type S	Vegetation Type W
FERNS				
SALVINIACEAE				
Azolla filiculoides Lamk.	azolla	X	−	+
MONOCOTS				
ARACEAE				
Colocasia esculenta (L.) Schott	taro, kalo	P	−	+
CANNACEAE				
Canna indica L.	canna	X	−	+
COMMELINACEAE				
Commelina benghalensis L.	hairy honohono	X	+	−
Commelina diffusa Burm. f.	honohono	X	+	+
CYPERACEAE				
Cyperus alternifolius L.	umbrella plant	X	−	+
Eleocharis geniculata (L.) R. & S.	eleocharis	X	−	+
Fimbristylis dichotoma (L.) Vahl	tall fringe rush	I	−	+
Kyllinga brevifolia Rottb.	green kyllinga	X	−	+
Pycreus polystachyos (Rottb.) Beauv.		I	−	+
Scirpus validus Vahl	great bulrush, 'aka'akai	I	−	+
GRAMINEAE				
Andropogon pertusus (L.) Willd.	pitted beard grass	X	+	−
Arundo donax L.	giant reed	X	+	−
Brachiaria mutica (Forsk.) Stapf.	California grass	X	+	+
Cenchrus echinatus L.	common sandbur	X	+	−
Chloris inflata Link	swollen finger grass	X	+	+

Scientific Name	Common Name	Status	Vegetation Type S	Vegetation Type W
Coix lachryma-jobi L.	Job's tears	X	-	+
Cynodon dactylon (L.) Pers.	Bermuda grass	X	+	+
Digitaria ciliaris (Retz.) Koel.	crab grass	X	+	+
Echinochloa colona (L.) Link	jungle rice	X	-	+
Echinochloa crusgalli (L.) Beauv.	barnyard rice	X	-	+
Eleusine indica (L.) Gaertn.	wire grass	X	+	-
Eragrostis tenella (L.) R. & S.	Japanese love grass	X	+	-
Panicum maximum Jacq. var. maximum	Guinea grass	X	+	+
Panicum maximum var. trichoglume Eyles ex Robyns	green panic grass	X	+	-
Paspalum conjugatum Berg	Hilo grass	X	-	+
Paspalum dilatatum Poir.	Dallis grass	X	+	+
Pennisetum purpureum Schumach.	elephant grass	X	-	+
Setaria verticillata (L.) Beauv.	bristly foxtail	X	+	-
Tricachne insularis (L.) Nees	sour grass	X	+	-
MUSACEAE				
Musa spp.	banana, mai'a	P/X	-	+
PALMAE				
Cocos nucifera L.	coconut, niu	P	-	+
PONTEDERIACEAE				
Eichornia crassipes (Mart.) Solms	water hyacinth	X	-	+
TYPHACEAE				
Typha latifolia L.	cattail	X	-	+
DICOTS				
ACANTHACEAE				
Asystasia gangetica (L.) T. Anders.	asystasia	X	+	-

Scientific Name	Common Name	Status	Vegetation Type s	Vegetation Type w
AMARANTHACEAE				
Alternanthera pungens HBK.	alternanthera	X	+	-
Amaranthus spinosus L.	spiny amaranth	X	+	-
Amaranthus viridus L.	slender amaranth	X	+	-
ANACARDIACEAE				
Mangifera indica L.	mango	X	+	-
Schinus terebinthifolius Raddi	Christmas berry	X	+	+
BATIDACEAE				
Batis maritima L.	pickle weed	X	-	+
BIGNONIACEAE				
Spathodea campanulata Beauv.	African tulip tree	X	+	-
BORAGINACEAE				
Heliotropium curassavicum L.	nena, kipukai	I	-	+
CAPPARACEAE				
Cleome gynandra L.	spider flower	X	+	-
CARICACEAE				
Carica papaya L.	papaya	X	-	+
CHENOPODIACEAE				
Atriplex semibaccata R. Br.	Australian salt bush	X	-	+
COMPOSITAE				
Ageratum conyzoides L.	ageratum	X	+	-
Bidens pilosa L.	Spanish needle	X	+	-
Calyptocarpus vialis Less.	hierba del cabello	X	+	-
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	+	-
Eclipta alba (L.) Hassk.	false daisy	X	-	+

Scientific Name	Common Name	Status	Vegetation Type S	Vegetation Type W
Emilia fosbergii Nichol.	red pua-lele	X	+	-
Pluchea indica (L.) Less.	Indian pluchea	X	+	+
Pluchea symphytifolia (Miller) Gillis	pluchea	X	+	-
Sonchus oleraceus L.	sow thistle	X	+	-
Tridax procumbens L.	coat buttons	X	+	-
Verbesina encelioides (Cav.) Gray	golden crown-beard	X	+	-
Youngia japonica (L.) DC.	Oriental hawksbeard	X	-	+
CONVOLVULACEAE				
Ipomoea alba L.	moon flower	X	-	+
Ipomoea aquatica Forsk.	ung-choi	X	-	+
Ipomoea cairica (L.) Sweet	koali-'ai	I	+	-
Ipomoea indica (J. Burm.) Merr.	koali 'awania	I	+	-
Ipomoea obscura (L.) Ker-Gawl	bindweed	X	+	+
Ipomoea triloba L.	little bell	X	+	-
Merremia aegyptia (L.) Urban	hairy merremia	I?	+	-
CRUCIFERAE				
Nasturtium microphyllum Boenn.	watercress	X	-	+
CUCURBITACEAE				
Momordica charantia L.	wild bittermelon	X	+	+
EUPHORBIACEAE				
Chamaecyse hirta (L.) Millsp.	hairy spurge	X	+	-
Chamaesyce hypericifolia (L.) Millsp.	wild spurge	X	+	-
Chamaesyce prostrata (Ait.) Sm.	prostrate spurge	X	+	-
Phyllanthus debilis Klein ex Willd.	phyllanthus	X	+	-
Ricinus communis L.	castor bean	X	+	+
LABIATAE				
Leonotis nepetaefolia (L.) Poit.	lion's-ear	X	+	-
LEGUMINOSAE				
Acacia farnesiana (L.) Willd.	klu	X	+	-

Scientific Name	Common Name	Status	Vegetation Type S	Vegetation Type W
Chamaecrista nictitans (L.) Moench.	partridge pea	X	+	-
Crotalaria incana L.	fuzzy rattle-pod	X	+	-
Desmanthus virgatus (L.) Willd.	virgate mimosa	X	+	-
Leucaena leucocephala (Lam.) de Wit	koa-haole	X	+	+
Mucuna sp.	mucuna	X	+	-
Pithecellobium dulce (Roxb.) Benth	'opiuma	X	+	-
Prosopis pallida (Willd.) HBK.	kiawe	X	+	+
Samanea saman (Jacq.) Merr.	monkeypod	X	+	-
Senna pendula (Humb. & Bonpl. ex Willd.) Irwin & Barneby	cassia	X	+	-
MALVACEAE				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon	X	+	-
Abutilon incanum (Link) Sweet	hoary abutilon	I	+	-
Hibiscus tiliaceus L.	hau	I	-	+
Malva parviflora L.	little mallow	X	+	-
Malvastrum coromandelianum (L.) Garcke	false mallow	X	+	-
Sida rhombifolia L.	Cuba jute	X	+	+
Sida spinosa L.	prickly sida	X	+	-
Thespesia populnea (L.) Correa	milo	P	-	+
MORACEAE				
Ficus microcarpa L. f.	Chinese banyan	X	+	-
MYRTACEAE				
Eugenia cumini (L.) Druce	Java plum	X	-	+
NYMPHAEACEAE				
Nelumbo nucifera Gaertn.	lotus	X	-	+
ONAGRACEAE				
Ludwigia octovalvis (Jacq.) raven	primrose willow, kamole,	I?	-	+

Scientific Name	Common Name	Status	Vegetation Type s	Vegetation Type w
OXALIDACEAE				
Oxalis corniculata L.	yellow wood sorrel	I?	+	-
PASSIFLORACEAE				
Passiflora foetida L.	red-fruited passionflower	X	+	-
PLANTAGINACEAE				
Plantago major L.	common plantain	X	-	+
PORTULACACEAE				
Portulaca oleracea L.	common purslane	X	+	-
RHIZOPHORACEAE				
Rhizophora mangle L.	mangrove	X	-	+
RUTACEAE				
Citrus spp.	citrus	X	-	+
SAPINDACEAE				
Cardiospermum halicacabum L.	balloon vine	X	-	+
SOLANACEAE				
Lycopersicon pimpinellifolium Mill.	currant tomato	X	+	-
Solanum americanum Mill.	popolo	I?	+	-
STERCULIACEAE				
Waltheria indica var. americana (L.) R. Br. ex Hosaka	hi'a-loa, uha-loa	I	+	-

Scientific Name	Common Name	Status	Vegetation Type S	Vegetation Type W
UMBELLIFERAE				
Centella asiatica (L.) Urban	Asiatic pennywort	X	-	+
VERBENACEAE				
Lantana camara L.	lantana	X	+	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	X	+	+

3.0 WILDLIFE

Information on the faunal resources found within the study site is scarce, largely because almost all the land along the two corridors is already developed. The wildlife on the study area is composed almost exclusively of introduced (or foreign) species. The few wetland areas on the site, however, are utilized to some extent by migratory shorebirds and native waterbirds.

3.1 Survey Methods

The field studies were conducted on May 04, 1988 between the hours of 0730 and 1500. Birds were detected by sight and their vocalizations. Mammalian presence and distribution were determined by sight and indirectly by tracks and scat.

Wetland areas were surveyed more intensively as native waterbird species are most likely to be found in these areas.

3.2 Wildlife Habitats

Within the survey area, there are few places with more or less unmaintained, natural vegetation. Koa-haole scrub provides habitat for the Northern Cardinal (_Cardinalis cardinalis_), Red-crested Cardinal (_Paroaria coronata_), and Japanese White-eye (_Zosterops japonicus_). A pair of White-rumped Shama (_Copsychus malabaricus_) was also observed in this habitat. Along the margins of the scrub, in open, grassy areas, Spotted Dove (_Streptopelia chinensis_) and Zebra Dove (_Geopelia striata_) can often be found feeding on seeds of weedy herbs and grasses. Small flocks of Nutmeg Mannikin (_Lonchura punctulata_) can also be found occasionally in these areas.

The area around the McGrew Point state park supports stands of mangrove forest and a small area with koa-haole scrub. Common

Myna (Acridotheres tristis), House Sparrow (Passer domesticus), Red-vented Bulbul (Pycnonotus cafer), and House Finch (Carpodacus mexicanus) were observed flying into and out of these wooded areas and the adjacent park. Mongoose (Herpestes auropunctatus) were heard in the koa-haole adjacent to the koa-haole scrub. A list of the bird species prepared for the McGrew Point Master Plan (Wilson Okamoto and Associates 1986) listed similiar species.

On mud flats along Aiea Stream, adjacent to the mangrove forest, four Black-crowned Night-Heron (Nycticorax nycticorax hoactli) were observed feeding on tilapia.

A list of all the avian species observed on the study site during the survey is presented in Table 1.

Although not observed during this study, Feral Cat (Felis catus), rats (Rattus rattus, Rattus norvegicus, Rattus exulans), and House Mouse (Mus musculus) are expected to occur on the project site.

3.3 Special Status Species and Important Wildlife Areas

Although the field survey focused on the wetland areas as endangered Hawaiian waterbirds are most likely to occur here, none were observed during the limited study. However, the Black-necked (Hawaiian) Stilt or Ae'o (Himantopus mexicanus knudseni), Common (Hawaiian) Moorhen or 'Alae-'Ula (Gallinula chloropus sandvicensis), and American (Hawaiian) Coot or 'Alae-Ke'oke'o (Fulica americana alae), all endangered species listed by the Federal and State governments, are expected to make occasional use of the wetland areas for feeding. For example, coot have have been censused from the Sumida watercress farm (Banko 1987).

No important wildlife areas such as wildlife refuges or major areas of waterbird concentrations are found on or near the corridors.

TABLE 1. Checklist of Avian Species Observed Along the Waiau-Makalapa Transmission Project Corridors

Common Name	Scientific Name	Status
Black-crowned Night-Heron	Nycticorax nycticorax hoactli	Indigenous
Spotted Dove	Streptopelia chinensis	Introduced
Zebra Dove	Geopelia striata	Introduced
Red-vented Bulbul	Pycnonotus cafer	Introduced
White-rumped Shama	Copsychus malabaricus	Introduced
Common Myna	Acridotheres tristis	Introduced
Japanese White-eye	Zosterops japonicus	Introduced
Northern Cardinal	Cardinalis cardinalis	Introduced
Red-crested Cardinal	Paroaria coronata	Introduced
House Finch	Carpodacus mexicanus	Introduced
House Sparrow	Passer domesticus	Introduced
Nutmeg Mannikin	Lonchura punctulata	Introduced

4.0 DISCUSSION AND RECOMMENDATIONS

Dense residential and commercial developments cover most of the area along and adjacent to the two corridors. Vegetation is dominated by introduced species; the few native plants on the project area are all indigenous, that is they occur throughout the Hawaiian Islands in similiar environmental conditions as well as other geographical areas. No remnant native plant communities or sensitive native species exist on the project area. The proposed project is not expected to have a *significant* negative impact on the botanical resources.

Introduced or foreign animal species characterize the faunal resources. Of the 12 avian species inventoried during this study, only the Black-crowned Night-Heron is native. No important wild-life areas are found along the two corridors, however, the wetlands may be utilized occasionally by native waterbirds, some of which are endangered. Care should thus be taken when working in these areas to prevent accidental spills of oil, fuel, and other toxic liquids which might pollute these wetlands.

5.0 LITERATURE CITED

Banko, W. E. 1987. Part I. Population Histories -- Species Accounts. Freshwater Birds: Hawaiian Coot 'Alae-ke'oke'o. CPSU/UH Avian History Report 12C, History of Endemic Hawaiian Birds. Univ. of Hawaii, NPS contract no. CX 8000 8 0012.

Elliott, M. E. and E. M. Hall. 1977. Wetlands and Wetland Vegetation of Hawaii. Prep. for the U.S. Army Corps of Engineers, Pacific Ocean Div., Ft. Shafter, Honolulu. Contract no. DACW 84-77-C-0014.

Fosberg, F. R. and D. Herbst. 1975. Rare and endangered species of Hawaiian vascular plants. Allertonia 1(1): 1-72.

Herbst, D. 1987. Status of endangered Hawaiian plants. Hawaiian Botanical Society Newsletter 26(2): 44-45.

Lamoureux, C. H. 1984. Checklist of Hawaiian Pteridophytes. Manuscript.

Porter, J. R. 1972. Hawaiian Names for Vascular Plants. Coll. of Tropical Agriculture, Univ. of Hawaii (Manoa). Departmental Paper No. 1.

St. John, H. 1973. List and Summary of the Flowering Plants in the Hawaiian Islands. Pacific Tropical Botanical Garden Memoir No. 1, Lawai, Kauai.

U. S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; Review of plant taxa for listing as Endangered and Threatened Species; Notice of review. Federal Register 50 (188): 39526-39527 + 57 p. table.

Wagner, W. L., D. Herbst, and S. Sohmer. In press. Manual of the Flowering Plants of the Hawaiian Islands. Bishop Museum, Honolulu.

Wilson Okamoto and Associates, Inc. 1986. Aiea Bay State Recreation Area Conceptual Master Plan and Draft EIS. Prep. for State Dept. of Land and Natural Resources.

Appendix E

Cultural Resources Technical Report and Field Survey Report

APPENDIX E

PHASE I CULTURAL RESOURCES TECHNICAL REPORT

AND

PHASE II FIELD SURVEY REPORT

FOR

THE WAIAU-MAKALAPA NO. 2 138 kV TRANSMISSION LINE

HAWAIIAN ELECTRIC COMPANY

By
Archaeological Consultants of Hawaii

For
CH2M HILL

August 1988

CONTENTS
PART I

PART II

PART I
INTRODUCTION

This study identifies existing cultural resources located between the Hawaiian Electric Waiau Power Plant and the Makalapa Substation.

This is a file search study and was conducted in February, 1988. As a result of the file search investigation, it was determined that a single National Register District exists within the study area (Pearl Harbor Naval Base) and that this National Register District has also been determined to be a National Historic Landmark.

A constraint system was devised for this report and was to be applied to any sites identified within the study area. Basically, there are three degrees of constraint (high, medium and low) which may be defined as follows:

HIGH CONSTRAINT AREAS are defined as unique, highly valued or complex resource areas that may conflict with current or planned use, or areas possessing substantial hazards to construction or operation of a transmission line. Impacts on these resource areas or conflicts with these hazards typically require rigorous and costly mitigation or high design and construction costs.

MEDIUM CONSTRAINT AREAS are defined as important, valued resources, resource hazards, special status resources or those with some potential for conflict with current or planned use, or areas possessing some hazards to construction or operation of a transmission line. Impacts on these resource areas or conflicts with these hazards typically require potentially difficult mitigation.

LOW CONSTRAINT AREAS are defined as areas of opportunity where little or no conflict with the proposed project will occur; no unique or special features occur; or resource conflict or hazards to construction or operation can be routinely mitigated through compensation, location or design.

In addition, a predictive model was developed for the study area. Archaeological possibilities are discussed by the presentation of predictive areas within the study area that are, (1) unsurveyed with a high likelihood of archaeological recovery, (2) unsurveyed with a medium likelihood of archaeological recovery and (3) unsurveyed with a poor likelihood of archaeological recovery. The reader may wish to refer to the Predictive Model Section of this report for an elaboration of these terms.

LOCATION AND SETTING

The study area is located along a portion of the south shore of the island of Oahu, State of Hawaii. The proposed transmission line will run between the Hawaiian Electric Waiau Power Plant, located on the shore of the East Loch of Pearl Harbor and the Makalapa Substation which is located near Radford High School in Foster Village (see Figure 1).

This area of the island has been heavily industrialized and includes substantial residential settlements as well. These include: Pearl City, Aiea, Aliamanu, and Foster Village. At this writing, there is very little open land that has not been subject to disturbance.

ETHNOGRAPHIC AND HISTORIC OVERVIEW

The study area covers a small portion of eight different ahupua'a in the Ewa district on the island of Oahu. These ahupua'a are: Waiawa, Manana, Waimano, Waiau, Waimalu, Kalauao, Aiea and Halawa.

Halawa

It is known that the flatland area of this political unit (comprising that portion of the ahupua'a that falls within the study area) was once the location of cultivation terraces. There are, of course, a number of mythological associations connected with the ahupua'a in general.

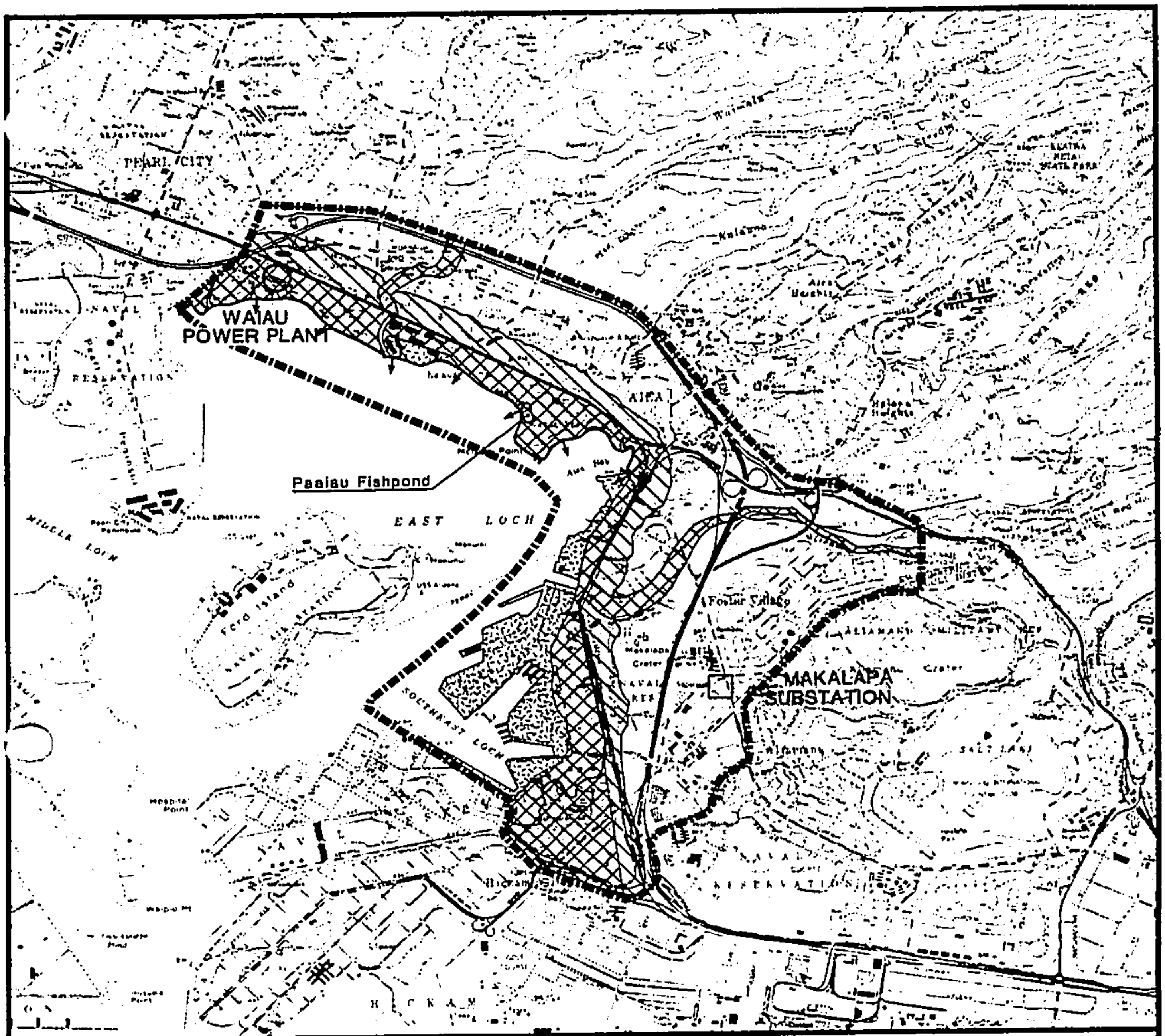
Aiea

Again, like Halawa, that portion of Aiea which enters the present study area was once the location of taro terraces and other cultivation. Perhaps the most famous aboriginal site in the ahupua'a is Keaiwa Heiau located at the top of Aiea Heights Road, some miles from the mauka boundary of the present study area.

Kalauao

Terraces were a predominant feature of the low-lying areas of this ahupua'a. In addition, here was the home of Kalaimanu, chieftess of Oahu; it was called Kukiiahu.

Kukiiahu was also the scene of a famous battle where Kalanikupule defeated his uncle Kaeo with the help of some English seamen. This is also known as the battle of Ewa which took place sometime in December, 1794.



CULTURAL RESOURCES

- Study Area Boundary
- Unsurveyed Areas with Good Cultural Resource Potential
- Unsurveyed Areas with Moderate Cultural Resource Potential
- Unsurveyed Areas with Poor Cultural Resource Potential
- Fill Area with Poor Cultural Resource Potential
- National Historic Landmark Boundary

0 1000 2000 5000 10,000 FEET

0 1/4 1/2 1 2 MILE

NORTH

FIGURE 5.2-8

Waiau - Makalapa No. 2 Transmission Line Project

Hawaiian Electric Company

CH2M HILL

Waimalu

For three quarters of a mile from the shoreline, terraces and banana groves were the dominant cultural features. There have been reports of at least one Heiau (destroyed) and burial caves in the lower section of this ahupua'a. In Waimalu was also the residence of Paul Marin. The exact location of Marin's house in Waimalu is unknown.

Waiau

Waiau has legendary association with the shark goddess Kaahupahu who was said to have a bathing place at Puhikani. There is also a report of a heiau called Kolokukahau (destroyed) and a field for the playing of the game maika.

Waimano

Campbell in his Voyage Around the World from 1806 to 1812 noted Waimano as a fertile plain in the "highest state of cultivation". He mentioned taro beds, yams, sweet potatoes, coconuts and at least three homes of some account. One of these was occupied by a Mr. William Stevenson who was the first man to produce Okolehau, the distilled version of ti.

Manana

There is some mention of "a few terraces" fed by Waiawa Stream. Manana was also the location of the Pearl City Stone once thought of supernatural origin to Hawaiians and later removed by Hawaiians who had converted to Mormons. It is said that the men who moved the stone died under mysterious circumstances.

Waiawa

There are map listings of an Old Ewa Church and Old Mission here as well as references to maika game fields and legendary associations.

Waipio

This was the site of many irrigated taro patches and the destroyed heiau Ahuena. It is also famous for being a place where Kamehameha the Great fell ill. John I'i was born in Waipio and it is said that tapa from mamaki bark originated from this ahupua'a.

As mentioned, this area has been subjected to massive disturbances and it is unlikely that any of the features mentioned in this section are still extant. This information is presented to give a brief indication of possible subsurface indications.

METHODOLOGY

The data presented in this report was collected in two basic ways - discussions with the naval archaeologist and the Oahu specialist at the Historic Sites Section of the Department of Land and Natural Resources (DLNR) and review of report documents on file at DLNR. In addition to this, information was gathered from Gilbert McAllister's 1931 survey of the island. Ethnographic and ethnohistoric data was taken from Summers and Sterling's 1978 Sites of Oahu. For a discussion of how constraint criteria will be applied to project area see following section (Predictive Models).

PREDICTIVE MODELS

Three areas of archaeological potential were established within the study area based on discussions with the Oahu specialist Historic Sites Section, Department of Land and Natural Resources (Fig. 1). Ecological factors relating to site frequency were primary determinants. Boundaries between the three areas were arbitrarily established. The three areas may be defined as follows:

Unsurveyed Area with High Archaeological Site Potential.

Archaeological site inventory information in Hawaii demonstrates that site frequency is quite high in shoreline and riverine areas. As can be seen in the location map for this area, both shoreline (primarily East Loch of Pearl Harbor and Aiea Bay) and riverine environments (the lower sections of Waimalu, Kalauoo, Kalauea, and Halawa Streams) are present. Determination for this category is based on a number of criteria. To begin with, similar environmental settings on other Hawaiian islands (and on Oahu as well) have proven to contain a high number of sites and other types of important archaeological data. Ethnographic and ethnohistoric data for the area also indicates that there is an excellent chance that information relating to these topics may also be forthcoming. It should be noted that above ground indications are unlikely due to urbanization and potentials will most likely be subsurface, if present at all.

Unsurveyed Area with Medium Archaeological Site Potential.

This determination is established to identify those sections of the study area which have not been surveyed but which may afford the chance of archaeological site discovery. Such areas are not considered very promising but previous survey projects in similar settings around the state have turned-up a variety of site types, albeit at a rather low frequency.

Unsurveyed Area with Low Archaeological Site Potential.

These are locations within the study area where archaeological recovery is unlikely. Large sections of land that have been disturbed considerably by urbanization, sugarcane and pineapple cultivation. Most important in the formation of this consideration is the supposed land use existent before these activities took place. For example, urban archaeology is a fast growing subfield and archaeological recovery in so called "plow zones" has been quite productive. However, in terms of this report, much of the urbanized and farming land considered a poor candidate for archaeological recovery was done so with the indication that prehistoric activities were unlikely to have occurred here.

The reader may wish to refer to the location may (Fig. 1) for the exact position of these three predictive zones within the study area.

RESULTS

A number of documents were examined for this area at the Historic Sites Section of the Department of Land and Natural Resources. To date, there are 10 reports relating to this general area of the island of Oahu.

Most of those reporting site locations are associated with early survey work for the H-3 Freeway. The survey areas for this proposed construction are located just outside the present transmission line study area.

While almost all other reports detail survey activity that resulted in finding no sites, one entitled "The Archaeology of Ewa," The Ahupua'a of Halawa, Halawa Interchange Survey by Deborah F. Cluff in 1970 is a notable exception.

In this survey, located in the Halawa Interchange section of the H-1 Freeway, Cluff discovered two cemeteries - one historic, one prehistoric - a heiau and other aboriginal style features including a house platform.

Of particular interest is her comment in the conclusions and recommendations section on page 24 of the report where it is stated, "...the findings of the survey, which covered only a portion of the total area to be occupied by the Halawa Interchange construction, do not preclude the possibility of significant archaeological remains in the area not yet examined."

Later in this section, Cluff mentions that the cemeteries will have to be relocated according to state law and that th remainder of the adjacent area be evaluated by a qualified archaeologist. There is no record of this having been done. It is likely, however, that the human burials were removed, as the proposed freeway interchange has been constructed according to state law.

Within the study area, a single National Historic District has been identified - this is the Pearl Harbor Naval Base. The entire base was also designated as a National Historic Landmark by the Secretary of the Interior in 1964. A Historic Preservation Plan for the base was prepared in February of 1978.

The Pearl Harbor Naval Base enjoys National Register as well as National Historic Landmark status not only because of its associations with a celebrated air attack in 1941 but also because of its age of the base and its development as a naval facility over the years.

It should be noted that all the existing facilities on the base are considered on the National Register as well as any archaeological structures or fishponds yet to be discovered as well as any prehistoric or historic subsurface materials.

It should be noted that there has not been a comprehensive archaeological inventory of existing prehistoric surface sites on the Pearl Harbor Naval Base nor any subsurface testing that would lead to predictive models.

The only recorded, individual sites located within the study area are those associated with the Pearl Harbor Naval Base.

These may be divided into three rough categories; (1) those existing buildings and facilities that are identified in the Pearl Harbor Historic Preservation plan, (2) the fishponds of aboriginal Hawaiian construction that may still exist within the limits of the naval base and (3) those yet-to-be-identified archaeological features both above and below the surface.

FISHPONDS IN PEARL HARBOR

There were once at least 27 fishponds listed for the Pearl Harbor area. Today, they may be broken down in the following way:

Destroyed

Loko Waiaho - known as Queen Emma's pond

Loko Pohaku - present site of Navy Yard

Wailolokai - located at Halawa

Site 100 - also could be Wailolokai

Filled In

Loko Ke'oki - near Watertown in Halawa

Papiolua - opposite the tip of Waipio

Loko a Mano - filled before 1900

Loko Kunana - between Halawa and Kuahua Island, could be partially filled

Loko Muliwai - between Halawa and Kuahua Island

Kahakupohaku - near old Aiea Railroad Station

Loko Opu - partially filled

Kukona Pond - Waiau

Loko Weloko - Waimano

Loko Paauau - Pearl City Peninsula

Loko Apala - Waiawa

Loko Kuhialoko - SW side of Pearl City Peninsula

Loko Eo - north end of Waipio Peninsula

Fishponds Thought to Still Exist

Loko Paaiau - swampy, located at Kalauao

Loko Paakea - Waimalu

Loko Moo - near railroad tracks in Waimalu

Kaaukuu - Waikele

Pouhala - Waikele

Laulaunui - adjoining Laulaunui Island

Kapaumoku - opposite tip of Waipio Peninsula

Okiokilepe - Puuloa

It will remain for the field work portion of this report to make a final determination concerning the status of those fishponds thought to still exist.

POTENTIAL IMPACTS/SITING ISSUES

In considering the siting, design and construction of a 138 kV transmission line within a yet-to-be-determined corridor between the Waiau Power Plant and the Makalapa Substation, the cultural resources contained within the entire study area (both archaeological and historic) and their attendant importance must be addressed.

In this case, the most obvious limiting cultural resource factor is the Pearl Harbor Naval Base National Register District/National Historic Landmark. It should be noted that this determination does not, in itself, preclude possible routing avenues. Impacts to sites, or districts, included on the National Register are routinely mitigated by appropriate archaeological measures.

The same holds true for portions of the subject property that have been determined to have high potential for archaeological recovery. It is in these areas, however, where special care must be taken in recognition of supposed potentials. Areas of medium potentials must be given due consideration but not with such a high degree of attention. Areas of low or poor potential are consistent with substantially disturbed regions where aboriginal/historic activities are figured to be very low or nonexistent.

In terms of the potential routing of the proposed Hawaiian Electric 138 kV transmission line through any portion of the Pearl Harbor Naval Base, it should be noted that special attention will have to be paid to the Historic Preservation Plan for the base, discussions with the Naval archaeologist, the State Historic Preservation Office, and the Advisory Council on Historic Preservation.

CONSTRAINTS TO SITING

The only type of cultural resource that would preclude (EXCLUSION AREA) the siting of a transmission line would be a National Historic Park. For example, impacts to the Pearl Harbor National Register District/National Historic Landmark can be mitigated by standard archaeological methods. As a result this district may be considered a MEDIUM CONSTRAINT AREA. There may, however, be some individual sites located within this area that must be considered HIGH CONSTRAINT AREA.

DATA FACTORS	CONSTRAINT RATING
National Historic Park (e.g., Arizona Memorial)	High
Selected National Register or Landmark Sites	High
Petroglyphs	High
National Register or Landmark Sites in General	Medium
Unsurveyed Areas with High likelihood of Archaeological Recovery	Medium
Unsurveyed Areas with Medium likelihood of Archaeological Recovery	Medium
Unsurveyed Areas with a Poor likelihood of Archaeological Recovery	Low

The criteria used in assigning these constraint ratings are as follows and are taken from an undated Outline for Waiau-Campbell Industrial Park Transmission Line Project Phase I Report, p.3. This document was used due to the similarities between the leg of the project and this.

PART II

ARCHAEOLOGICAL FIELD SURVEY REPORT

INTRODUCTION

As a partial requirement of the subconsultant services agreement between CH2M HILL Northwest, Inc. and Archaeological Consultants of Hawaii, Inc., a field survey has been conducted along a preferred corridor within a larger study area defined by Hawaiian Electric Company (see Figure 2). This corridor has been established in anticipation of the placement of a proposed 138 kV transmission line.

As stated in the Cultural Resources Scope of Work, "The field survey for cultural resources within the preferred corridor will be accomplished with the overall objective of identifying, recording and assessing the significance of resources." Accordingly, this field study report will 1) describe existing archaeological sites within the preferred corridor (if any), 2) identify survey methods, 3) review a selection of pertinent archaeological literature and 4) discuss archaeological potentials within the preferred corridor.

The field work was conducted between May 15 and May 30, 1988, by two qualified archaeologists with a combined total of over 30 years field experience in Hawaii. As a result of the field investigations, it was determined that a single National Register District exists within the study area (Pearl Harbor Naval Base), and that this National Register District has also been determined to e a National Historic Landmark. This survey was done in order to comply with Hawaii Revised Statutes, Chapter 6E.

LOCATION AND SETTING

The location and setting for this field study has been described in Part I of this report. It should be noted that field examination was restricted to the preferred corridor.

PREVIOUS ARCHAEOLOGICAL WORK WITHIN THE PREFERRED CORRIDOR

The primary piece of research upon which information in this report is based was conducted by the author in February of 1988 and entitled Phase I Cultural Research Technical Report for the Waiau-Makalapa No. 2 Transmission Line.

In this report, archaeological and archival records in the State of Hawaii, Department of Land and Natural Resources, Historic Sites Section, were reviewed in order to collect and present a list of previous archaeological projects that have been conducted within a large study area defined by the Hawaiian Electric Company. It is within this broad study area that the preferred corridor is located. The reader may wish to refer to the February 1988 report and accompanying site location map for a listing and location of identified sites within the broad study area.

1) Archaeological sites or districts recorded on the National Register of Historic Places.

Within the study area, a single National Historic District has been identified - this is the Pearl Harbor Naval Base. The entire base was also designated as a National Historic Landmark by the Secretary of the Interior in 1964. A historic Preservation Plan for the base was prepared in February of 1978. Pearl Harbor enjoys National Register as well as National Historic Landmark status not only because of its associations with a celebrated air attack in 1941 but also because of the age of the base and its development as a naval facility over the years.

It should be noted that all existing facilities on the base are considered on the National Register as well as any archaeological structures or fishponds yet to be discovered as well as any subsurface materials. To date, no formal archaeological survey of the base has been performed.

As far as the preferred corridor is concerned only one National Register Site is involved - that being a portion of Pearl Harbor Naval Base. A limited field check of this potentially impacted site was conducted and the results of this inspection are discussed below.

The Pearl Harbor Naval Base is a heavily modernized complex of buildings, roads and ship repair and support facilities that for the most part preclude the existence of any remaining surface archaeological features. Beyond this, much of the shoreline of the naval base has been transfigured by extensive fill operations. Should some agreement be forthcoming that would allow the proposed 138 kV line to pass through the base proper, it is highly unlikely that any surface archaeological sites would be endangered.

The exception to this may be the few remaining fishponds that still exist at different locations on base. Records indicate that, perhaps, only eight of the original twenty-eight ponds in the area are still extant; most have either been completely destroyed or else filled-in. Of those eight that are thought to remain, none are operational and it is, again, highly unlikely that the construction of a 138 kV line through a portion of Pearl Harbor Naval Base would have an effect on any of the remaining ponds.

2) Reports on File at the State of Hawaii Historic Sites Division, Department of Land and Natural Resources.

Based on the data collected and the map produced in the Phase I Cultural Resources Technical Report for the Waiau-Makalapa No. 2 Transmission Line Report, (Phase I of this report) there are no recorded archaeological sites located within the limits of the preferred corridor as drawn. Survey reports mentioned in Phase I detailed work conducted outside of this study area.

SURVEY METHODS

Due to environmental conditions, and especially the artificial landscape that comprises most of the study area, it was determined that the majority of survey work could be conducted by automobile. Pedestrian examination by two archaeologists took place by systematic compass transects in the few sections where this was necessary. The pedestrian survey areas consisted of a few vacant lots and open grassy areas. Spacing of transects varied according to visibility in these areas and did not exceed five meters.

The only exceptions to this were the partially submerged mangrove areas in and around Pearl Harbor where access was impossible. It should be noted that these are regions where surface archaeological features are almost completely nonexistent.

As mentioned earlier, visibility was poor in some areas due to thick stands of grasses, vines and mangrove; therefore 100% coverage of non-urbanized or unused plantation land was not possible.

PREDICTIVE MODEL

A detailed explanation of how unsurveyed areas with high, medium and low site potential were determined for the study area has been discussed in Phase I of this report, pages 5 and 6. Field work conducted in the preferred corridor included examination of land in high and medium site potential areas (see Figure 1 and 2). Both areas were surveyed in identical fashion, i.e., "windshield" survey in urbanized, military and residential areas, pedestrian transects in the few open and undisturbed areas.

Unsurveyed Areas with High Site Potential

Most of the preferred corridor begins at the Waiau Power Plant and runs makai of Kamehameha Highway to the shoreline most of the way to Aiea Bay. It is worth restating, however, that due to heavy urbanization and fill activities it is highly unlikely that any archaeological surface features will be impacted by construction of the proposed transmission line. The designation "high likelihood of archaeological recovery" refers to subsurface potentials - and even these potentials must be considered suspect due to substantial subsurface disturbances.

Field examination of this area revealed mostly urbanized Waimalu, Pearlridge, Aiea, Foster Village and Makalapa, complete with dense housing and light industrial districts; schools, roads, eating establishments and municipal buildings comprise the remainder of land in this "High Site Potential" area. As expected, no surface archaeological features were noted. Visibility was good in most open areas but was restricted in some others by dense overburden.

Unsurveyed Areas with Medium Site Potential

Most of the preferred corridor is routed across land where the expectation of archaeological recovery has been designated "medium" (see Figures 1 and 2). No surface features were encountered in this portion of the preferred corridor.

Unsurveyed Areas with Low Site Potential

No part of the preferred corridor is classified as having a "low" potential for discovering archaeological sites.

RESULTS, POTENTIAL IMPACTS, CONSTRAINTS TO SITING

No surface sites of archaeological significance remain in, or along, the route of the preferred corridor. This is not surprising given the route of the corridor through heavily modernized and urbanized areas of Waimalu, Pearlridge, Aiea, Foster Village, Makalapa and the Pearl Harbor Naval Base. Nevertheless, it must be said that archaeologial potentials continue to exist for some portions of the preferred corridor.

These potentials exist in the form of buried deposits and/or structures and burials that may well sit below land in high and medium site potential areas. Results of recent urban archaeological projects in Hawaii and elsewhere have indicated that substantial subsurface deposits often remain intact below heavily modernized surface conditions.

The greatest potential for subsurface recovery corresponds to those areas designated as having a "High Site Potential" on the Cultural Resources Environmental Map prepared by the author and CH2M HILL in the Phase I Cultural Resources Technical Report for the Waiau Makalapa No. 2 Transmission Line Project.

A noted exception to this may be burials. While traditional burial patterns seem to indicate group deposits in or near settled areas are a norm, it is not unheard of to discover group or individual burials in somewhat remote areas as well.

Both "High" and "Medium" Site Potential Areas have a medium constraint rating; a "High" constraint rating applies to the entire Pearl Harbor Naval Base as per definitions and discussions presented on page 9 of this report.

BIBLIOGRAPHY

Bath, Joyce	Department of Land and Natural Resources, Historic Sites Section Personal Communication, Feb. 1988
Cordy, Ross	Department of Land and Natural Resources, Historic Sites Section Personal Communication, Feb. 1988
Cluff, Deborah F.	The Archaeology of Ewa. Halawa Interchange Survey. Hawaii State Archaeological Journal 70-1 DLNR, Honolulu, 1970
Heffner, J.	Department of Defense Police Pearl Harbor Naval Base Personal Communication, May 1988
Hommon, Robert	U.S. Navy Archaeologist Pearl Harbor Naval Base Personal Communication, Feb. 1988
McAllister, Gilbert	Archaeology of Oahu BPBM Bull. #104, Honolulu, 1933
Summers, E. & Sterling, C.	Sites of Oahu. BPBM, Department of Anthropology, Honolulu, 1978

Appendix F
Potential Permits and Authorizations

Appendix F
POTENTIAL PERMITS AND AUTHORIZATIONS

HAWAIIAN ELECTRIC COMPANY

CH2M HILL
November 1989

PDX399.047.50.1

INTRODUCTION

The construction of the Waiau-Makalapa No. 2 138 kV Transmission Line will require a number of permits or authorizations. Each of the potential permits or authorizations that may be required for the project in any of the preferred alignment segments is profiled in the following section. Routine construction or building permits are not included in this list.

FEDERAL AGENCIES

Agency	Corps of Engineers, U.S. Department of the Army
Permit	Section 10 Permit General Permit for Utility Crossings
Reference	Section 10 of the Rivers and Harbors Act of 1899, as amended (33 USC 403); 33 CFR 320-330
Action Requiring Permit	Applies to utility crossing of navigable waters of the United States, including coastal and tidal waters, rivers, and the mouths of major streams. Activities requiring the general permit include construction of wires, cables, or other structures over the waters, and pipes, cables, or tunnels under the water; dredging and excavation; and depositing fill and dredged materials.
Process	Permit request filed with the U.S. Army Corps of Engineers. At least 30 days prior to commencing the work, District Engineer must authorize the work by writing to the applicant. The District Engineer also coordinates the notification of the agencies of the proposed activities at least 20 days prior to the date that an activity will begin and consider their comments before authorizing the project. The agencies notified include both state and federal entities. The permit is effective for 5 years from the date of issuance and may be considered for revalidation at that time.
Source	33 CFR 320-330; 33 USC 403 General Permit PODCO-O GP 77-1E, July 11, 1988
Contact	Warren Kanai, Operations Branch, Regulatory Compliance Section Phone: 438-9258

Agency	Corps of Engineers, U.S. Department of the Army
Permit	Section 404 Permit
Reference	Section 404 of the Federal Water Pollution Control Act (Clean Water Act, 33 USC 1344); 33 CFR 320-330
Action Requiring Permit	Applies to dredge and fill activities in the waters of the United States, including coastal and tidal waters, ponds, rivers, streams, and wetlands. Activities requiring permits include any dredging and excavation, depositing of fill and dredged materials, or filling of wetlands.
Process	Permit request filed with the U.S. Army Corps of Engineers. Public notice issued, usually providing 30-day comment period. District Engineer prepares Environmental Assessment or Environmental Impact Statement. Permit can be issued within 60 days after receipt of a complete application if project is not controversial and no substantive objections are received.
Source	City and County of Honolulu, Permit Register, February 1987. 33 CFR 320-330; 33 USC 1344
Contact	Warren Kanai, Operations Branch, Regulatory Compliance Section Phone: 438-9258

Agency	Council of Environmental Quality/ Federal Agency Taking Action or Issuing Permit
Permit	National Environmental Policy Act (NEPA) Compliance
Reference	40 CFR Chapter 5
Action Requiring Permit	Any federal action (including issuing a permit) that may significantly affect the environment. The U.S. Corps of Engineers, for example, must comply with NEPA in issuing a Section 404 or Section 10 Permit.
Process	Before issuing a permit or taking action, the federal agency reviews the proposal to determine the potential for significant environmental effects. The product of the review may be a Categorical Exclusion, Environmental Assessment (EA), and/or an Environmental Impact Statement (EIS). Both EAs and EISs include mandatory public hearing and review periods.
Source	40 CFR Chapter 5
Contact	The agency issuing the permit

Agency	Federal Aviation Administration
Permit	Notice of Proposed Construction or Alteration Determination of No Hazard to Air Navigation
Reference	Section 307, Federal Aviation Act of 1958; 14 CFR 77.1 et seq.; Advisory Circular No. 70/7460-2H, dated November 15, 1986
Action Requiring Permit	Erection or alteration of an object that may affect navigable airspace if (1) taller than 200 feet above ground level at its location or (2) within air interference zone (defined in the regulations by distance from runway and height of the object).
Process	Must be filed with the Manager, Airspace and Procedures Branch, FAA Western-Pacific Regional Office (Los Angeles), at least 30 days prior to the earlier of construction or the filing of a building permit. The FAA acknowledges in writing, stating whether the proposal would exceed any FAA standard, would be a hazard to air navigation, or would require lighting or marking. State Department of Transportation coordinates for FAA in Hawaii, and the Barbers Point Naval Air Station will be consulted.
Source	City and County of Honolulu, Permit Register, February 1987, Henry Sumida, Department of Transportation, Airports Division Federal Aviation Regulations, Part 77
Contact	Henry Sumida Department of Transportation Airports Division Phone: 541-1230 David J. Welhouse FAA, Honolulu Airports District Office Phone: 541-1243

STATE AGENCIES

Agency	Coastal Zone Management, Office of State Planning (State of Hawaii)
Permit	Coastal Zone Management (CZM) Program Federal Consistency
Reference	Section 307, National Coastal Zone Management Act of 1972, as amended (16 USC 1451, et seq.); Section 205A-3(3), Hawaii Revised Statutes; 15 CFR 930
Action Requiring Permit	Activities requiring a federal license, permit, or permission that are likely to affect land or water uses in the Coastal Zone (defined as all land areas within the state except for state forest reserves). Such federal permits include Corps of Engineers Section 404/Section 10 Permits.
Process	As part of the application to the federal permitting agency and to the DBED (with a copy to the City/County Department of Land Utilization), applicant includes an assessment of the activity's impacts with respect to Hawaii's CZM objectives and a statement that the activity is consistent with the CZM program. Submission should be 90 days before a final decision is made by the permitting agency. Within 90 days after a review process, including public comment, DBED must approve consistency statement or prescribe conditions for consistency.
Source	Department of Planning and Economic Development, <u>Hawaii Coastal Zone Management Program Federal Consistency Procedures Guide</u>, April 1985
Contact	John Nakagawa/Doug Tom, Coastal Zone Management, Office of State Planning Phone: 548-5973

Agency	Department of Health (State of Hawaii)
Permit	Variance from Community Noise Control Rules
Reference	Hawaii Revised Statutes, Chapter 342; Title 11, Administrative Rules, Department of Health, Chapter 43: Community Noise Control for Oahu
Action Requiring Permit	Use or operation of vehicles, construction equipment, power tools, sound amplifiers, and other devices that emit or may emit noise levels in excess of the limits specified in the regulations, or at times other than those allowed by the regulations.
Process	Application must be submitted at least 30 days before activity to begin. The application will be reviewed by the Director of the Department of Health. The following factors will be considered:

- Whether the proposed noise-emitting activity is in the public interest as defined by HRS §342-6
- Whether the services or activities for which the permit is sought are temporary and cannot be delayed, postponed, or rescheduled to a time period in which such services are permitted
- Whether the applicant requires additional time to alter or modify his activity or operation to comply with this rule
- Whether the applicant has disclosed any possible impact from noises created by the proposed nighttime activity that may affect the immediate surroundings
- Whether the applicant plans to notify the people in the surrounding area of planned nighttime activity

A decision to grant or deny the permit will be made by the Director within 30 days. If the Director does not act on the application within 30 days, the permit is deemed granted. Each permit is valid for only a specific location, date(s), and time period.

Source — Title 11, Administrative Rules, Department of Health, Chapter 43: Community Noise Control for Oahu

Contact — Thomas M. Anamizu, Department of Health
Phone: 548-3075

Agency	Department of Land and Natural Resources, State Historic Preservation Program (State of Hawaii)
Permit	Historic Site Review
Reference	Hawaii Revised Statutes Chapter 6E
Action Requiring Permit	Any construction or alteration on a site listed in the Natural Register of Historic Sites, Hawaii Register of Historic Places or historic properties owned by the state or county even if not listed.
Process	Application filed 90 days ahead of proposed start date. Department responds in 90 days with permission to proceed, requirement to investigate further, or initiation of condemnation proceedings to acquire the property.
Source	City and County of Honolulu, <u>Permit Register</u>, February 1987 HRS Chapter 6E
Contact	Dr. Don Hibbard, State Historic Preservation Program, DLNR Phone: 548-6408

Agency	Department of Land and Natural Resources, Division of Water and Land Development (State of Hawaii)
Permit	Stream Channel Alteration Permit
Reference	State Water Code CH 174c-71 (3a)
Action Requiring Permit	Required for any channel alteration including actions that (1) obstruct, diminish, destroy, modify, or relocate a stream channel; (2) change the direction of flow of water in a stream channel; (3) place any material or structures in a stream channel; and (4) remove any material or structures from a stream channel. Permit applies to any stream on Oahu either intermittent or perennial.
Process	Prior to undertaking any stream channel alteration, the proponent must apply for a permit to the Water Resources Commission. Water Code CH 174c-93 outlines the process used and the contents of the application. Within 30-days after the completion of the construction or alteration of any stream diversion work, the permittee must file a written statement of completion with the Commission. The Commission shall designate the form of such statement and such information it requires.
Source	State Water Code CH 174c.71(3a), Department of Land and Natural Resources, personal interview with Sherrie Samuels, July 18, 1988
Contact	S. Samuels, Division of Water and Land Development, DLNR Phone: 548-7543

Agency	Department of Land and Natural Resources, Division of Land Management (State of Hawaii)
Permit	Easement for Use of State Lands
Reference	Hawaii Revised Statutes Chapter 171
Action Requiring Permit	Easement for Use of State Lands
Process	Application to the Division of Land Management, DLNR, must be accompanied by environmental assessment. The Division of Land Management recommends to the Board of Land and Natural Resources, the permitting body.
Source	City and County of Honolulu, <u>Permit Register</u>, February 1987; HRS Chapter 171
Contact	Mike Shimabukuru, Division of Land Management, DLNR Phone: 548-2574

Agency	Department of Transportation, Harbors Division (State of Hawaii)
Permit	Permit for Construction to Cross or Enter the State Energy Corridor
Reference	Hawaii Revised Statutes Chapter 277
Action Requiring Permit	Any construction within or crossing the established Energy Corridor.
Process	Applicant submits plans to DOT and each current tenant of the Energy Corridor (HIRI and GASCO, Inc.). Applicant is responsible for satisfying tenants' and DOT's requirements. When such requirements are satisfied, applicant forwards copies of each tenants' approval to DOT, which prepares easement document and assesses rental fee.
Source	City and County of Honolulu, Permit Register, February 1987; HRS Chapter 277
Contact	Derrick Lining, Property Manager, Harbors Division, DOT Phone: 548-2525

Agency	Department of Transportation, Highways Division (State of Hawaii)
Permit	Permit to Perform Work on a State Highway
Reference	Hawaii Revised Statutes Chapter 264; Department of Transportation Administrative Rules Chapter 105, Title 19
Action Requiring Permit	Any work within the state highway right-of-way (ROW).
Process	Permit issuance is contingent on approval by DOT of construction plans and adherence to all requirements of Chapter 264, Hawaii Revised Statutes.
Source	City and County of Honolulu, <u>Permit Register</u>, February 1987. Department of Transportation, Administrative Rules Chapter 105, Title 19. HRS Chapter 264
Contact	Morris Arakaki, Highway Division, DOT Phone: 548-7587

Agency	Environmental Quality Commission (EQC) and Office of Environmental Quality Control (State of Hawaii)
Permit	Environmental Impact Statement
Reference	Hawaii Revised Statutes, Chapter 343; Title 11, Administrative Rules, Chapter 200
Actions Requiring Permit	Projects involving:

- Use of state or county lands or the use of state or county funds
- Lands within State Conservation District
- Lands within the Special Management Use area
- Lands within any historic site as designated in either the state or national Register of Historic Places
- Lands in the Waikiki-Diamond Head area
- A amendment to the City's General Plan where such amendment would result in a designation other than agriculture, conservation, or preservation.

An EIS is required for projects in the above categories only when the responsible agency determines that the action may have a significant affect on the environment and the action is not exempt according to EQC regulations.

Process

The proposing/approving agency prepares an environmental assessment and then notifies EQC of a Negative Declaration or of the need for an EIS. The EQC publishes the EIS Preparation Notice in the EQC Bulletin (semimonthly). The public then has 30 days to request to be a consulted party during EIS preparation. After the EIS is issued, the public has an additional 30 days during which to comment in writing. The EIS must be approved by the accepting authority within 60 days after the completed EIS is filed with EQC (this period may be extended 30 days if requested by the applicant).

State and federal law encourage the coordination of state and federal environmental review.

Source

Office of Environmental Quality Control, EIS Handbook for Hawaii, October 1979. City and County of Honolulu, Permit Register, February 1987. HRS Chapter 343. Title 11 Administrative Rules, CH 200

Contact

Roy Sakamoto, Office of Environmental Quality Control
Phone: 548-6915

Agency	Public Utilities Commission (State of Hawaii)
Permit	Approval for Construction in a Residential Area
Reference	Hawaii Revised Statutes, Chapter 269
Action Requiring Permit	PUC approval is required for construction of a utility line of 46 kV or greater in a residential area.
Process	PUC approval is required prior to any commitment for construction of the project. A public hearing is required and the PUC requires 3 months from time of application to approve the project. If a General Order No. 7 approval is also required (for capital expenditure costing more than $0.5 million), the two processes can be combined in a single application.
Source	HRS Chapter 269
Contact	Public Utilities Commission, State Department of Budget and Finance Phone: 548-3990

Agency	Public Utilities Commission (State of Hawaii)
Permit	Exemption from General Order No. 6 requirements relating to conflicting lines
Reference	Public Utilities Commission Revised General Order No. 6, Section 21.7.
Action Requiring Permit	Installation of conflicting transmission or distribution lines.
Process	PUC must be notified of the proposal to construct lines that will conflict; i.e., "lines so situated with respect to each other (except at crossings) that the overturning of one line will result in contact of its poles or conductors with the poles or conductors of the second line, assuming no conductors are broken in either line; except that lines on opposite sides of a thoroughfare are not considered as conflicting if separated by a distance not less than 60 per cent of the height of the higher pole line above the ground line and in no case less than 20 feet."
Source	PUC General Order No. 6, Section 21.7
Contact	Public Utilities Commission, State Department of Budget and Finance Phone: 548-3990

Agency	Public Utilities Commission (State of Hawaii)
Permit	Public Utilities Commission (PUC) General Order No. 7 Approval
Reference	Hawaii Revised Statutes, Chapter 269; Public Utilities Commission, <u>Standards for Electric Utility Service in the State of Hawaii, General Order No. 7</u>, Section 2.3(g)(2).
Action Requiring Permit	Any capital expenditure related to plant expansion or modernization costing more than $500,000.
Process	Application must be made to PUC at least 60 days before the earlier of beginning construction or committing to the expenditure. A public hearing is required. If the PUC takes no action within 90 days, the utility may include the costs in its rate base. This application may be combined with the application for PUC approval for construction in a residential area.
Source	PUC General Order No. 7
Contact	Public Utilities Commission, State Department of Budget and Finance Phone: 548-3990

CITY/COUNTY AGENCIES

Agency	Department of Land Utilization (City and County of Honolulu)
Permit	Conditional Use Permit Type 1
Reference	Hawaii Revised Statutes Chapter 46, City and County of Honolulu Ordinance No. 86-96
Action Requiring Permit	Type B utility installations, including: 138 kV transmission substations, power generating plants, base yards, and other similar major facilities. According to Calvin Ching of the Department of Land Utilization, a Conditional Use Permit, Type 1, is also required for the construction of 138 kV lines (phone conversation of February 12, 1988). A Conditional Use Permit Type 1 is required for Type B utility installations in agricultural or urban districts.
Process	A Type 1 permit takes about 45 days to process. A public hearing is not required.
Source	City and County of Honolulu, Department of Land Utilization, Land Use Ordinance (Ordinance No. 86-96), October 22, 1986
Contact	Calvin Ching, City and County of Honolulu Department of Land Utilization Phone: 523-4299

Agency	Department of Land Utilization (City and County of Honolulu)
Permit	Shoreline Setback Variance
Reference	Hawaii Revised Statutes, Chapter 205-31, Ordinance No. 4631(76), Ordinance No. 84-90
Action Requiring Permit	A variance is required for all proposed construction within the shoreline setback area (40 feet inland from the upper reaches of the wash of waves, or 20 feet in certain circumstances) on land owned or within the jurisdiction of the state. Shore areas developed with harbor facilities are generally exempted from the definition of shoreline.
Process	The applicant is responsible for surveying the land to determine whether construction activities will take place within the shoreline setback area. The determination must then be certified by the State Land Surveyor. If project activities will take place within the setback area, a variance is required. This variance is usually combined with the SMA Use Permit (since the SMA includes the setback area). The DLU has the authority to act on shoreline setback variances only for projects exempt from the SMA Use Permit or those receiving an SMA "Minor Permit."
Source	City and County of Honolulu, Permit Register, February 1987. Shoreline Setback Rules and Regulations of the City and County of Honolulu
Contact	Bennett Mark, City and County of Honolulu, Department of Land Utilization Phone: 527-5038

Agency	Department of Land Utilization and Honolulu City Council (City and County of Honolulu)
Permit	Special Management Area Use Permit
Reference	Hawaii Revised Statutes, Chapter 205A; City Ordinance No. 84-4, Chapter 33, as amended
Action Requiring Permit	Any development within the designated Special Management Area (SMA).
Process	Development costing less than $65,000 and having no significant environmental effects (as determined by DLU) can be issued a Minor Permit. Any project costing more than $65,000 requires an application for Special Management Area Use Permit, preceded by a Negative Declaration of environmental impact filed by the DLU with the Office of Environmental Quality Control or an EIS accepted by the DLU. After the application has been accepted, a public hearing is held between 21 and 60 days. The City Council must act on the application within 60 days after the hearing. Issuance of a Special Management Area Use Permit must, by statute, precede any other permit approvals.
Source	City and County of Honolulu, Permit Register, February 1987. Chapter 33, Revised Ordinances of Honolulu, as amended
Contact	Bennett Mark, City and County of Honolulu, Department of Land Utilization Phone: 527-5038

Agency	Department of Public Works (City and County of Honolulu)
Permit	Permit for Construction Within a County Road Right-of-Way
Reference	Article 1, Chapter 20, as amended, City and County of Honolulu Revised Ordinances
Action Requiring Permit	Any construction within the right-of-way of a county road. Also known as "trenching" or "excavation" permit.
Process	Application is made to the Department of Works. Construction plans are reviewed by the Department of Public Works, Department of Transportation Services, Board of Water Supply, and utility companies.
Source	Winston Watani, Department of Public Works
Contact	Winston Watani, Department of Public Works Phone: 527-6303

Agency	Department of Transportation Services (City and County of Honolulu)
Permit	Street Usage Permit
Reference	Hawaii Revised Statutes, Chapter 286, City Ordinance No. 4650(76)
Action Requiring Permit	Any construction performed on city and county streets, highways, roads, lanes, paths, alleyways, and/or sidewalks; parking on city and county roads associated with construction; or street closure in association with construction.
Process	Application (accompanied by construction drawings) must be made to the Department at least 5 days before starting work. Permit is issued after review of traffic control plans. Applicant must notify other city services and utilities.
Source	City and County of Honolulu, Permit Register, February 1987

Appendix G
Summaries of Public and Agency Consultations

APPENDIX G

PUBLIC AND AGENCY CONSULTATION

HAWAIIAN ELECTRIC COMPANY

CH2M HILL

CONTENTS

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

FACT SHEET

Waiau-Makalapa No. 2
Transmission Line Project

FACT SHEET

Hawaiian Electric Company

February 1988

Purpose of the Project

Hawaiian Electric Company (HECO) is beginning a route selection study for a new 4-mile long 138,000 volt transmission line between its Waiau Power Plant and Makalapa Substation. The project will serve two major functions:

- Increase reliable delivery of power by preventing overloads to the existing Waiau-Makalapa No. 1 line. This will reduce the risk of major outages caused by lightning, fires, vehicular accidents, and high winds, and during periods when other lines are out of service for routine maintenance.

- Provide additional transmission capability to meet growing demands for power in the Pearl Harbor, Foster Village and Aiea areas, as well as throughout the island. HECO's transmission system must be expanded to meet forecasted future demands to ensure that power from all power generating stations can be delivered where it is needed.

Route Selection Study

As part of its regional planning approach to transmission system expansion, HECO is conducting this route selection study concurrently with its study of another new 138,000 volt transmission line between Waiau Power Plant and the Campbell Industrial Park (CIP) Substation. As in that study, HECO has retained CH2M HILL, an engineering and environmental consulting firm, to evaluate opportunities and constraints for alternative line locations within the study area (see map on the opposite side). On the basis of land use, socioeconomic, biological, cultural and earth resources studies, CH2M HILL will narrow the study area to a single corridor about one-half mile wide, and then to several alternative alignments, each about 200 feet wide. Following this analysis, HECO will select a preferred alignment.

Public Involvement

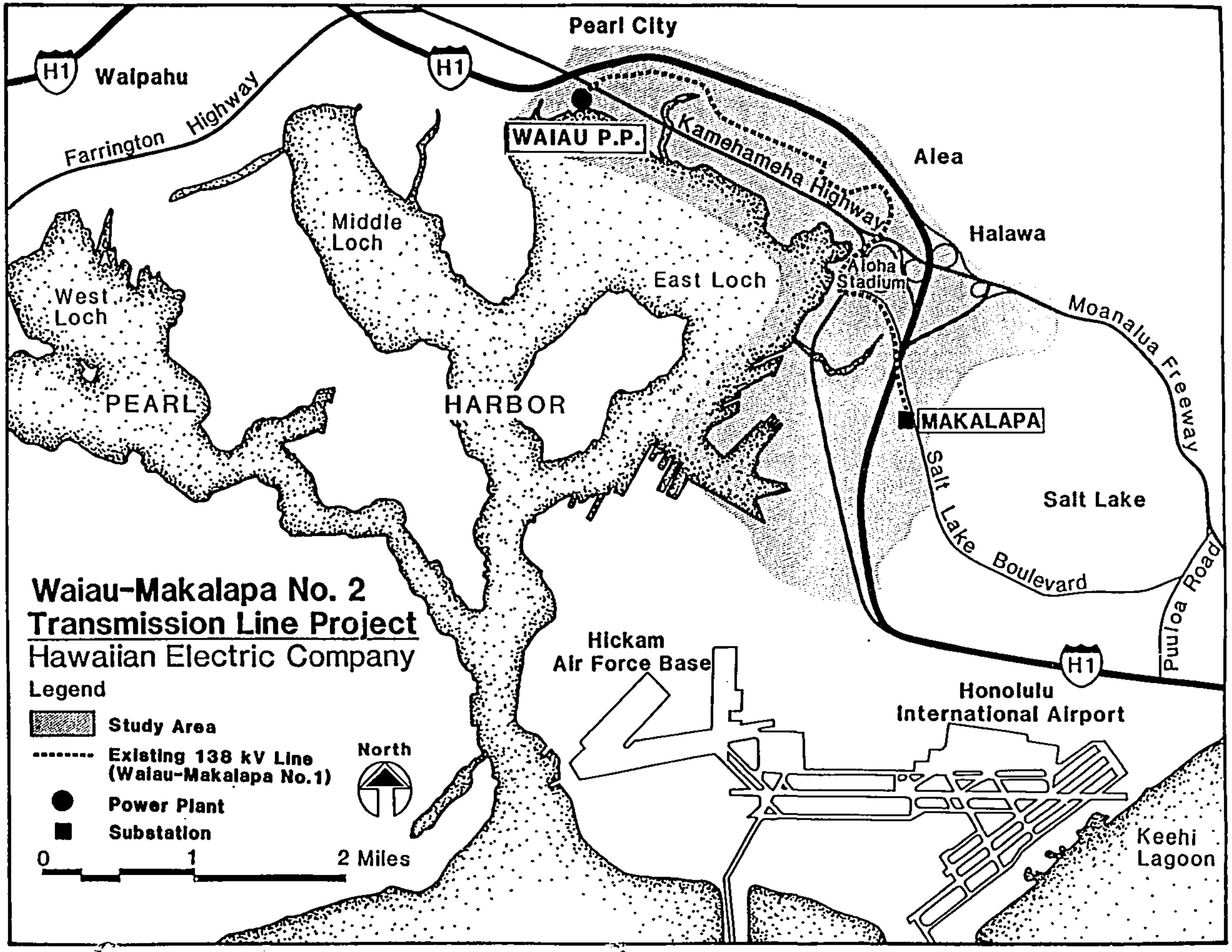
HECO will conduct a public involvement program to develop and maintain a dialogue with elected officials, government agencies and community organizations to ensure their concerns and values are considered in the screening of alternative corridors and alignments.

Community workshops to discuss alternative alignments for the Waiau-Makalapa and Waiau-CIP projects are scheduled for Spring 1988. Newsletters and media releases will provide periodic progress reports on both projects.

If you are interested in being placed on the project mailing list, please contact:

Mr. David Nagata, HECO Project Manager
Engineering Department
P. O. Box 2750
Honolulu, Hawaii 96840

Phone: 548-4472


Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company
Legend
Study Area
Existing 138 kV Line (Waiau-Makalapa No.1)
Power Plant
Substation
North
0
1
2 Miles
Pearl City
Waipahu
H1
Farrington Highway
WAIAU P.P.
Kamehameha Highway
Alea
Halawa
Aloha Stadium
Moanalua Freeway
MAKALAPA
Salt Lake
Salt Lake Boulevard
Puuloa Road
West Loch
Middle Loch
East Loch
PEARL
HARBOR
Hickam Air Force Base
Honolulu International Airport
Keehi Lagoon

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

NEIGHBORHOOD BOARD MEETING SUMMARIES

PEARL CITY

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No: P24780.A1
File No:
Document No:
Issue Date: March 21, 1988

SUBJECT: Pearl City Neighborhood Board: Development Plan and Zoning Committee

DATE: March 17, 1988 TIME: 8:00 p.m.

LOCATION: Pearl City Library, Waimano Home Road

ATTENDEES:

Development Plan and Zoning Committee Members

Al Fukushima, Chairman, Development Plan and Zoning Committee
Tom Kam
Karen Yim
Al Konishi

HECO Representatives

Fred Karimoto/HECO
Scott Shirai/HECO
Eugene Yoshimi/HECO
Herb Lee/Lee Communications
Keith Kobuke/HECO
John Everingham/CH2M HILL
Andy Linehan/CH2M HILL

Several agenda items preceded HECO's presentation. Scott Shirai then introduced the HECO team and outlined the purpose of the presentation that night: an introduction to the proposed Waiau-Makalapa No. 2 Transmission Line Project. Gene Yoshimi narrated a slide presentation on HECO's existing generation and 138 kV transmission system and the purposes for the project. Mr. Yoshimi described the HECO actions that followed the 1983 island-wide power outage. Analysis by an engineering consulting company, Stone and Webster, recommended over 90 improvements to the HECO system. HECO has acted on most of those recommendations.

Two major projects remain: constructing a new 138 kV transmission line from the CIP Substation to Waiau Power Plant, and a separate 138 kV line from Waiau Power Plant to Makalapa Substation. One 138 kV line now connects Waiau and Makalapa. The new line is needed to assure reliability (particularly when other lines are out for maintenance and during transmission system emergencies caused by hurricanes, cane fires, or plane or car accidents) and to meet growing island-wide loads. Mr. Yoshimi's slide presentation concluded with an illustration of a typical 138 kV tower on Dillingham Blvd.

John Everingham then described the route selection process that is being used for the Waiau-Makalapa project. The methodology is essentially similar to that described to the committee during HECO's presentation on the Waiau-CIP project. John Everingham described the study area, data factors studied, and the preliminary preferred corridor. He stated that goals for the routing process include avoiding residential areas and making use of existing road and transmission line corridors.

Scott Shirai moderated questions and answers.

Q: Why did HECO's loads grow above 1000 MW in 1987 as indicated in the slide show?

A: The rapid load growth in the last few years is probably due to a combination of low oil prices, overall economic growth (including the construction industry), and the fact that most conservation opportunities have already been acted upon.

Q: Will the new line be designed to accommodate the growth planned for Ewa and Central Oahu? In other words, will HECO have to come back with another line proposal after these developments are complete?

A: The project is planned to accommodate the proposed development. HECO's 20 year transmission study suggests that no new lines will be needed until well after the turn of the century, except perhaps to link Makalapa with points east.

Q: Has the alternative of using a marine cable been ruled out?

A: A marine cable would have to be routed through the Naval Reserve of Pearl Harbor. The Navy would probably be very concerned about disruption of military operations and of the U.S.S. Arizona Memorial area. In addition, the cost of marine cable would be many times greater than an overhead line.

Q: Won't constructing the new line disrupt traffic?

A: Traffic disruption is one of the factors the routing study will examine very carefully. If we build along a city street, our city permit will undoubtedly require us to work only during off-peak periods (i.e., about 9 a.m. - 2:30 p.m.). The construction activities would not require much time at any one spot, but the whole line may take about nine months.

Q: Would it be possible to add another 138 kV line to the existing Waiau-Makalapa 138 kV line towers, and reroute the 46 kV lines that are strung below the 138 kV lines on the same towers?

A: The existing Waiau-Makalapa 138 kV line does not have enough room to replace the 46 kV line with 138 kV lines (since the 138 kV lines take more vertical room than the 46 kV lines). If added on the other side of the towers from the existing 138 kV lines, the new lines would be too close to residences along much of the route. In addition, putting a second line next to the first would not satisfy the objective of separating the new line from the existing line to improve reliability.

Q: Councilman Margado talked to the committee about whether the line is needed at all. We have responded that the project objective of reducing the likelihood of blackouts seemed worthwhile. He also asked whether HECO could give something back to the community in return for requiring it to bear the burden of all the lines that run into Waiau. He suggested reduced rates for residents near the line.

A: The Public Utilities commission would not let us discriminate like that. Moreover, we all have to put up with necessary community facilities--high schools, prisons, landfills--as part of living in the community.

Q: Does HECO, like the phone company, offer discount rates to its employees?

A: HECO does provide a break to its employees (just as most businesses do), but it cannot offer different rates to customers according to where they live.

Q: HECO should consider ways to be more active in the community. When HECO wanted an outfall at Kahe, it provided $250,000 in local improvements. HECO used to be more active in the community; for example, it used to conduct cooking classes in the community.

A: HECO is thinking about ways to offer more to the community. HECO can't make any promises, but among the ideas being considered are helping to maintain Blaisdell Park, providing trees for the park, maintaining the bike path right-of-way, and helping with the anti-graffiti campaign.

Q: You should consider painting your transformers and other equipment. They look awful.

A: We will certainly see what we can do.

Q: Near Aloha Stadium, there is not much room between the existing 138 kV line and the shoreline. Will there be enough room to add another line and meet your separation criteria?

A: There appears to be about 700-900 feet between the existing line and the shore. One tower's height (80-120 feet) would provide enough separation, and there appears to be that much room. Certainly we will be looking at that spot very carefully.

Q: How about undergrounding to get through that area?

A: We will consider undergrounding there, but undergrounding a 138 kV line requires a transition station occupying about 10,000 square feet at either end of the underground section. HECO does not now have any underground 138 kV lines. The few underground lines are 46 kV lines, which do not require the elaborate oil-insulated cable, oil pumps, and transition stations required by 138 kV lines.

Q: What will be the effect of this project and the Waiau-CIP line on our rates?

A: There should be no effect on rates, particularly if loads continue to grow as rapidly as they have in the last few years.

Q: Why not overbuild the existing Waiau-Halawa lines instead of adding a new Waiau-Makalapa line?

A: Those lines (a pair of 138 kV circuits and a pair of 46 kV lines) are already double circuit lines, and thus another circuit cannot be added to them.

John Everingham concluded the meeting with an update of the Waiau-CIP project. He identified study corridors that have been eliminated and the preferred corridors that remain. In the Pearl City area, the difficulty of siting around residential areas and the location of Waiau Power Plant have meant that the two preliminary corridors will continue to be studied in the alignment study phase of the routing study.

Analysis of Public Comments
The questions of the Pearl City Neighborhood Board revealed what are likely to be major issues. Several of these issues have been touched upon in earlier public meetings, and it is likely that they will appear again. These issues merit careful consideration and the development of a strategy for response.

1) HECO's Relations with the Community
Pearl City residents live with the Waiau Power Plant and numerous 138 kV and 46 kV lines. They feel that in building two more lines in their neighborhood, HECO is taking something from the neighborhood without the neighborhood gaining anything in return. The load growth in Oahu will occur largely in other areas, yet Pearl City has to bear the burden of new lines. A second element of Pearl City's reaction is the sentiment that HECO has not done enough in recent years to show itself to be a good corporate citizen of the community.

The attitude toward HECO revealed at Pearl City was expressed most clearly by Councilman Al Morgado; however, Morgado's comments apparently reflect a latent attitude of Pearl City Neighborhood Board members. The same attitude is likely to be evident in other communities in the study area, even if Pearl City is the only neighborhood that has a power plant located within its borders.

At the March 17, 1988 meeting at HECO (the dry run for the Makalapa presentation), short and long-term responses were identified.

Short-term actions have potential to improve HECO's relations with the communities that are directly affected by the two projects. Options include:

1) Offering to help maintain Blaisdell Park and/or provide shade trees ("adopt-a-park")

2) Maintaining the bike path right-of-way

3) Support for the campaign against graffiti

4) New paint for transformers and other HECO equipment

Other actions could prove more beneficial in the long run and could help HECO establish a better foundation of community good will, which could be built upon for future projects. The longer-term strategy is not necessarily costly, but its value might be evident only after a period of months or years.

Actions that can improve HECO's relationship with the community in the long run include:

1) Encouraging HECO employees to attend their Neighborhood Board Meetings and run for Board positions. Additional tangible support might include occasional office help, e.g., xeroxing on company machines, typing, etc.

2) After HECO has become aware of community concerns through its employees, it can respond in a more timely way to local concerns. For example, if a neighborhood plans a neighborhood clean-up or anti-graffiti campaign, HECO might offer logistical or volunteer support.

3) Better targeting of HECO's corporate charitable activities to causes that have high community visibility may generate more community support.

2. <u>Traffic Disruptions During Construction</u>

At the Neighborhood Board Meetings we have attended so far, traffic problems have uniformly been a major concern. Whether the proposal under consideration was residential development, a church expansion, or highway improvements, the neighborhood has primarily been concerned with the potential to make traffic problems worse. At the March 17 presentation, we were questioned about the extent of traffic disruption while the new line is being constructed, and we can expect increasing concern about traffic as the construction date approaches.

Traffic disruption is primarily an EIS-level issue; i.e., it probably won't greatly affect the selection of alignments, but it is an issue that will have to be addressed in the EIS as a project impact. Well before the EIS stage, however, traffic may become a focus of opposition to the project. Before the next series of public meetings, HECO needs to formulate a response to questions about traffic disruption. The response should address:

1) HECO's standard construction practices in urban areas.

2) A more detailed explaination of the time required for each phase of construction. For example, erecting towers requires X hours or days per tower. Conductoring and sagging takes X days. If a lane of traffic has to be closed, typically it may be closed for X days during specified off-peak hours.

3. Undergrounding

The alternative of undergrounding the 138 kV line continues to be raised. While the cost issue is important (particularly to the P.U.C.), cost is not a very effective argument to people who are facing a transmission line in their community. HECO should emphasize the disruption to traffic during construction and repair work, the difficulty of locating faults (perhaps resulting in longer outages when outages occur) and the area occupied by transistion stations.

4. Marine Cable

The alternative of laying a marine cable also comes up frequently in public meetings. Again, cost is not the most persuasive issue to affected neighborhoods. The response to questions about marine cables should emphasize the size of the transition station and the remaining need to build overhead line segments from the shoreline to the substation. In the case of the Makalapa project, we should also explore the Navy's reaction to laying a cable through Pearl Harbor and in the close vicinity of the U.S.S. Arizona Memorial. It is very plausible that the Navy would object very strenuously on the grounds that a marine cable would disrupt Naval activities and the historic site.

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No: PDX24780.A1
File No:
Document No:
Issue Date: September 7, 1989

SUBJECT: Pearl City Neighborhood Board Presentation

DATE: Thursday, August 31, 1989 TIME: 7:00 pm

LOCATION: Pearl City Library, Waimano Home Road

ATTENDEES:

Pearl City Neighborhood Board Members

Bob Cogswell
Karen Yim
Bob Cooney
David Howton
Alan Miyamota
Thomas Kam
Albert Fukushima
Geri Bolosan
Jonathan Kaaukuu
Kenneth Dote
Toy Arre
Jerry Souza
Edwin J. Gayagas

HECO Representatives

Stan Tanno
Scott Shirai
Keith Kobuke
Mary Ellen Nordyke Grace
Nick Kashiwabara
George Okuda
David Nagata
John Everingham/CH2M HILL

Others

Al Matasumoto - Councilman Morgado's Office

Several agenda items preceded HECO's presentation.

Mary Ellen Nordyke Grace introduced the HECO team and Scott Shirai who gave a 15 minute slide presentation about the project.

The presentation consisted of a description of HECO's transmission system on Oahu and how power is delivered from the power plants over the transmission, subtransmission and distribution systems to the home and business of HECO customers.

Mr. Shirai explained that the reasons for the Waiau-Makalapa No. 2 project were 3 fold.

- To prevent overloading of the Waiau-Makalapa No. 1 line
- To insure "area" reliability (Pearl City, Foster Village, Aiea/Aliamanu)
- To insure and improve "overall" system reliability

The presentation by Mr. Shirai also included a discussion and explanation of the following:

- Actual and projected electrical loads
- The transmission routing study process
- Type of poles, using photos of existing 138kV poles in place near Pearlridge Shopping Center and in Navy Marine Golf Course
- Description of the preferred alignment using slides of alignment maps.
- What the line will look like; visual simulations from Kam Hwy at McGrew Point and Kam Hwy at Radford Drive.

Mr. Shirai also discussed the issue of electromagnetic fields (EMF) which has been raised in other meetings and the media. He stated that, the proposed Waiau-Makalapa No. 2 line would have EMF values in the range of 3-35 milligauss (mg).

He said that studies throughout the nation are underway to determine if there is or is not a link between EMF and health. He acknowledged there has been conflicting studies and much public concern regarding EMF. He mentioned that HECO is supporting the ongoing research.

Scott Shirai moderated a brief question and answer period following the presentation.

Q: What agency will approve the project?

A: The Public Utilities Commission

Q: Will copies of the final Routing Report be made available to the Neighborhood Board for review.

A: Yes, copies of the final report will be available to the Board in late October.

Q: You said you are planning to underground the 12kV line along Kam Hwy. What kind of traffic disruption do you expect from construction?

A: All construction plans will be submitted to the State Department of Transportation for approval and coordination. Construction will be conducted during off-peak traffic hours (9 am to 2:30 pm) and HECO will issue traffic advisories when construction is planned to alert motorists. Lane closure will be limited to one lane.

Q: Will the project affect the Aiea Bay jogging and bike path?

A: John Everingham of CH2M HILL reported that the location of the bike path and the proposed Aiea Bay State Recreation Area were considered in the route selection study. He said that the bike path would not be impacted by the construction of the new line.

Q: What is the earth's magnetic field?

A: 4-5 milligauss.

Q: What about the Omega Station; how much magnetic field is emitted by its operation?

A: The Omega station is a radar facility with magnetic fields which are a different wave length than transmission lines.

At this point in the Q&A Scott Shirai distributed to the Board a paper prepared by HECO which discusses some of the frequently asked questions about EMF.

Q: Is there some law, City or State, which regulates the set-back distance of poles from the edge of the roadway?

A: Yes, both the City/County and State have set-back requirements. A greater set-back is required on State Highways than City/County Roads.

Q: Is HECO participating in City/County planning for growth on Oahu?

A: HECO forecasts future loads and is in contact with developers and monitors plans for growth and new construction. These are factored into HECO's 5 year and twenty year generation and transmission forecasts.

Tom Kam, Neighborhood Board Chairman thanked HECO for the presentation and advised the Board that no resolution was required at this time. He suggested that the Board review the Routing Report and consider the project at a future board meeting.

AIEA

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No: P24780.A1
File No:
Doc. No:
Issue Date: 5/2/88

SUBJECT: Aiea Neighborhood Board #20 Meeting
DATE: APRIL 11, 1988 TIME: 7:30 P.M.
LOCATION: Halawa Gym, 99-795 Iwaiwa Street
ATTENDEES:

Neighborhood Board (Mike Miura, Chairman)

HECO Representatives

Fred Karimoto/HECO	Herb Lee/Lee Communications
Scott Shirai/HECO	Tom Packard/EDAW
Eugene Yoshimi/HECO	John Everingham/CH2M Hill
Keith Kobuke/HECO	Nancy Olmsted/CH2M Hill
David Nagata/HECO	Andy Linehan/CH2M Hill

Others Present
Arnold Morgado, City Council
Debbie Ushijima, Councilman Morgado's office
John Bickel, Office of State Representative Okamura

The project presentation followed several agenda items. Scott Shirai introduced the project team and then turned over the presentation to Keith Kobuke. Using a slide presentation, Mr. Kobuke described HECO's generation and transmission Systems and outlined the purposes of the proposed Waiau-Makalapa No. 2 Transmission Line Project:

1. Reliability: The new 138 kV transmission line will be needed by 1995 in order to maintain adequate transmission system reliability. By that date, the new line will be a crucial link in the transmission system during transmission system emergencies (such as hurricanes and cane field fires) and when other lines are not in service because of maintenance.

2. New generation: In order to meet Oahu-wide load growth, HECO will be purchasing electricity from independent power producers at Campbell Industrial Park. The new line will help transmit the power from the generation site to the major load centers in Honolulu and Central Oahu.

Mr. Kobuke described the transmission poles likely to be used in the project and showed slides of similar 138 kV poles along Dillingham Blvd., Moanalua Blvd, and in the Navy Golf Course. Before concluding, Mr. Kobuke briefly described the related Waiau-CIP 138 kV Transmission Line Project.

Next, John Everingham described the process HECO is using to select the location of the new line. The study area, between Waiau Power Plant and Makalapa Substation, was defined largely by the project purposes. Within the study area, the team researched and mapped data factors relevant to transmission line siting. Using these data maps, and keeping in mind the primary project goal of avoiding residential areas, the team selected preliminary preferred corridors.

One corridor runs between Kamehameha Highway and the shoreline from Waiau Power Plant to North Road, and then follows Radford Drive and Bougainville Drive to Makalapa Substation. Another corridor follows Salt Lake Blvd to the substation. The study team is now studying the preliminary preferred corridors in order to identify one or more preliminary preferred alignments (up to 200' wide). The preliminary preferred alignments will be presented to the public at project workshops during the second week of June.

Scott Shirai moderated a question and answer period.

Q: Why not use the same corridor as the Waiau-Makalapa #1 line?

A: There may not be room within the existing easement to add another 138 kV circuit. Moreover, reliability may be jeopardized by siting both 138 kV lines between Waiau and Makalapa within a single corridor: a transmission system emergency (such as high winds) could down both lines or carry one line onto the other.

Q: Could the new line cause radio or TV interference?

A: High voltage lines do sometimes cause radio interference, but HECO has been able to correct interference where in a few cases that has been a problem on existing lines.

Q: Could the line be built under water or on towers in the water across Pearl Harbor?

A: HECO has looked into the feasibility of a submarine cable, but several problems rule out using that alternative. Laying a cable in Pearl Harbor could interfere with Navy operations and cause concerns for safety of ships, boats, and the cable. In addition, a submarine cable would cost many times more than conventional overhead construction. HECO has not examined siting the line on towers across Pearl Harbor, but probably the potential for interference with boating and the engineering difficulty of building underwater and in wet soils would make such an alternative impractical.

Q: Does HECO provide power to the Pearl Harbor military installations? What about the power plants within the Navy grounds?

A: HECO does sell bulk power to the Navy, which distributes it on the Navy distribution system. The HECO responder was not aware of any power plants on Navy land.

Q: How much of the need for the new line is due to the military's needs for power?

A: Transmission lines are added to serve system-wide needs and are not dedicated to particular customer groups. It would be very difficult to determine to what degree the military bases are responsible for the overall need for the new line.

Q: After Hurricane Iwa, Aiea/Halewa Heights experienced a 2-3 day outage, whereas parts of Pearl City experienced no outage at all. Why was that so? Are the two areas served by different power plants?

A: The two areas are served by the same power plants. After an outage, engineers provide electricity to each area in sequence, while attempting to balance loads on the one hand and generation and transmission capability on the other. That may mean that some areas are brought on earlier than others, due to the configuration of lines that serve them.

Q: Could the new line parallel the freeway within the freeway easement?

A: Roads that are financed with Federal funds are governed by Federal regulations. Those regulations do not allow utilities to parallel freeways within the right-of-way.

Q: Why not run the line along Kamehameha Highway near McGrew Point -- along that stretch the highway is not Federal.

A: Although it is not Federal, it is still a state highway, subject to the state regulations.

Q: Are the existing lines shown on your maps above or below ground?

A: They are above ground. HECO did consider an underground line. There are several problems with an underground line. Faults are more difficult to locate and repair, so outages might be more protracted. In addition, an underground line would be four to six times more costly than an overhead line.

Q: Isn't the bike path a utility corridor?

A: Yes, the bike path near Aiea has oil/gas pipelines below ground and a 46 kV line above ground. Siting along the bike path is one option HECO will study.

Q: How dangerous is a 138 kV line?

A: A 138 kV line would be fatal if touched, of course. The public often raises the issue of electro-magnetic field (EMF) effects. HECO supports research on the subject conducted by the Electric Power Research Institute (EPRI). Recent studies conducted by the New York Power Lines Project included analysis of the incidence of cancer near household appliances and distribution and transmission lines in Seattle and Denver. The studies showed no conclusive evidence of health effects from transmission lines. HECO has employed an expert in electro-magnetic fields who measured fields near a fully loaded 69 kV line and within the home of a member of the Public Utilities Commission. He found magnetic fields of 0.438 milligauss near the 69 kV line, while within the home, a measurement near an electric shaver was 1875 milligauss and 13.125 on a bed near an electric clock radio. Of course, the typical exposure to fields as high as those measured near the electric razor is very brief, whereas homes near transmission lines may involve exposure over longer periods of time. However, the field measured near the clock radio indicates that within the home some fields experienced for extended periods may be comparable or higher than fields near transmission lines. The point is that electro-magnetic fields are a part of life today.

Q: Will an EIS be completed on the project?

A: HECO will prepare an environmental assessment (EA), and then prepare an EIS if indicated by the E.A..

Q: (Councilman Arnold Morgado): I have heard this presentation three times, and it now appears to have been toned down compared to earlier presentations. I am concerned about the EMF effects. Are fields higher or lower near an underground line compared with an overhead line?

A: People would probably be closer to an underground line than an overhead line (four feet versus thirty feet). It isn't clear how the electro-magnetic fields would compare, because there has been very little research on underground line EMF.

Q: (Councilman Morgado): How would the fields from a submarine cable compare with an overhead line?

A: No one has demonstrated any adverse effects from 138 kV lines, so trying to make such comparison is pointless.

Q: From my own experience with cables, I know that the shielding for both submarine and underground cables provides more protection from EMF than overhead lines. However, I think that the risk from EMF is less than the risk of a line falling.

Q: (Councilman Morgado): The City Council has approved projects (eg. Mililani) where lines have been put underground. Evidently, in those cases, the costs were not so high as to rule out undergrounding. What would be the cost of undergrounding compared to overhead construction?

A: It is true that in new subdivisions, distribution lines are generally put underground (and those costs are usually paid by the developer). Transmission lines are another, and far more costly, matter.

Q: (Councilman Morgado): Has HECO costed out the underground alternative? I asked for that information at an earlier meeting. Please provide me with it. Is the Waiau-CIP transmission line still a valid project?

A: Yes, that is a separate project that HECO is also undertaking.

Q: (Councilman Morgado): Why did HECO terminate its plans for the Palolo Valley project after public protest? If the Palolo project had been built, would this project be needed?

A: The Palolo line was needed primarily to meet load growth, and in the year or two after the project was proposed, the load growth failed to materialize due to economic recession. The Waiau-Makalapa project, in contrast, is required primarily for reliability.

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No: PDX24780.A1
File No.
Document No:
Issue Date: September 12, 1989

SUBJECT: Aiea Neighborhood Board Presentation

DATE: Monday, September 11, 1989 TIME: 7:39pm

LOCATION: Aiea Library, 99-143 Moanalua Road

ATTENDEES:

Aiea Neighborhood Board Members

Alfred Abe
Wilbert Ho
Gerald Sakamura
Jan Mon
Alika Thompson
Alice Takehara
Mike Miura-Chairman
Mary Booth
Hiroaki Morita
Bea Kealoha
Keith Ridely

HECO Representatives

Mary Ellen Nordyke Grace
Scott Shirai
Keith Kobuke
Fred Karimoto
Nick Kashiwabara
Garrett Osborn
David Nagata
John Everingham/CH2M HILL
Herb Lee/Lee Communications

Several agenda items preceded HECO's presentation.

Mary Ellen Nordyke Grace introduced the HECO team and Scott Shirai who gave a 15 minute slide presentation about the project.

The presentation consisted of a description of HECO's transmission system on Oahu and how power is delivered from the power plants over the transmission, subtransmission and distribution systems to the home and business of HECO customers.

Mr. Shirai explained that the reasons for the Waiau-Makalapa No. 2 project were 3 fold.

- To prevent overloading of the Waiau-Makalapa No. 1 line
- To insure "area" reliability (Pearl City, Foster Village, Aiea/Aliamanu)
- To insure and improve "overall" system reliability

The presentation by Mr. Shirai also included a discussion and explanation of the following:

- Actual and projected electrical loads
- The transmission routing study process
- Type of poles, using photos of existing 138kV poles in place near Pearlridge Shopping Center and in Navy Marine Golf Course
- Description of the preferred alignment using slides of alignment maps.
- What the line will look like; visual simulations from Kam Hwy at McGrew Point and Kam Hwy at Radford Drive.

Mr. Shirai also discussed the issue of electromagnetic fields (EMF) which has been raised in other meetings and the media. He stated that, the proposed Waiau-Makalapa No. 2 line would have EMF values in the range of 3-35 milligauss (mg).

He said that studies throughout the nation are underway to determine if there is or is not a link between EMF and health. He acknowledged there has been conflicting studies and much public concern regarding EMF. He mentioned that HECO is supporting the ongoing research.

Scott Shirai moderated a brief question and answer period following the presentation.

Q: How does the Makalapa Transmission Line tie into the transmission lines along Vineyard Blvd?

A: The Makalapa No.2 line will tie into HECO's integrated transmission system at the Makalapa substation.

Q: Will the power that is transmitted over the new line come from Waiau Powerplant or Kahe Powerplant?

A: HECO's entire generation and transmission system are tied together and work as a unit.

Q: Are you looking for Board support for the project?

A: We didn't come seeking support but would welcome it.

Q: What is the Archer Substation project and why is it underground and not the proposed Waiau-Makalapa No.2 line?

A: The PUC tariff directs HECO to place all lines above ground. The Archer project is underground because is passes through City designated design districts that require the line to be underground.

HECO is proposing to underground the 12kV lines along Kam Hwy as part of the Makalapa project. The cost for this undergrounding is an additional seven million dollars. The undergrounding is subject to PUC approval.

Q: Are you definitely going underground?

A: HECO will require PUC approval for undergrounding the 12kV line. We feel the PUC will approve the additional cost for undergrounding the 12Kv line but probably not the entire project. We agree that it would look better if the entire line were underground but the PUC tariff will not presently allow us to do it.

Q: Did you say it would cost only seven million dollars to underground the line?

A: The seven million dollars is the additional cost for undergrounding the 12kV line along Kam Hwy from the Waiau powerplant to McGrew Point.

Q: There are several houses along Kam Hwy near McGrew Point. Will the line affect radio and TV reception?

A: If properly designed it should not be a problem. If so, HECO will correct any problems caused by the transmission line.

Q: What about magnetic fields. In New York state the New York Power Authority requires the utilities to set transmission lines back at least 125 feet from houses and buildings?

A: HECO has hired a consultant Mike Silva to conduct EMF measurements. There are many studies being conducted nationwide on EMF and HECO is monitoring this research. Right now there is no conclusive evidence that magnetic fields are a health risk. The earth has a magnetic field and the appliances in your home emit electric and magnetic fields. The Congressional Office of Technology Assessment (OTA) recently published a study on EMF. HECO is considering the information in this study and the measurements by Enertech Consultants in the siting if its transmission lines.

Comment: A Board member indicated he would be willing to pay more for electricity each month to have the line placed underground where the potential hazards from EMF would be less.

Mike Miura, Neighborhood Board Chairman asked if there were further questions. There were none.

Alice Takehara then introduced a motion that the Board recommend and support HECO's Waiau-Makalapa #2 transmission line project including expenditure of an additional seven million dollars to underground the 12Kv line. The motion was seconded and put to a vote of the entire Board. The Board unanimously approved the motion to support the transmission line project including undergrounding of the 12Kv line.

Chairman Mirua thanked HECO for the presentation and moved on to other Board business.

Meeting Notes Prepared by: John M. Cunningham / CH2M Hill

ALIAMANU/
SALT LAKE/FOSTER VILLAGE

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No.: P24780.A1
File No.:
Doc. No.:
Issue Date: 5/18/88

SUBJECT: Aliamanu/Salt Lake/Foster Village Neighborhood Board #18
DATE: May 12, 1988 TIME: 7:30 p.m.
LOCATION: Aliamanu Intermediate School
ATTENDEES:

Neighborhood Board

Howard Shima (Chairman)
Peggy Cabrinha
Nathan Dement
Len Pepper
Darrell Mattos
Lerae Britain
Bob McNamara
Jake Manegdeg

HECO Representatives

Andy Chang/HECO
Fred Karimoto/HECO
Keith Kobuke/HECO
David Nagata/HECO
Scott Shirai/HECO
Stan Tanno/HECO
Eugene Yoshimi/HECO
Herb Lee/Lee Communications
Andy Linehan/CH2M HILL

The project presentation followed several agenda items. Scott Shirai introduced the project team and then turned over the presentation to Keith Kobuke. Using a slide presentation, Mr. Kobuke described HECO's generation and transmission Systems and outlined the purposes of the proposed Waiau-Makalapa No. 2 Transmission Line Project:

1. Reliability: The new 138 kV transmission line will be needed by 1995 in order to maintain adequate transmission system reliability. By that date, the new line will be a crucial link in the transmission system during transmission system emergencies (such as hurricanes and cane field fires) and when other lines are not in service because of maintenance.

2. New generation: In order to meet Oahu-wide load growth, HECO will be purchasing electricity from independent power producers at Campbell Industrial Park. The new line will help transmit the power from the generation site to the major load centers in Honolulu and Central Oahu.

Mr. Kobuke described the transmission poles likely to be used in the project and showed slides of similar 138 kV poles along Dillingham Blvd., Moanalua Blvd, and in the Navy Golf Course. Before concluding, Mr. Kobuke briefly described the related Waiau-CIP 138 kV Transmission Line Project.

Next, Andy Linehan described the process HECO is using to select the location of the new line. The study area, between Waiau Power Plant and Makalapa Substation, was defined largely by the project purposes. Within the study area, the team researched and mapped data factors relevant to transmission line siting. Using these data maps, and keeping in mind the primary project goal of avoiding residential areas, the team selected preliminary preferred corridors.

One corridor runs between Kamehameha Highway and the shoreline from Waiau Power Plant to North Road, and then follows Radford Drive and Bougainville Drive to Makalapa Substation. Another corridor follows Salt Lake Blvd to the substation. The study team is now studying the preliminary preferred corridors in order to identify one or more preliminary preferred alignments (up to 200' wide). The preliminary preferred alignments will be presented to the public at project workshops during the second week of June.

Scott Shirai moderated a question and answer period.

Q: What permits will be needed for the project?

A: The permit requirements vary according to the route selected. If HECO follows city streets, its city franchise allows the line to be built there with no additional permit requirements. Along the shoreline, however, a Special Management Area use permit would probably be needed, among other permits.

Q: Will an Environmental Impact Statement (EIS) be prepared?

A: The type of environmental documentation required depends partly on what route is selected. If we build solely along the roadway, no EIS would be needed. We expect to prepare at least an Environmental Assessment.

Q: How will the costs of this project be paid, and what will be the effect on rates?

A: HECO's loads have been growing steadily and rapidly. The costs of the project will be spread over a growing number of customers, and HECO does not intend to ask for a rate increase.

Q: Are you aware of the plan to widen Salt Lake Boulevard? Will you take into account that project, or if not, who pays for relocating the lines when the road is widened?

A: If we sited the line along Salt Lake Blvd., we would site it so it would be at the edge of the road after the widening project.

Q: Why did HECO's load grow so rapidly in 1986-87, as indicated in HECO's slides?

A: There were several causes of load growth, including the fact that conservation opportunities had largely been exhausted, the economy had recovered, oil prices had dropped, and HECO's retail rates had dropped in real terms.

Q: Did your slide of load growth show peak or average loads?

A: It showed peak loads. HECO's peak loads broke records 7 times in 1987.

Q: Can HECO condemn property?

A: Yes, but HECO has never yet had to do so.

Q: What voltage lines can be undergrounded?

A: HECO does not have any 138 kV underground transmission lines--only underground distribution lines. There are several problems with undergrounding. It is hard to locate faults on underground lines. In 1987, the largest cause of outages was underground distribution line faults. Undergrounding would also be far more expensive--approximately 4 times more costly than overhead lines. We have a responsibility to our rate payers to minimize costs. For our Waiau-CIP project we studied several options, including submarine cable and underground line. An overhead line is the only practical option, for both technical and cost reasons.

Q: Do you now use steel poles only? I've seen several wooden poles that were knocked over recently.

A: For transmission lines, HECO generally uses steel poles.

Chairman Shima closed HECO's portion of the Board meeting by stating that he hoped that with the Waiau-Makalapa Project, there would be no more outages.

HA41S.010

Meeting Summary
Waiau-Makalapa No. 2 Transmission Line Project

Project No: PDX24780.A1
File No:
Document No:
Issue Date: 15 October 1989

SUBJECT: Aliamanu/Salt Lake/Foster Village Neighborhood Board Presentation

DATE: Thursday, September 14, 1989 TIME: 7:30pm

LOCATION: Aliamanu Intermediate School

ATTENDEES:

Board Members

Rey Graulty - Chair
Peggy Cabrinha
Wendell Ching
Franklin Kam
Len Pepper
Howard Shima
Kenn Sprague

HECO Representatives

Mary Ellen Nordyke-Grace
Keith Kobuke
George Okuda
Andy Linehan/CH2M HILL
Herb Lee/Lee Communications

Others

Donna Hoshide (Councilman Morgado's office)
Alice Fujikawa (Councilmember Donna Mercado Kim)
A representative from Representative Romy Cachola's office

Several agenda items preceded HECO's presentation. Among the correspondence that the chairman noted had been received by the Board was a letter on electromagnetic fields by Representative James T. Shon. During the police report question and answer period, Mr. Kim mentioned that he had seen new graffiti on a HECO transformer near the Ice Palace at Stadium Mall.

Herb Lee introduced the HECO team. Mary Ellen Nordyke Grace then gave a 10 minute slide presentation about the project.

The presentation consisted of a description of HECO's transmission system on Oahu and how power is delivered from the power plants over the transmission, subtransmission and distribution systems to the home and business of HECO customers.

Ms. Nordyke-Grace explained that the reasons for the Waiau-Makalapa No. 2 project were 3 fold.

- To prevent overloading of the Waiau-Makalapa No. 1 line
- To insure "area" reliability (Pearl City, Foster Village, Aiea/Aliamanu)
- To insure and improve "overall" system reliability

The presentation by Ms. Nordyke-Grace also included a discussion and explanation of the following:

- Actual and projected electrical loads
- The transmission routing study process
- Type of poles, using photos of existing 138kV poles in place near Pearlridge Shopping Center and in Navy Marine Golf Course
- Description of the preferred alignment using slides of alignment maps.
- What the line will look like; visual simulations from Kam Hwy at McGrew Point and Kam Hwy at Radford Drive.

Ms. Nordyke-Grace also discussed the issue of electromagnetic fields (EMF) which has been raised in other meetings and the media.

She said that studies throughout the nation are underway to determine if there is or is not a link between EMF and health. She acknowledged there has been conflicting studies and much public concern regarding EMF. She mentioned that HECO is supporting the ongoing research.

Mary Ellen Nordyke-Grace moderated a brief question and answer period following the presentation. All questions were asked by Board members.

Q: The letter from Representative Jim Shon states that there will be magnetic fields in the range of 20-30 milligauss at Lehua Elementary School. According to the letter, those levels would be 2 to 3 times higher than the levels shown in the research to cause problems. Is that so?

A: The Waiau-Makalapa No. 2 line will not pass near Lehua School. The letter from Representative Shon must be referring to one alternative considered for a different transmission line project, the Waiau-CIP Transmission Line. This is another transmission line project recommended by the Stone and Webster report after Hurricane Iwa. As I mentioned earlier, HECO is aware of the public concerns about electro-magnetic fields. Although there is no conclusive evidence of health risks, HECO believes that prudent avoidance means that HECO should try to avoid siting transmission lines near schools and houses to the extent possible.

Q: Are there any places where the Makalapa line will pass near residential areas?

A: Although we were able to avoid most residential areas, there are a few places where the line will pass near houses. There are a few single family houses and apartments along Kam Highway between the Waiau Power plant and McGrew Point and also a few houses on the mauka side of Kam Highway near Radford Drive. We did make siting decisions to avoid two schools, Hale Keiki Kindergarten on Bougainville Drive and Pearl Harbor Elementary School.

Q: Does that include the section where you will put the line underground?

A: We are only proposing to put the 12kV lines underground along part of Kam Highway. Putting the whole 138kV line underground would be 4 to 5 times the cost.

Q: Where are you moving the Makalapa-Iwilei line?

A: Moving the Makalapa-Iwilei 138kV line so that the new line could use its alignment was considered as an alternative, but the alternative along the Malaai street was selected instead. Near Aloha Stadium, the existing Waiau-Makalapa No. 1 line will have to be moved from the makai to the mauka side of Kam Highway to accommodate the new line on the makai side.

Len Pepper: I am very appreciative that HECO has taken our concerns about electromagnetic fields seriously and has kept the line out of most residential areas.

Ms. Nordyke-Grace: Thank you for your time this evening. I will make sure that the right people at HECO are informed about the graffiti on the transformer at Stadium Mall so that it can be cleaned up.

Later in the Board meeting the Board passed the motion to support the preferred alignment for the Waiau-Makalapa No. 2 Transmission Line.

Meeting notes prepared by:

Andrew O. [illegible] /CH2M Hill 9/20/87

Waiau-Makalapa No. 2
Transmission Line Project
Hawaiian Electric Company

PUBLIC MEETING SUMMARIES

PEARL CITY

AGENDA

WAIAU-CAMPBELL INDUSTRIAL PARK TRANSMISSION LINE PROJECT
&
WAIAU-MAKALAPA NO. 2 TRANSMISSION LINE PROJECT

ALIGNMENT PUBLIC MEETING

<u>PEARL CITY</u>
Pearl City Elementary School Cafeteria
November 16, 1988

7:00 Introduction	David Nagata, HECO Project Manager
Project Meeting Format	Jim Creighton Creighton & Creighton

<u>WAIAU-CIP TRANSMISSION LINE</u>

7:05 Need for the Project	Scott Shirai, HECO Corporate Communications
7:20 Route Selection Process and Location of Preferred Alignment	John Everingham, CH2M HILL
7:35 Overhead Cost Options	Scott Shirai, HECO
7:45 Question and Answer/ Comment Period	Jim Creighton (Facilitator)
8:15 Break	

<u>WAIAU-MAKALAPA NO. 2 PROJECT</u>

8:30 Need for the Project	Scott Shirai, HECO
8:40 Location of Preferred Alignment	John Everingham, CH2M HILL
9:00 Question and Answer/ Comment Period	Jim Creighton (Facilitator)
9:45 Closing Comments	David Nagata, HECO
10:00 End of Meeting	

Thank you for participating.

MEETING SUMMARY
WAIAU-CAMPBELL INDUSTRIAL PARK TRANSMISSION LINE PROJECT &
WAIAU-MAKALAPA NO. 2 TRANSMISSION LINE PROJECT

SUBJECT: Pearl City Alignment Public Meeting

DATE: November 16, 1988

TIME: 7:00 p.m.

LOCATION: Pearl City Elementary School

ATTENDEES:

HECO:

Andy Chang/Governmental Relations
Kevin Doyle/Governmental Relations
Fred Karimoto/Engineering
Keith Kobuke/Engineering
Rick McQuain/VP-Engineering
David Nagata/Engineering
Richard Naone
Gary Okura/Distribution Department
Scott Shirai/Corporate Communications
Larry Valdez/Distribution Department
Ann Yamamoto/Rate and Regulatory Affairs Department
Steve Yoshida/Engineering/Structural
Eugene Yoshimi/Engineering

CONSULTANT TEAM:

John Everingham/CH2M HILL
Nancy Everingham Olmsted/CH2M HILL
Andy Linehan/CH2M HILL
Jim Creighton/Creighton and Creighton
Herb Lee/Lee Communications
Michael Silva/Enertech Consultants
Eric Zigas/EDAW

PUBLIC:

Rita Ebisu/Pearl City Community Church
Mary Yasuda/Pearl City Community Church
Gary Yonamine
George and Shirley Iwahiro
Mr. and Mrs. James R. Proffitt
Thomas Kam/Pearl City Neighborhood Board
Francis Hirakami
Bob Loew/KDEO Radio

AGENDA AND MEETING MATERIALS

An agenda, name tag, and newsletters for both the Waiau-CIP and Waiau-Makalapa No. 2 Transmission Line Projects were provided to each participant. The meeting agenda and sign-in sheet are attached.

PRESENTATION

David Nagata introduced the project team and informed the group that two projects would be presented: the Waiau-CIP and Waiau-Makalapa No. 2 projects. Jim Creighton asked the group's preference for how the evening's discussion would proceed, and it was agreed that the Waiau-CIP project would be presented and discussed first. The Waiau-Makalapa project would be discussed after a short break.

Scott Shirai described the purpose and need for both projects. John Everingham presented the methodology used to select the preferred alignment for the Waiau-CIP project and then described the preferred alignment in detail.

As a point of clarification, Jim Creighton asked why two alignments are needed in the Pearl City/Waipahu areas. John Everingham responded that in the Ewa area, there is enough space for a double circuit line with conductors on both sides of each pole. In the more urban areas of Pearl City and Waipahu, insufficient room is available for the right-of-way required for a double-circuit line, and so the line must split into two single circuit alignments along different routes.

Jim Creighton also asked John Everingham why the OR&L corridor was no longer being considered for the alignment, since at the public meetings in December and Neighborhood Board meetings during the spring, the OR&L right-of-way appeared to be the most promising alignment. John Everingham described the geotechnical investigation of the OR&L right-of-way. It revealed problematic soil conditions, including wet, boggy soils. These soil conditions would make it difficult to install pole foundations, and it would also be difficult or impossible for heavy construction equipment to get access across the wet soils. In addition, there are many oil and gas pipelines in the area that could be damaged by foundation construction. For these reasons, the OR&L corridor was eliminated as an alignment option.

Next, Scott Shirai brought up two issues that had been raised in previous public meetings. He discussed electric and magnetic fields (EMF) surrounding the new lines, and described research findings on the health effects of EMF. He noted that most of the research has focused on much higher voltage lines than the 138 kV lines proposed here, which have lower field strengths associated with them. None of the research panels investigating the current studies has concluded that EMF from higher voltage lines causes any health effects. HECO is, however, following the research very closely, and is participating with other utilities in funding further research.

Scott Shirai also discussed the pros and cons of undergrounding transmission and distribution lines. The foremost benefit of undergrounding lines is visual. However, undergrounding lines poses problems, as well. Locating and repairing faults is more difficult, so outages may be more prolonged. Undergrounding any type of line is far more expensive than installing an overhead line. HECO has never before installed an underground 138 kV line.

However, HECO is now breaking ground on a new 2-mile underground 138 kV transmission line from the Archer Substation to the Iwilei Substation. For this line HECO is required to put the line underground because the line is sited through three design districts. The regulations governing design districts prohibit overhead lines, and it is for that reason that HECO is forced to put the line underground, despite higher costs and maintenance drawbacks.

Scott Shirai then brought up one option for the Waiau-CIP and Waiau-Makalapa lines that HECO wants to discuss with the communities involved. HECO would be willing to underground the 12 kV distribution lines along Kam Hwy and Farrington Hwy as a way of "cleaning up" the array of overhead lines. However, undergrounding the distribution lines is expensive. The projected cost of the Waiau-CIP line is $46.6 million, if all lines are overhead. If the distribution lines are put underground, the cost will increase by an additional $13.4 million.

In addition, customers who now have overhead service connections would have to pay the cost of the new underground service connection between the new underground distribution lines and their homes or businesses. Service connections are payed by the customer, generally as part of the cost of the new building when constructed. In Mililani or other recent developments, for example, where (by recent City ordinance) all distribution lines are underground, the cost of undergrounding is included in the cost of the house. If service connections are put underground later, the customer has to pay the cost of that improvement. The cost of undergrounding service connections ranges from $2,500 to $5000, depending on the type of service and the distance involved. Scott Shirai noted that many businesses along Kam Hwy and Farrington Hwy already have underground service connections from the overhead distribution lines, and these customers would not have to pay any additional cost.

QUESTIONS AND COMMENTS

Jim Creighton facilitated questions and answers and comments.

Q: Would every other wood pole remain along Kam Hwy?

A: Yes. Along Kam Hwy, every other wood pole would remain to support the light standard (owned by the City/County), even if distribution lines are put underground.

The following questions (until the break) were asked by Bob Loew of KDEO Radio. Mike Silva of Enertech responded to the questions about EMF.

Q: At what height above the ground are EMF measurements taken?

A: We use an engineering standard, which is to take the measurements about waist height, assuming a lateral profile.

Q: Are EM fields uniform around the conductors and does the vertical versus horizontal conductor configuration make any difference?

A: Fields surrounding vertical configuration conductors can be somewhat lower than around horizontal configurations when measured from below the line because the three phases of the circuit tend to cancel each other out, to some extent, in the region near the conductors.

Q: What is the "drop-off" rate of EMF with distance from the conductors?

A: The drop-off rate is rapid with distance: about $1/2\ r^2$ near the conductors and $1/r$ further away.

Q: There are some apartment buildings on Farrington Hwy along the proposed alignment. They are certainly closer than 35 feet to the line. What would the fields be there?

A: As you move closer to the conductors in vertical elevation, field values are higher--perhaps 25 to 33% higher for a height of 10-12 feet than the field levels quoted earlier.

Q: How close are the closest apartments to the line?

A: I cannot say off-hand; we would have to check the aerial photos or go out and measure the distance.

Q: Do you agree that there are no studies showing health effects of EMF?

A: What Scott Shirai described earlier were the major literature reviews that have evaluated all available studies. These reviews (such as the New York Panel) have concluded that there is no proof of health effects from EMF. However, there have been individual studies that have claimed to show evidence both ways (in particular the Denver and Seattle studies). The major scientific panels have found these studies contradictory and inconclusive.

A couple of states have been considering new regulations to limit allowable EMF near high voltage lines. I think New York's guideline may be (for magnetic fields) 50 mG twenty-four hour rolling average allowable field at the edge of the right-of-way, with a 100 mG peak field limitation. Florida is also considering similar regulations. In both cases, the regulations were designed with much higher voltage lines in mind than the 138 kV lines proposed here. The pole design that HECO proposes is for poles that are often 5-7 feet higher than typical for 138 kV poles on the mainland. Therefore, the fields measured at ground level will be lower than most 138 kV lines on the mainland.

Q: Why not put both circuits along the H-1 freeway?

A: Federal and state highway regulations prohibit siting transmission lines along freeways within the right-of-way. There is room mauka of H-1 to place one circuit of the line along a canehaul road, overhanging that road, but there is not room for two circuits without overhanging the freeway.

Q: Why not use higher poles with a vertical configuration along the H-1 freeway; i.e., one 138 kV circuit above the other on the same side of the pole?

A: That would create a reliability problem. If one conductor fell, it would trip out the other line underneath it. Improving reliability is a primary goal of this project which would be compromised by placing one line above the other.

Q: Why not build a bigger (higher voltage) line along the H-1 freeway?

A: Again, there would be a reliability problem of relying too heavily on a single line.

At this point there was a 20 minute break. Questions resumed after the break.

Q: What action can we take now to make sure that more lines are undergrounded in the future? Does HECO have any programs to underground lines?

A: The City/County requires undergrounding of all distribution lines in new subdivisions. The costs of the underground service connections are passed on by the developer to the purchaser. Oahu has a high proportion of underground distribution lines compared to other parts of the U.S.A. because of this requirement.

Q: Are there any programs on the mainland to replace overhead with underground lines?

A: PG&E has an annual program to convert to underground distribution--but this is done primarily because undergrounding is required by community ordinances. There must always be a mechanism to decide whose service will be undergrounded and therefore who has to pay the service connection cost. Otherwise, what happens where a few customers do not want to participate? Often local governments use special improvement districts as a way to do such improvements. In all cases, only distribution lines are involved. Undergrounding transmission lines is not done because of the prohibitive cost.

Q: Why have there been so many studies of EMF if it's not a problem?

A: The field levels investigated by the studies have generally been around much higher voltage lines. The 138 kV line HECO proposes would have much lower field strengths.

Q: Do you have in-house standards for EMF field strengths?

A: We are aware of other states' standards, but the field strengths of 138 kV lines are much lower.

Q: Would HECO commit to keeping within the limits of the other states' guidelines?

A: HECO is comfortable with those limits. Often household appliances have higher fields than our lines.

Rick McQuain (HECO Vice-President): Our transmission line standards are based on the power we need to transmit. There has begun to be some thought about upgrading some lines from 138 kV to 345 kV. We would look at EMF as part of any assessment of such a project. As long as our lines are no higher than 138 kV, the maximum fields would be much lower than any mainland guidelines, so we have not needed to set specific standards.

MAKALAPA PRESENTATION

John Everingham reviewed the methodology used to select a preferred alignment for the Waiau-Makalapa No. 2 line, and discussed in detail the preferred alignment. Scott Shirai reviewed the cost of overhead construction ($13.1 million) and the additional cost of undergrounding the distribution lines along Kam Hwy from the power plant to McGrew Point (an additional $5 million). As in the Waiau-CIP project, each customer along Kam Hwy would have to pay for the underground service connection ($2,500-$5000 each).

MAKALAPA QUESTION AND ANSWERS AND COMMENT SESSION

Jim Creighton moderated questions and answers and comments.

Q: What was the reaction of the business community representatives in Waipahu to the undergrounding idea?

A: It came down to the details of how much visual benefit there would be from undergrounding the distribution lines, compared to how much each customer might have to pay. There was no clear "yes;" rather, people seemed intrigued by the idea but needed more information. There is some movement in Waipahu among the business community to clean up Farrington Highway (adding side-walks, etc.), so there is some interest in the under-grounding option in conjunction with the general clean-up efforts.

Comment (Bob Loew): I would like to see the line under-grounded through Waipahu. An even better way to spend the money would be to lobby State and Federal agencies to allow both circuits of the line to be sited along the H-1 freeway.

Q: (Tom Kam) Have you talked to the business community in Pearl City?

A: Not yet. Would a joint meeting with the Neighborhood Board and business community be valuable, or should we meet with each group individually?

A: (Tom Kam) A joint meeting would be useful.

Q: What happens to the old line (the Waiau-Makalapa No. 1 line)?

A: It remains. Both lines are needed for reliability.

Q: Can the street light standards be improved when the distribution lines are undergrounded? They are rather ugly wooden poles.

A: The street lights belong to the City. The City would have to decide whether to improve the light standards at the same time.

Q: Can you persuade the phone company to underground the phone lines at the same time?

A: Sometimes the phone company will cooperate. There would be an economy in the trenching costs. The phone company will be informed about the project and encouraged to participate.

David Nagata thanked everyone present for attending. The meeting closed at 9:35 p.m..

AIEA/FOSTER VILLAGE/ALIAMANU

AGENDA

WAIAU-MAKALAPA NO. 2 TRANSMISSION LINE PROJECT

ALIGNMENT PUBLIC MEETING

AIEA/FOSTER VILLAGE/ALIAMANU
Aliamanu Intermediate School Cafeteria
November 17, 1988

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7:00	Introduction	David Nagata, HECO Project Manager
	Project Meeting Format	Jim Creighton, Creighton & Creighton
7:05	Need for the Project	Scott Shirai, HECO Corporate Communications
7:20	Route Selection Process and Location of Preferred Alignment	John Everingham, CH2M HILL
7:35	Overhead Cost Options	Scott Shirai, HECO Corporate Communications
7:50	Question and Answer Period	Jim Creighton, Creighton & Creighton (Facilitator)
8:30	Break	
8:45	Open Comment Period	
9:45	Closing Comments	David Nagata
10:00	End of Meeting	

Thank you for participating.

MEETING SUMMARY
WAIAU-MAKALAPA NO. 2 TRANSMISSION LINE PROJECT

SUBJECT: Aiea/Foster Village/Aliamanu Alignment Public Meeting

DATE: November 17, 1988

TIME: 7:00 p.m.

LOCATION: Aliamanu Intermediate School

ATTENDEES:

HECO:

Andy Chang/Governmental Relations
Kevin Doyle/Governmental Relations
Keith Kobuke/Engineering
David Nagata/Engineering
Gary Okura/Distribution Department
Scott Shirai/Corporate Communications
Larry Valdez/Distribution Department
Steve Yoshida/Engineering/Structural
Eugene Yoshimi/Engineering

CONSULTANT TEAM:

John Everingham/CH2M HILL
Nancy Everingham Olmsted/CH2M HILL
Andy Linehan/CH2M HILL
Jim Creighton/Creighton and Creighton
Herb Lee/Lee Communications
Michael Silva/Enertech Consultants
Eric Zigas/EDAW

PUBLIC:

Alice Fujikawa/Office of City Councilwoman Donna Kim
Mike Miura/Chairman, Aiea Neighborhood Board No. 20

AGENDA AND MEETING MATERIALS

An agenda, name tag, and newsletter were provided to each participant. The meeting agenda and sign-in sheet are attached.

PRESENTATION

David Nagata introduced the project team. Because of the sparse attendance, the prepared program was replaced by an informal presentation. Scott Shirai described the project's purpose, and John Everingham presented the methodology used to select the preferred alignment and then described the preferred alignment in detail.

Scott Shirai also discussed the pros and cons of undergrounding transmission and distribution lines. The foremost benefit of undergrounding lines is visual. However, undergrounding lines poses problems, as well. Locating and repairing faults is more difficult, so outages may be more prolonged. Undergrounding any type of line is far more expensive than installing an overhead line. HECO has never before installed an underground 138 kV line.

However, HECO is now breaking ground on a new 2-mile underground 138 kV transmission line from the Archer Substation to the Iwilei Substation. For this line HECO is required to put the line underground because the line is sited through three design districts. The regulations governing design districts prohibit overhead lines, and it is for that reason that HECO is forced to put the line underground, despite higher costs and maintenance drawbacks.

Scott Shirai then brought up one option for the Waiau-Makalapa lines that HECO wants to discuss with the communities involved. HECO would be willing to underground the 12 kV distribution lines along Kam Hwy between the power plant and McGrew Point as a way of "cleaning up" the array of overhead lines. However, undergrounding the distribution lines is expensive. The projected cost of the Waiau-Makalapa line is $13.1 million, if all lines are overhead. If the distribution lines are put underground, the cost will increase an additional $5 million.

In addition, customers who now have overhead service connections would have to pay the cost of the new underground service connection between the new underground distribution lines and their homes or businesses. Service connections are payed by the customer, generally as part of the cost of the new building when constructed. In Mililani or other recent developments, for example, where (by recent City ordinance) all distribution lines are underground, the cost of undergrounding is included in the cost of the house. If service connections are put underground later, the customer has to pay the cost of that improvement. The cost of undergrounding service connections ranges from $2,500 to $5000, depending on the type of service and the distance involved. Scott Shirai noted that many businesses along Kam Hwy already have underground service connections from the overhead distribution lines, and these customers would not have to pay any additional cost.

QUESTIONS AND COMMENTS

Jim Creighton facilitated questions and answers and comments.

Q: Why are transmission lines not undergrounded?

A: Generally transmission lines are not undergrounded because cables tend to deteriorate underground and faults are more difficult to locate and repair. This means longer outages and more expense in correcting outages. In addition, construction of underground transmission lines are far more expensive than overhead lines.

Q: Did you only think of the option to underground distribution lines this week?

A: HECO had thought about it a great deal, but only reached a decision to suggest this option at the beginning of the week.

Q: Was there much interest in this option at the other public meetings?

A: In Waipahu there is a strong move to clean up the neighborhood--install sidewalks and that sort of thing--and undergrounding the distribution lines could be a start. In Pearl City turnout was low, but we did agree to meet with them again to provide more detailed information about costs.

Comment (Mike Miura): I did not want to see the line sited along the shoreline or Moanalua Road, so I think the preferred alignment you have selected is a good choice. It should be mandatory to underground the distribution lines along Kam Hwy.

Response (Scott Shirai): HECO does not have the authority to mandate this action. The PUC must approve HECO's portion of the undergrounding, and the customers would have to pay for the underground service connection. Normally, HECO has nothing to do with the service connection: the customer contracts to have the service connection installed by an electrician.

Q: Will the transmission line conflict with the proposed mass transit system?

A: The Rapid Transit System preferred alignment is down the median of Salt Lake Boulevard and Kam Highway. As long as the line is in the median, it should not conflict with the transmission line. Where there are stations, it should be possible to span the stations, since pole spans are up to 600 feet or so.

Q: How would construction be phased?

A: There are several stages in constructing the line: foundation preparation, pole erection, conductor stringing. If traffic lanes have to be coned-off for work in the road, that would only be done in off-peak traffic periods.

HECO Question (Scott Shirai): What would be the best way to get community opinion about the undergrounding option?--What group speaks for the business community?

A (Mike Miura): The Neighborhood Board would be the best mechanism. The undergrounding option looks like a good alternative, but the whole Board and the businesses involved need to be contacted.

Q: Where does HECO go from here?

A: HECO will assemble more detailed information about the undergrounding option. We can come back to the Board in January with that detailed information, and discuss the option with the Board and affected businesses and other customers.

David Nagata thanked everyone for attending, and the meeting ended at 8:45 p.m..

Waiau-Makalapa No. 2
Transmission Line Project

Hawaiian Electric Company

AGENCY CONSULTATION MEETING SUMMARIES

MEETING SUMMARY

WAIAU-CAMPBELL INDUSTRIAL PARK TRANSMISSION LINE PROJECT:

Project No: P22957.B1
File Number: 00-04
Document No: 570
Issue Date: 13 February 1988

SUBJECT: CONSOLIDATED APPLICATION PROCESS (CAP):
Waiau - CIP Transmission Line Project

DATE: 5 February 1988

TIME: 9:00 AM

LOCATION: Department of Business and Economic Development (DBED)
Office of Coastal Zone Management
9th Floor Conference Room
250 South King Street
Honolulu, Hawaii

ATTENDEES:

HAWAIIAN ELECTRIC COMPANY AND CONSULTANTS:

Herb Lee	Lee Communications
Fred Karimoto	HECO Engineering
Scott Shirai	HECO Engineering
Nancy Olmsted	CH2M HILL
David Nagata	HECO Engineering
John Everingham	CH2M HILL
Keith Kobuke	HECO Engineering
Joseph Kennedy	Archaeological Consultants
Winona Char	Char & Associates
Charlie Ane	HECO Real Estate
Eugene Yoshimi	HECO Engineering

INVITED PARTICIPANTS:

Ian Tanaka	Dept. of Transportation
David Borgeson	Dept. of Health
David Wellhouse	Federal Aviation Admin.
Douglas Tom	Coastal Zone Management
Napoleon Agroan	Dept. of Transportation Harbors Division
Derrick Lining	Dept. of Transportation Harbors Division
Bennett Mark	Dept. of Land Utilization
Gerald Lesperance	DBED, Energy Division
Thomas E. Harvey	U.S. Fish and Wildlife Service
Andy Yuen	U.S. Fish and Wildlife Service

Calvin Ching	Dept. of Land Utilization
Esther Ueda	Land Use Commission
Morris Arakaki	Dept. of Transportation
Warren Kanai	U.S. Army Corps of Engineers
John Nakagawa	DBED
Faith Miyamoto	Office of Environmental Quality

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I. CALL TO ORDER AND INTRODUCTIONS

Douglas Tom, DBED, Coastal Zone Management Division, opened the meeting by asking individuals to introduce themselves and the agency they represented. Mr. Tom stated the purpose of the meeting was to initiate the Consolidated Application Process (CAP) on the Waiau-CIP Transmission Line Project. He recommended early review of proposed projects and he had asked everyone to come so they could provide input prior to selecting a preferred corridor for the new line.

Mr. Tom indicated that additional meetings would likely be required for specifics on the preferred corridor and transmission line siting. He suggested that this meeting be conducted as informally as possible to allow everyone to provide their input. He then turned the meeting over to David Nagata, Project Manager for the Hawaiian Electric project.

II. HAWAIIAN ELECTRIC PRESENTATION

Introduction

Mr. Nagata welcomed all the agency personnel to the meeting and stated the meeting goals and objectives. Please refer to the goals and objectives, Attachment A. He briefly described the two 138 kV transmission line projects underway with HECO. Waiau-CIP Transmission Project was initiated in June 1987 and Waiau-Makalapa was begun in January 1988. He then introduced Scott Shirai who was to describe the project need, routing methodology, and the alternative corridors through a slide presentation.

Slide Presentation

Mr. Shirai described Hawaiian Electric's need for improving the power supply and distribution on Oahu. He stated the demand for electricity has far exceeded the production. Since July 10, 1987, the recorded demand has broken the production level six times. Because of this HECO is now considering building two new 138 kV transmission lines within the same corridor. He appealed to the group for input and suggestions and their comments on the decision on the line route. He briefly described the existing transmission systems and the purpose and need for the project.

He outlined the history of power outages due to natural catastrophes (i.e., hurricane and fires) and the rolling blackouts due to the explosion at Kahe Power Plant. He related that a study conducted by Stone and Webster at the request of HECO resulted in 96 recommendations to help HECO meet their needs for power reliability and safety. One of the recommendations was to establish a new electric power transmission line across Oahu to provide reliability and to meet the needs for the growing loads in the Ewa Plain.

The proposed new Waiau-Campbell Industrial Park line is the project that will meet this need and fulfill Stone and Webster's recommendations. HECO's plan is to initiate this new line by the second quarter of 1991. There are studies underway to carefully determine the route for the new 138 kV transmission line.

The routing methodology used by HECO identifies and evaluates numerous factors including the existing transmission system and project need, the economics, electric reliability. The objective of the routing study is to evaluate information from the public and technical studies and to balance the economic, environmental and public interest concerns. The route selection process involves five steps each focusing on a smaller aspect of the route:

1) Define the Project
2) Identify the study region
3) Identify Corridors and Select a Preferred Corridor(s)
4) Choose alignments within a preferred corridor
5) Select a preferred alignment (200 to 500 feet wide)

After selecting the preferred alignment, determination of the most appropriate transmission line right-of-way (less than 75 feet wide) is the final step in the siting process prior to applying for necessary permits. HECO has selected several alternative corridors which were shown on a slide (and map) and now is in the process of selecting one or more preferred corridors.

There are thirteen major steps within three phases of the routing study. Phase I has already been completed. It is the regional study where the study region boundaries are identified and an environmental data base is prepared for the region. Phase II, the Corridor Evaluation and Alignment Selection is now being conducted. The objective in this

Phase is to determine the preferred alignment. This work uses the environmental data base for the region to identify/evaluate the factors that affect transmission line siting and identifying alternative corridors. Another important aspect of Phase II is to request input from landowners, agencies, and other interested citizens for their opinions and comments to gain insight into the specific concerns and to evaluate and select a preferred corridor.

After evaluating the preferred corridor and determining the major opportunities and constraints for siting, alternative alignments are selected within it for further examination. This is the point where public workshops are held again to talk more specifically about the route selection. The process is then documented in a routing study as part of the background for the final aspect of the work, the preparation of an environmental assessment of impact statement.

The work was initiated in June 1987; the entire study will take approximately one year. The first public meetings took place in December 1987. The public will be kept informed through a series of newsletters and through the Consumer Lines Mailer in the HECO monthly billing statements. Mr. Shirai addressed some of the community concerns that were revealed in the public meetings held throughout November and December. The meeting was then turned back to David Nagata.

III. <u>QUESTIONS/DISCUSSION</u>

Mr. Nagata introduced John Everingham, project manager of CH2M HILL, who reiterated the goals and objectives of the meeting and presented each person with a list of questions that related to the objectives (see Attachment B). He requested that each person express any concerns or questions they may have regarding the projects.

A summary of the principal remarks made is listed by each agency below:

- <u>Public Utilities Commission (State)</u>

Mr. Tom asked if this project has been brought before the Public Utilities Commission (PUC). David Nagata said that PUC would approve the project, but they are not involved as yet. If the line was routed (46 kV or greater) through a residential area, a public hearing would be required prior to approval by the PUC. Mr. Tom then called on the individuals one at a time to voice their concerns.

- Land Use Commission (State)

Esther Ueda stated that LUC had no concerns about the project. There would be no action that would need to be taken by LUC unless a land use district designation was to be amended and this was not the case with Waiau-CIP.

- Department of Land Utilization (City/Council)

Calvin Ching noted a Conditional Use Permit would be required for any selected corridor. This project could also require a Special Use Permit for Type B Utility Construction (under the Development Plan for the City and County in any zoning district). This permit process has a 45 day review.

Bennett Mark addressed the Shoreline (Special) Management Area (SMA) policies and permits. This is the first permit that would need to be obtained following draft review and approval of the EA or EIS. The corridors that would require an SMA Use Permit are W-4 and P-2. Even though there is an existing 46 kV line across these corridors, the construction of a new line would require an SMA Use permit. HECO should followup with the SMA office to discuss the permit requirements on an overbuild of the existing 46 kV lines.

The issues that are reviewed most closely in the SMA process are shoreline views (visual resources), archaeological resources, and drainage. The "Coastal View Study" has been prepared by the City/County and should be consulted during the routing study. (Note: This study has already been consulted and recognized shoreline views are being evaluated in the Phase I effort).

The SMA Use Permit is initiated after environmental documentation has been completed in either an EA or EIS. The SMA Use Permit process takes 21 to 60 days for DLU staff review after submittal of the application. Then, the City Council reviews it for an additional 60 days and they issue the permit. Total processing time is 80 to 120 days. In some cases for highly controversial projects, an additional City Council review period is required and the council may opt to hold public hearings on the project.

- Coastal Zone Management (State)

CZM policies apply to all construction within the coastal zone. CZM review would be necessary along with the City Council.

- U.S. Fish and Wildlife Service (Federal)

Andy Yuen spoke for the USFWS. Their principal mandate is to protect the wildlife resources in the project area. He stated that the "Service" recommends corridor segments E-B, P-2, and W-4 be avoided if possible because they contain valuable wildlife refuges where intensive waterbird management is occurring to help enhance the existing bird population of Oahu. Other concerns were the possibility of bird strike with the the new line because of poor visibility during storms, night flight or fog.

- U.S. Army Corps of Engineers (Federal)

The issues that would trigger involvement with the Corps include:

- any dredge or fill actions within the waters of the U.S. including construction within wetlands and streams: Corps Section 404 permit required
- crossing of navigable waters (these are waters that have tidal influence).

The project as proposed at this time does not appear to trigger the NEPA process.

- Department of Transportation (State)

Highway Division

Morris Arakaki recommended avoiding crossings or paralleling the H-1 freeway. DOT recommends against any work within the highway right-of-ways and they have Administrative Rules that state this policy. He presented the Administrative Rules of DOT.

Harbors Division

The energy corridor is a possibility for siting the transmission line. The land easements have been acquired by DOT; the corridor is 30 feet wide and there are two users now that have pipelines in 10 feet of the energy corridor. The remaining 20 feet are available for other users. Derrick Lining, Property Manager for Harbors Division, presented Chapter 277 of the HRS that outlines the policy for the energy corridors (Attachment C).

A Shorewaters and Shoreline Permit would be required if construction takes place within the shoreline waters. This permit process would only be invoked if the Conservation District Use Application (CDUA) process is not agreed to by DOT. The DLNR is the principal authority on the CDUA.

- <u>Department of Economics and Business Development (State)</u>

DEBD would only become involved in the review process if Federal agencies were also involved. The Federal Consistency Review process is a requirement with DBED when federal permitting agencies are involved in a project.

- <u>Federal Aviation Administration (Federal)</u>

HECO would need to comply with the FAA regulations with "Objects Affecting Navigable Airspace" only if the towers were placed within the air interference zone. The exclusion area for air interference zones was accurately mapped prior to selecting the alternative corridors. A routine application of "Construction or Alteration of Navigable Airspace" and a review of the project by FAA pursuant to Part 77 "Objects Affecting Navigable Airspace" would be required.

- <u>Department of Health (State)</u>

Since the studies on the health effects of high voltage transmission lines are inconclusive, DOH concerns focus on avoiding schools, nursery schools and playgrounds. DOH role would primarily be review of the EIS.

- <u>Department of General Planning (City/County)</u>

The question arose whether the transmission line project would have to be included in the Public Facilities Map for the DGP Development Plan. This is a long process that would have to be initiated soon if there is a requirement for transmission lines to be on the Public Facilities Map. We should contact Lon Polk for the DGP requirements.

- <u>Department of Land and Natural Resources (State)</u>

Although there were no representatives from DLNR, Mr. Tom mentioned permits would be required under the following circumstances. If the project involved (crossed):

Factor	Permits
Conservation District Lands	Conservation District Use Application (CDUA) process
Historic sites or Districts	Historic Preservation Act compliance
Lands owned by the State	State Lands Use Permit

The contacts for the various departments within DLNR are:

State Lands Permit:	Mike Shimokokuru, Land Management
Historic Preservation Issues:	Don Hibbard, Historic Sites Section
CDUA Permit:	Robin Evans, Conservation
Wildlife Issues:	Ron Walker, Division Chief of Forestry and Wildlife

ATTACHMENT A

WAIAU-CIP and WAIAU-MAKALAPA TRANSMISSION PROJECTS

AGENCY MEETING OBJECTIVES

FEBRUARY 5, 1988

1) Brief agencies on the purpose and need for the Waiau-CIP and Waiau-Makalapa projects.

2) Present the corridor alternatives and discuss the factors considered in identifying them, i.e., constraints and opportunities.

3) Identify specific agency issues and concerns

   -compatibility or conflict with jurisdiction/statute

   -information or policies which could influence corridor acceptability

4) Identify criteria or guidelines which agencies feel are important to consider in evaluating and selecting preferred corridors. What criteria or factors are most important.

5) Discuss agency jurisdiction and possible permits. Discuss permit process if time permits or discussion is brief.

6) Discuss concept of "joint-use" of existing transportation, utility and energy corridors as a means of avoiding conflicts with existing and proposed uses. (Scarcity of vacant land in urbanizing area.)

7) Discuss corridor preferences and identify possible means for minimizing and resolving siting conflicts - land use jurisdiction & policy.

8) Identify contacts person(s) for follow-up discussion and additional data collection in Phase II Alignment Identification.

HNB1.082

ATTACHMENT B

WAIAU - CIP TRANSMISSION PROJECT
AND
WAIAU - MAKALAPA NO. 2 TRANSMISSION PROJECT

QUESTIONS TO AGENCIES

CAP - Agency Meeting
February 5, 1988

1. Based on your knowledge of the area and transmission lines, what from your agencies point of view are the issues we should be aware of in our siting study? Are they major or minor issues?

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2. Identify the criteria or guidelines which your agency feels are important to consider in evaluating and selecting a preferred corridor? What factors or criteria are most important?

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3. What policies or plans of your agency could influence the siting of the transmission lines?

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4. What permits may be required? Can we obtain copies of these permit requirements or application forms?

____
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HNB1.083.1

5. You will note that our Proposed Projects Environmental Data Maps depicts primarily major residential/commercial developments in the study region. Are you aware of any other recently approved or potential projects in or near the corridors not shown on the Proposed Projects Maps?

6. Are you aware of other constraints (e.g.. biological, geological, etc.) in or near the corridors that should be considered in the siting studies?

7. What is your opinion of siting the transmission line in or near established transportation, utility or energy corridors?

8. Do you have a preference for a corridor? Are there other alternative corridors that are not shown on the map which should be considered?

9. Do you have suggestions for minimizing or resolving issues of concern to your agency?

10. Who will be your agency's primary contact for questions and follow-up? Who else either within your agency or elsewhere should we talk to regarding this planning effort?

MEETING SUMMARY

WAIAU-CAMPBELL INDUSTRIAL PARK TRANSMISSION LINE PROJECT
WAIAU-MAKALAPA TRANSMISSION LINE PROJECT

SUBJECT: CONSOLIDATED APPLICATION PROCESS (CAP) MEETING #2
PREFERRED ALIGNMENTS

DATE: 29 November 1988

TIME: 9:00 AM

LOCATION: Department of Business and Economic Development
9th Floor Conference Room
250 S. King Street

ATTENDEES:

HECO and CH2M HILL Consultants:

Brenner Munger	HECO Engineering
David Nagata	HECO Engineering
Scott Shirai	HECO Corporate Communications
Keith Kobuke	HECO Engineering
John Everingham	CH2M HILL
Nancy Olmsted	CH2M HILL

AGENCY REPRESENTATIVES:

Doug Tom	CZM Director
Fred Shinsato	State Dept. of Transportation - Highways Division
Morris Arakaki	State Dept. of Transportation - Highways Division
Emil Barroga, Jr.	State Dept. of Transportation - Harbors Division
Thomas Fujikawa	State Dept. of Transportation - Harbors Division
Derrick Lining	State Dept. of Transportation - Harbors Division
Maurice Kaya	DBED, Energy Division
Gerald O. Lesperance	DBED, Energy Division
Dean Uchida	DLNR - Conservation
Joyce Bath	DLNR - Historic Sites
Roger Evans	DLNR - Land Division
George Matsumoto	DLNR - Water Division
Ray Young	State Land Use Commission
Kelvin Sunada	State Dept. of Health
Stan Arakaki	U.S. Army Corps of Engineers
John Nakagawa	Office of State Planning/CZM
Bruce Swartz	Office of Environmental Quality Control
Marvin Char	City/County Dept. of Transportation Services

I. CALL TO ORDER AND INTRODUCTIONS

Mr. Doug Tom, DBED, Coastal Zone Management Division, opened the meeting by welcoming the attendees and briefly reviewing the activities that have occurred with the projects since the first CAP meeting, February 5, 1988. He said that a preferred alignment had been chosen and that the purpose of this meeting was to identify permits that would be required. He then asked individuals to introduce themselves and the agency they represented.

He suggested that this meeting be conducted as informally as possible to allow everyone to provide their input. He then turned the meeting over to David Nagata, Project Manager for HECO.

II. HAWAIIAN ELECTRIC PRESENTATION

Mr. Nagata welcomed the agency personnel to the meeting, thanked them for coming, and stated that a preferred alignment had been chosen and this meeting should focus on the permits required to construct the line in the preferred alignment.

He then introduced Scott Shirai who was to describe the need for both the Waiau-CIP and Waiau-Makalapa projects.

Purpose and Need for Projects

Mr. Shirai described Hawaiian Electric's need for improving the power supply and distribution on Oahu. He briefly described the existing transmission systems and the purpose and need for the project. He stated the demand for electricity has far exceeded production in recent months. The purposes of the project are to improve system reliability, to provide power for the growing loads on Oahu, and to export power from the AES-BP independent power producer in Campbell Industrial Park (generation that would be in service by 1991).

Routing Selection Process

Mr. Shirai then introduced John Everingham from CH2M HILL to discuss the routing methodology, the schedule of the planning studies, and the preferred alignment. Mr. Everingham stated he would discuss the Waiau-CIP project first and then the Waiau-Makalapa project separately.

The routing methodology used by HECO identifies and evaluates numerous factors including the existing transmission system and project need, the economics of the project, and electric reliability. The objective of the routing study is to evaluate information from the public and technical studies and to balance the economic, environmental and public interest concerns. The route selection process involves five focusing steps to clearly define the new transmission line route:

1) Define the Project
2) Identify the study region
3) Identify Corridors and Select a Preferred Corridor(s)
4) Choose alternative alignments within a preferred corridor
5) Select a preferred alignment

After selecting the preferred alignment, determination of the most appropriate transmission line right-of-way is the final step in the siting process prior to applying for necessary permits. HECO has selected a preferred alignment(s) that is shown on the maps and aerial photos in the meeting room. The slide presentation illustrated the preferred alignment through on-site location photos.

<u>Preferred Alignment for Waiau-CIP</u>

Mr. Everingham then presented a series of slides depicting the preferred alignment(s) through the Ewa Plain, Waipahu, and Pearl City and discussed the configuration of the line as it changed from a double circuit single line of poles along Renton and Mango Tree roads to two single circuit lines that pass through Waipahu and Pearl City. Through Waipahu, one single circuit line would run parallel to Farrington Hwy and the other would run up Kunia Road to the H-1 freeway then along the mauka side of H-1 to the Pearl City.

The single circuit lines would then run through Pearl City, one mauka of the Waiawa Interchange and one makai of the interchange to continue on opposite sides of the Kam Hwy to Lehua Avenue. At Lehua Avenue, one single circuit would turn makai to the bike path and then follow the existing 46 kV alignment into the Waiau Power Plant and substation. The other circuit would follow Kam Hwy directly into the power plant.

<u>Preferred Alignment for Waiau-Makalapa</u>

Mr. Everingham's presentation then focused on the Waiau-Makalapa Transmission Line Project. He described the methodology, the configuration, and the preferred alignment. The single circuit line would follow the mauka side of Kam Hwy from the Waiau Power Plant to Radford Drive then turn left along Radford and Bougainville Drive into the Makalapa Substation.

This alignment would require two existing 138 kV lines to be relocated. The segment near the Aloha Stadium would require that the Makalapa No. 1 line be moved closer to the sound wall at Aloha Stadium and the new Makalapa No. 2 line be placed on the existing alignment of the Makalapa No. 1 closer to the shoreline. The last portion of the line would require building the new line in the same alignment as the Makalapa-Iwilei 138 kV line; therefore, to maintain separation criteria, the Makalapa-Iwilei line would have to be relocated to a route that now contains a 46 kV line makai of the Navy Exchange and Commissary.

<u>Overhead vs. Underground Technology</u>

Mr. Shirai discussed overhead vs. underground transmission lines. He said that underground lines would be more costly, have greater maintenance problems, and possibly longer outages during repairs. Therefore, HECO does not consider undergrounding transmission lines (46 kV or higher voltage) a viable option except in certain circumstances such as where a special design district has been established which dictates that all lines be underground (i.e., buried).

Mr. Shirai then discussed the option of undergrounding just the 12 kV distribution lines in order to improve the visual appearance through public areas. HECO is willing to include this in the design of the Waiau-CIP project if the public desires it and is willing to pay the necessary connection fees. The cost of these connections are not included in the PUC's tariff for the utility.

III. QUESTIONS/DISCUSSION

Mr. Doug Tom moderated the discussion period. A summary of the principal remarks made by each agency is listed below:

<u>Department of Transportation Services (City/County)</u>

Mr. Marvin Char said that for the most part there is no apparent conflict with the proposed transmission line and the City's Rapid Transit System (RTS) plans. However, there are two possible areas of concern. One, would be the Transit Station just Diamond Head of Waimano Home Road in the CIP project and the other would be the crossover on Kam Hwy near Radford Drive in the Makalapa Project. The proposed rapid transit system track and cars will need about 75 feet clearance along most of the route.

Question (DTS): Will there be a conflict with the RTS project going underneath the new line?

A: We have been consulting with Jim Ball, DTS Rapid Transit System Project Manager, and others in the group, and we will continue to do so. There seems to be no problem with the two projects since they are sited in different locations. Any potential conflicts can be accommodated by increasing the span lengths between poles or increasing the height of the poles, where necessary.

Question (Everingham): When is construction of the RTS project due to start?

A: Optimistically, early 1990.

Comment (Everingham): It would be a good idea for a HECO engineer to start talking with a RTS engineer on any specific design problems.

Department of Health (State)

Mr. Kelvin Sunada asked if we had investigated the electromagnetic field (EMF) strengths at the sides of the right-of-way along the preferred alignment. DOH would like data on the potential EMF prior to reviewing the project in order to make a thorough review of the project effects on public health. HECO should contact Mr. David Borgeson, Environmental Epidemiologist from DOH and provide him with a record of the findings on the EMF modeling and analysis.

Then, Mr. Doug Tom asked if there were any other questions regarding the project or design. Since there were none, he asked that the discussion move to identifying any permits required by either project and determining the sequencing of the permits. He also asked the group to indicate if a public hearing would be involved with the permit approval and, if more than one was necessary, whether there was a possibility of a joint public hearing. He opened by discussing the Department of Land Utilization's involvement.

Department of Land Utilization (City/County)

Mr. Tom addressed the Special Management Area (SMA) Use Permit since no one from DLU was present. The SMA Use Permit is the first permit that would need to be obtained following draft review and approval of the EA or EIS. It is fairly certain that an SMA Use Permit would be required on both projects given the preferred alignment(s) pass through or near the boundary of the SMA. Since this if the first permit, the DLU would be designated the lead review agency, they would have the discretion of requiring an EIS, and they would be the accepting authority. The DLU also has responsibility for zoning and setback requirements; therefore, they should be consulted on the requirements for a Conditional Use Permit, and other possible zoning restrictions.

The issues that are reviewed most closely in the SMA process are shoreline views (visual resources), archaeological resources, and drainage. The "Coastal View Study" has been prepared by the City/County and Mr. Tom recommended this study be consulted during the preparation of the routing study. (Note: This study has already been consulted and a discussion of shoreline views are included in the Visual Resource Evaluations of both projects).

The SMA Use Permit is initiated after environmental documentation has been completed in either an EA or EIS. The SMA Use Permit process takes 21 to 60 days for DLU staff review after submittal of the application. Then, the City Council reviews it for an additional 60 days and they issue the permit. Total processing time is 80 to 120 days. In some cases, for highly controversial projects, an additional City Council review period is required and the Council may ask to hold public hearings on the project.

Department of General Planning (City/County)

The DGP submitted a letter indicating they had no objections to the project as it has been proposed. There would be no requirement for a General Plan Amendment. The letter received from DGP is included as Attachment A (to these minutes).

Office of Environmental Quality (State)

Mr. Bruce Swartz stated that usually the agency that grants the first permit (or the most approvals) becomes the lead agency in the EA review. If the EA is submitted with the routing study this will certainly expedite the review process and will help DLU determine the necessity for an EIS.

Land Use Commission (State)

Mr. Ray Young stated "No LUC action is required for either project." There would be no action that would need to be taken by LUC unless a land use district designation was to be amended and this is not the case with either Waiau-CIP or Waiau-Makalapa projects.

Department of Land and Natural Resources (State)

The representatives from DLNR indicated that they were not aware of any permits that would be required unless there was a possibility of crossing conservation lands. The avoidance of conservation lands was a primary route selection criteria; therefore, it is unlikely that the Conservation District Use Application would have to be filed.

With regard to Historic and Cultural Resources, Dr. Joyce Bath indicated that both projects would require State Historic Preservation Review since the OR&L (an historic site) and the Pearl Harbor (a National Landmark) are so close to the alignment. She also advised that HECO work with the Navy regarding Pearl Harbor National Landmark (Note: this has been done). As far as the archaeological subsurface features in the project area, she recommended having an archaeologists in the field prior to the construction contractors to survey the proposed excavation sites for the pole foundations. HECO should follow the Historic Site Section's recommendations during their review of the project routing study.

<u>DBED</u> - <u>Energy Division</u>

Jerry Lesperance mentioned that the PUC would be involved in the process through the requirement for a public hearing in accordance with their regulations. HRS Chapter 269, Section 27.5 states that a public hearing is required for development of a transmission line 46 kV or higher voltage that would be sited through a residential area.

HECO indicated that the PUC's hearing and approval process is well known to them.

<u>Department of Transportation (State)</u> - <u>Highways Division</u>

Mr. Shinsato said a permit for construction within a State highway right-of-way would be required. There are potential areas of concern at both the Halawa (Makalapa project) and Waiawa interchange (CIP Project) crossings.

DOT recommends against any work within the highway right-of-ways and they have Administrative Rules that state this policy. He suggested that HECO meet with DOT privately to discuss the safety, clearance requirements, highway lighting, placement of curbs, and highway crossings (especially the Waiawa interchange).

The Encroachment Committee (Highways Division) will have to approve the project through an administrative review. HECO would be advised to submit plans as early as possible to allow plenty of time for the DOT review and specific requirements.

<u>Department of Transportation (State)</u> - <u>Harbors Division</u>

DOT asked if HECO had received their letter (enclosed as Attachment B). Mr. Lining said there are two places where the line may cross or parallel the energy corridor: Farrington Hwy and Lehua Avenue. The Harbors Division would like detailed drawings of the proposed route to determine if and how the energy corridor would be affected.

Their approval process is an administrative review by the Energy Corridor Committee with specific review/approval by HIRI and GASCO (i.e., the current tenants of the energy corridor). The Committee needs to be assured that any intrusion into the corridor would be limited to only one (5-foot wide) slot on the makai side and that the cathodic protection of the existing pipelines would not be impaired by electromagnetic interference.

HECO should submit plans showing line configuration, pole locations, and foundation specifications in order for the DOT Harbors Division to adequately review the project. Then, Harbors Division will provide their recommendations on the project construction.

Department of Health (State)

Mr. Kelvin Sunada said DOH requires no permits except a routine construction noise permit to be obtained by the contractor prior to commencing construction activities within areas with sensitive receptors (i.e., residential, commercial, and industrial). This permit requires very little approval time.

A Water Quality Certification is required from DOH only if there is to be work within the wetlands or streams. It is unlikely this certificate would be necessary on either project.

U.S. Army Corps of Engineers (Federal)

Mr. Stan Arakaki said the Corps may be involved if there is construction within a wetland or if there is a stream crossing where the streambed would be affected. The project as proposed at this time, does not appear to require these permits and the Corps representative suggested that the EA and Routing Report would suffice for their review.

Coastal Zone Management-Federal Consistency Review (Federal)

This review would be necessary only if a federal permit is required. This does not seem to be the case in either of the projects. The issues that trigger Federal Consistency Review are also under the Corps of Engineers jurisdiction (i.e., impact to wetlands, wet soils, stream crossings). CZM also reviews for impacts to visual quality; CZM would probably review the project for this element along with the City/County, Department of Land Utilization.

DBED-CZM would only become involved in the review process if Federal agencies were also involved. The Federal Consistency review process is a requirement with DBED when federal permitting agencies are involved in a project.

Federal Aviation Administration (Federal)

The FAA representative, Mr. Henry Sumida, had called to report that he could not attend and that they had no concerns about the air interference zone.

IV. SUMMARY

1. The SMA Use Permit would be the key requirement in both projects. The approval process involves an application, a public hearing, and approval by the City Council.

2. An EA would be required and perhaps an EIS would be called for by DLU that comprehensively examines all the concerns expressed by the other agencies as well as DLU. Mr. Tom recommends a comprehensive document to prevent costly delays in supplemental environmental documentation.

3. Concerns expressed by the DTS, DOT-Highways, and DOT-Harbors regarding the project can be resolved through careful design engineering. HECO should meet with these agencies to work out the design solutions at their earliest opportunity.

4. It is recommended to attempt to avoid work in wetlands and the necessity of a Section 404, Corps permit. This is turn would avoid both CZM Federal Consistency Review and DOH water quality certification.

V. FOLLOW UP

The DTS would be interested in a joint meeting with DOT to discuss the design solutions to possible conflicts with the Rapid Transit System plans, highway crossings specifications, and safety requirements.

DOT-Highways will contact HECO (and CH2M HILL) to discuss the possibility of a meeting (i.e., time, location, data required prior to meeting, etc).

HECO to contact Mr. David Borgeson, Environmental Epidemiologist, with EMF modeling results issue on both projects. It was decided that HECO should arrange for him to receive the EMF Technical Reports for both the Waiau-CIP and Waiau-Makalapa projects.

HECO will contact Bennett Mark (Tel. 523-4077) of the DLU to set up a meeting to discuss the SMA Use and City/County zoning approvals.

The meeting was adjourned at 10:25 A.M.